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DEFORMITIES

A TREATISE ON ORTHOPÆDIC SURGERY

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A TREATISE ON ORTHOPÆDIC SURGERY

INTENDED FOR

PRACTITIONERS AND ADVANCED STUDENTS

BY

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ILLUSTRATED WITH 15 PLATES AND 302 FIGURES, OF WHICH 200 ARE ORIGINAL AND BY NOTES OF 100 CASES

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TO MANY FRIENDS

AMONGST

THE PAST AND PRESENT STUDENTS

OF

GUY'S HOSPITAL

THIS VOLUME IS INSCRIBED

BY

THE AUTHOR

PREFACE

This volume is the outcome of several years' work at the National Orthopædic Hospital, the Evelina Hospital for Sick Children, and for a shorter time in the Orthopædic Department at the Westminster Hospital. Almost all the cases quoted are from my note-books, and 200 of the illustrations have been drawn from my patients specially for this work. The observations on the "Repair of Tendons," a subject so ably handled by Mr. Adams several years ago, have been repeated by me from the standpoint of the wider pathological horizon of the present day. It has been my endeavour to make myself acquainted, by direct observation, with the methods of treatment practised in Orthopædic Clinics abroad as well as at home, so that most of the details have been personally verified.

The object, however, of this treatise is not only a record of one's own work, but also to give a succinct account of our knowledge on the subject of "Deformities." I have not, therefore, hesitated to avail myself of the writings of Bradford and Lovett, published in America; of Rédard in France; of Hoffa in Germany; of Adams, Reeves, Walsham and Hughes in this country. Above all, I cannot omit to express my sense of indebtedness to the many admirable writers who have recorded their experiences in the *Transactions of the American Orthopedic Association.*

Some of the material has from time to time appeared in the pages of the *Hospital*, and I have to acknowledge the permission of the editor of that journal to reproduce it here.

In the matter of Plates and Figures, my best thanks are due to Mrs. E. Davis and Mr. Prendergast Parker, for the care with which they have made the drawings; to Mr. F. Gustav Ernst, for permission to make use of many of the illustrations in his work on Orthopædic Apparatus; and to my publishers, Messrs. Macmillan, for the liberality with which they have met my wishes for a fully illustrated volume.

To Mr. Vincent Moxey and to Mr. W. Spencer Payne I am grateful for valuable suggestions and assistance in seeing the work through the press.

The practice of Orthopædic Surgery in England does not include all phases of diseases of the bones and joints, such as tubercular ostitis and arthritis of the hip and knee, on what grounds it is difficult to understand; nor in such a work as this would it be customary to write on many congenital deformities, such as cleft palate and hare-lip, which are within the domain of Plastic Surgery.

That this volume may be a reliable guide to medical men in the treatment of deformities, and to advanced students in the understanding of a somewhat difficult branch of surgery, is the wish of

THE AUTHOR.

25 Weymouth Street, Portland Place, W.
June 1896.

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CHAPTER I

CARIES OF THE SPINE OR ANGULAR DEFORMITY

Definition—Etiology, Age, Sex, Tubercular Diathesis, Heredity—Causation—Pathological Anatomy—Natural Methods of Cure—Results of Spinal Caries, Deformity, its Causation, Co-existence with Lateral Deviation, Causes of Increase in Amount of Deformity—Abscess, its Frequency, Direction taken by Pus, Contents, Future Course—Compression Paraplegia, its Causation, Frequency, Pathological Anatomy, Symptoms, Prognosis and Diagnosis.

Synonyms.—English, *Angular Curvature* (an incorrect expression, and a contradiction in terms), *Pott's Disease, Kyphosis, Spondylitis;* German, *Die Pott'sche Kyphose, Spitzbückel,* or *Winckelförmige Knickung der Wirbelsäule;* French, *Cyphose* or *Mal de Pott.*

Definition.—A morbid process occurring in the vertebræ, frequently accompanied by destruction of bone and resulting in deformity.

Camper and Sévérin directed their attention to this disease; but to Percival Pott, Surgeon to St. Bartholomew's Hospital, must be ascribed the honour of accurately describing it in 1779. Numerous surgeons in the latter part of the last century and in the present have further depicted it, but have succeeded in adding little to Pott's description. The discovery of the tubercle bacillus, however, by Koch in 1882 placed the whole question of chronic bone disease in a new light.

Etiology.—This may be looked at from several points of view.

Age.—The disease is most common during the years of active growth, and notably in early childhood; and frequently follows exanthemata. The results of statistics differ considerably, but a review of several collections shows that the larger the total of cases the greater is the preponderance of the disease in children under 5 years of age. Mohr[1] found that of 72 cases, 29 per cent occurred

[1] Quoted by Bradford and Lovett, *Orthop. Surg.* New York, 1890, pp. 9 and 10.

between the first and fifth years. Drachman noted that in 161 cases, 41 per cent occurred at this period of life, the youngest being eight weeks. Taylor found that of 376 cases, 60 per cent were under 5 years. The common occurrence of the disease so early in life, and the rapid diminution of the number of cases up to the age of 25 should not, however, cause us to overlook the possibility of its onset in middle life and old age. It is undoubtedly a rare event in declining years. Mr. Howard Marsh[1] was able to cite only three cases in people over 60 years; one of a man, aged 65, who developed disease of the cervical spine with displacement and projection, followed by an abscess; a second in a patient, aged 64, under Mr. Butlin's care; a third the case of a clerical dignitary, who died at the age of 72 years. A *post-mortem* examination in the last-mentioned case revealed much erosion of the lateral masses of the atlas, the axis, and of the body of the third cervical vertebra, such as occurs in childhood. Sir James Paget speaks of a case in a patient aged 55, and Drachman says he knew of a case in a man aged 77. Such cases are probably instances of a form of "Senile Scrofula," the subject of one of Sir James Paget's *Clinical Lectures and Essays*.

The Sex does not appear to exercise any particular influence. All statistics agree in that, unlike scoliosis, it is quite as frequent in girls as in boys. Nor is this to be wondered at if we remember that girls before puberty exercise their limbs as freely, and often run as nearly equal risks of injury as boys.

Tuberculosis.—A very large proportion of cases are either due to, or aggravated by tuberculosis, the hereditary nature of which is universally conceded. Gibney[2] found a hereditary taint in 76 per cent. In 35 per cent this was traced to the father, in 38 per cent to the mother, and in 31 per cent to both. In 15 per cent tubercular disease existed in other children of the same family; and in 16 per cent the taint was manifested in both parents and children. These and similar observations in the same direction point to tuberculosis as the great factor in the etiology, whether the predisposition be congenital or acquired. In the latter case the inherent weakness is often traceable to an attack of measles, scarlet-fever, or whooping-cough. Grafted on to the tubercular history is frequently that of *traumatism*. While admitting freely and without reserve that in the determination of the disease these two causes are often at work in very many instances, I am far from conceding that such universally

1 *Trans. Amer. Orthop. Assoc.* vol. iv. p. 235.
2 Quoted by Bradford and Lovett, *op. cit.* p. 11.

obtains. There are few parents who will not think of some slight fall or other accident to their child at the time when the illness was first noticed by them, the recollection of an accident being often unwittingly assisted by leading questions on the part of the surgical attendant. It appears to me that the question may be summed up by remarking that in a large proportion of instances both factors are at work. Excellent examples are the following cases.

CASE 1. *Pott's Disease following Injury in a Tubercular Patient.*—Ethel D——, aged 23, a dancer at one of the London Music Halls, came

FIG. 1.—Cervico-dorsal caries (Case 2).

FIG. 2.—Front view of the patient in Fig. 1, showing the deformity of the chest in dorsal caries.

to me at the National Orthopædic Hospital in March 1893, complaining of pain at the lower part of the back and inability to dance. I found projection of the fourth lumbar vertebra, with rigidity of the spinal muscles and pain, and advancing phthisical mischief in the right lung.

CASE 2.—Walter H——, aged 6 years, came to the same Hospital in June 1893. He fell from the top of an omnibus on his head twelve months previously, and now presented angular deformity limited to the first four dorsal vertebræ, with lateral deviation of the spine to the right in the lower dorsal and lumbar regions (see Fig. 1). He was suffering also from strumous ophthalmia.

In many other cases the history of traumatism is so equivocal or entirely absent[1] that one is forced to infer that tubercular deposits in the spine are solely responsible for the disease.

Traumatism.—In a minority of instances however, the absence of hereditary tubercular taint, the distinct history spontaneously volunteered of a severe fall or accident, the subsequent benign progress of the disease unaccompanied by suppuration, and frequently the complete cure, with ankylosis it is true, force us to recognise that simple traumatic ostitis in the adult and epiphysitis in children are alone responsible. A good example of this is the following case.

CASE 3. *Traumatic Pott's Disease.*—A. G., aged 40 years, fell from a height, severely straining the back in attempting to save himself from falling. He developed all the symptoms of Pott's disease, and lay recumbent for six years. He completely recovered without complications, and is now well able to bear the fatigue and strain of active exercise, such as mountain climbing, with comparatively little inconvenience, in spite of ankylosis of the lumbar spine.

Another cause is *syphilitic disease of the vertebræ.* It may be acquired or congenital. An instance of the latter form is quoted by Reeves,[2] who "at the London Hospital had a case of syphilitic caries a few years back, in which the boy coughed up portions of the vertebræ which had penetrated the lung."

In whatever way the disease is acquired, in the structure and functions of the spine there are conditions which predetermine its onset and facilitate its persistence. Such are, the rapid rate of growth of the spine, its liability to frequent jarring, the great amount of cancellous tissue in the bodies of the vertebræ, the pressure of the superincumbent weight of the body, and the exceeding mobility.

Pathological Anatomy. — *Localisation.* — The region most frequently involved is the dorsal. On this point nearly all authors are agreed. Of a series of 100 cases observed by Rédard at the Dispensaire Furtado-Heine, 6 were in the cervical, 5 in the cervico-dorsal, 62 in the dorsal, 5 in the dorso-lumbar, 20 in the lumbar, and 2 in the lumbo-sacral region.[3] R. W. Parker, quoted by Erichsen,[4] gives the following figures: cervical, 9; dorsal, 82; dorso-lumbar, 21; lumbar or lumbo-sacral, 37, out of 149 cases. To be

[1] Cf. case by Sayre, *Orthopedic Surg.* p. 277.

[2] *Bodily Deformities and their Treatment,* p. 133.

[3] *Traité de Chirurgie Orthopédique,* p. 232.

[4] *Science and Art of Surg.* 8th ed. vol. ii. p. 421.

more precise as to the individual vertebræ involved, I may perhaps quote further statistics. As there are more dorsal than cervical or lumbar vertebræ, it is natural that the disease should commence more often in the mid-region of the back. Mohr found that in

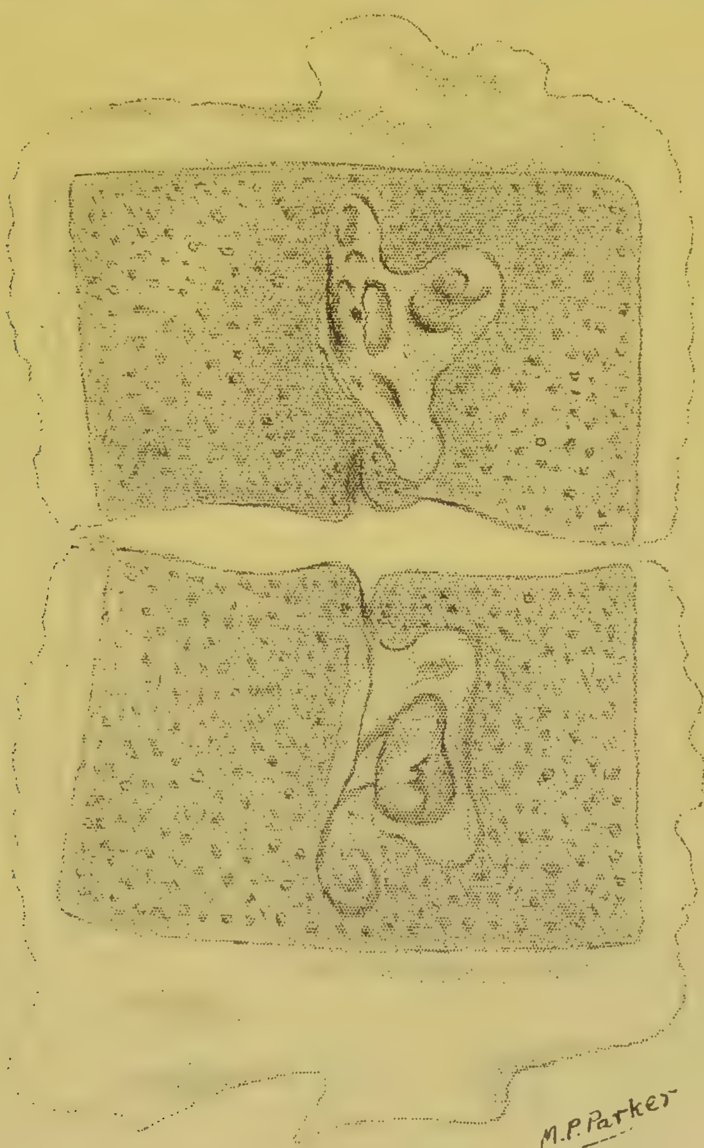


FIG. 3.—Disease on either side of the intervertebral disc, extending to the bodies (Guy's Hospital Museum, 1021[30]).

adults the twelfth dorsal and first lumbar vertebræ were most frequently the seat of the disease, the second dorsal the next in frequency, then in the fourth dorsal and fifth lumbar nearly as often. My own observations incline one to the belief that the vertebræ from the eighth dorsal to the first lumbar are the most frequently attacked.

The Part of the Vertebræ first attacked.—This is undoubtedly the bodies, owing to the influence of the superincumbent weight and their cancellous structure. It is stated, although I do not know on whose authority, that quadrupeds do not suffer from spinal caries. A case, however, of spinal caries in a dog was shown by Mr. W. G. Spencer at the Pathological Society, in which two dorsal and four lumbar vertebræ were affected. The intervertebral disc and the adjacent surfaces of second and third lumbar vertebræ were destroyed by ulceration. Sinuses, three on one side and two on the other side of the back, were present during life.[1] It is needful to remember that in childhood each vertebra has an epiphysial plate on its upper and lower surface. So that the disease in many cases, reasoning by analogy with other bones of the body, commences as a juxta-epiphysitis, tubercular or traumatic. This is supported by direct observation (Fig. 3). From the epiphysis it invades the intervertebral disc on the one side, or spreads to the body on the other side. Not infrequently the first sign of caries is seen at the anterior aspect beneath the anterior common ligament. It may, however, begin in the centre of the body; and I am inclined to regard cases so beginning as purely tubercular; or the disease may commence in the lateral or posterior[2] aspect of the body. It is of much importance, however, not to overlook the fact that several foci may be formed simultaneously in different vertebræ (see Fig. 4). The opinion expressed that the intervertebral discs are the starting-points of the disease may be dismissed on histological and pathological grounds, although Luschka[3] states there is a synovial membrane in each disc, and that the lobes of the pulp correspond to the villi of a synovial membrane. This statement I have been quite unable to verify. I have made numerous observations on the intervertebral discs of children, adults, and animals, and

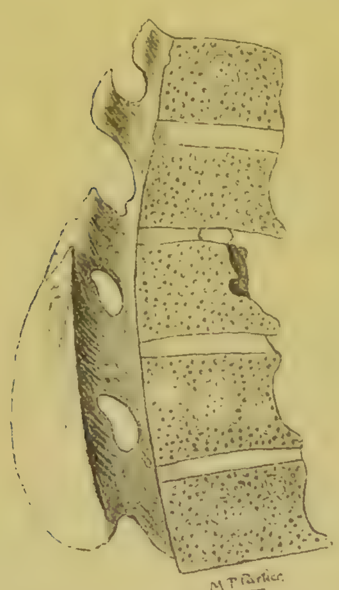


FIG. 4.—Multiple foci of disease in the vertebral column (Guy's Hospital Museum, 1289[45]).

[1] *Path. Soc. Trans.* 1890, vol. xli. p. 341.
[2] Quoted by Erichsen, *Science and Art of Surgery*, 8th ed. vol. ii. p. 417.
[3] Cf. case alluded to by Barker, *System of Surg.* 3rd ed. vol. ii. p. 404, with plate on p. 403.

have seen no trace, either with the naked eye or with the microscope, of such a cavity. Undoubtedly the discs soon become invaded secondarily to the bone, and partially or wholly disappear.

Affection of other parts of the vertebræ is unusual. The spinous process alone may suffer. A good example of this is quoted by Ashby and Wright.[1]

CASE 4. *Necrosis of Cervical Spinous Process.*—"E. H., aged 4 years and 5 months. Six weeks ago a hard lump was noticed at the back of the neck, he having a fortnight before fallen on the back of his head; the swelling had formed gradually, but he had neither pain nor tenderness. On admission he was well nourished; there was a large fluctuating swelling in the middle of the back of the neck; on opening it about three drachms of healthy pus escaped; the tips of one or more of the spines were bare. The abscess continued to discharge for five months through a small sinus. Subsequently a sequestrum consisting of the spinous process was removed, and he quite recovered."

Disease may occur in the costo-vertebral articulations and extend thence to the vertebræ. I am unable to quote a case commencing in the transverse processes, although it is affirmed in several works that such has happened. No record exists of disease beginning in the articular processes.[2] It is stated by Ashby and Wright[3] that disease of the costo-vertebral articulations may simulate spinal caries, "owing to the presence of radiating pain, and the formation of an abscess—possibly some cases of psoas abscess may be due to this cause." The diagnosis is made by the absence of curvature, the unilateral nature of the pain, and the absence of general rigidity of the muscles. To sum up, then, we are enabled to state that the disease starts in the bodies, rarely in the laminæ or processes. But with regard to the exact *fons et origo mali* in the bodies, it frequently happens on the *post-mortem* table that the destruction has proceeded so far that all trace of the initial lesion is lost.

Events of the Inflammatory Process.—Beginning as a carious process, the lesion is always accompanied by the formation of granulation tissue.[4] The succeeding events vary considerably. In some instances the granulation tissue is absorbed almost as fast as it is formed, the affected bone disappearing gradually without the forma-

[1] *Diseases of Children*, p. 561. [2] *Ibid.* p. 561. [3] *Ibid.* p. 572.

[4] For the exact processes in caries of bone, I must refer my readers to works on Surgical Pathology.

tion of pus—caries sicca—resulting often in considerable deformity.[1] In other cases the granulation tissue breaks down, abscesses form, and make their way to the surface. In more rapid cases before the affected bone has been replaced by granulation tissue, portions of considerable size may be isolated by rarefaction and form sequestra of varying size, the condition then being known as caries necrotica—always a serious event, owing to the rapid destruction of bone, and the difficulty of arresting the disease by removal of the sequestra. Occasionally, if the area involved be a small one, calcareous degeneration of the granulation tissue takes place, and an encysted nodule forms which remains harmless for years. In rarer instances, true ossification occurs in the inflammatory material, and a rapid and complete cure is effected. An example of this is seen in Fig. 5, where the intervertebral discs and bone have been replaced by granulation tissue, which in turn has ossified, the result being complete and perfect bony ankylosis of the adjacent bodies. Such a happy result may usually be ascribed to thorough and early treatment, with maintenance of good general health from first to last.

FIG. 5.—Complete ankylosis of adjacent vertebræ (Guy's Hospital Museum, 1014[35]).

The ligaments, especially the anterior common ligament, become softened and thickened when the disease is situated in the anterior parts of the bodies; while the surfaces of the neighbouring vertebræ,

[1] Cf. Clinical Lecture by Howard Marsh, *Lancet*, 1893, vol. ii. p. 792. He quotes a case of a young adult, aged 19, who had a perfectly distinct angular curvature of the lower dorsal spine of which he could give no account. His back was strong, and he was leading an active life, and he could not remember any period at which his spine had given him inconvenience. Mr. Marsh adds, "Clinically such cases are of much importance, because they contradict common experience in two respects: firstly, they run their course much more rapidly than the common set of cases; and secondly, they always end, so far as I know, in firm ankylosis, which the surgeon can do nothing to avert. Firm ankylosis is a result which, unless you can make an authoritative statement to the contrary, parents will certainly attribute to your method of treatment by fixation; but I am quite sure you are justified in maintaining that it is not due to this treatment. It would have occurred just the same even if no splints had been employed."

together with their periosteum, participate in the inflammatory process, but to a less degree, resulting in the formation of spiculæ of bone, which may subsequently serve as supports to the buttress of new tissue thrown across the chasm.

The Natural Methods of Cure.—In non-tubercular cases we may take it that the ostitis induced by injury comparatively rarely sets up any extensive caries. At the most, it is limited to one or two vertebræ. And it is in this class of cases that dry caries occurs, and abscess does not complicate the spinal disease. The granulation tissue frequently ossifies, so that a certain amount of localised bony rigidity permanently remains. In tubercular cases what happens is that the affected area becomes encysted[1] and undergoes calcification; or if the destruction be more extensive, the carious parts are gradually disintegrated, and come away in the discharge either as minute spiculæ of bone or as sequestra of appreciable size. As the destruction of the bodies proceeds the opposed surfaces of granulation tissue come together, and with the extrusion of all diseased bone, coalesce. Subsequent ossification of this soft material occurs and the gap is bridged over by a buttress of bone, so that the site of the disease is rendered as strong, but with loss of mobility, as before the disease. That most extensive loss of bone is consistent with perfect recovery, numerous specimens in museums testify, notably one from the Peabody Museum, Cambridge, Mass.—a specimen of prehistoric Indian remains in which the whole of the dorsal region has been involved.

Results of Spinal Caries.—*Deformity.*—Although this is not always present, yet in the great majority of cases it is by far the most marked feature of the disease. Its production is sufficiently explained by the stress of the disease falling on the bodies, and their collapse under the superincumbent weight of the upper part of the trunk and head. It is the onset of deformity that leads patients in many cases to seek advice. Hence the disease often goes untreated in its early stages. R. Whitman[2] estimates that not more than 5 per cent of the cases are seen before deformity sets in, and the peculiar train of symptoms in spinal disease is such that they may not unskilfully be referred to other slighter causes than caries. The presence of a posterior projection dispels all doubt.

The nature and extent of the deformity depends upon the

[1] Cf. F. S. Eve, *Path. Soc. Trans.* 1888, vol. xxxix. "Caries without Suppuration," pp. 266-269.

[2] *Trans. Amer. Orthop. Assoc.* vol. iv. p. 240.

number of vertebræ and the region affected. If but one vertebra is affected, especially in the dorsal region where the normal physiological curve is backwards, a very sharp angle is produced; if two or three are diseased, the projection is less sharp but very marked. In this case the whole of the spine above and the affected vertebræ are displaced backwards, while the remainder of the spine below is straightened and its curves flattened out. At the extremities of the spine where the physiological curve is forwards, the displacement is less, and is more readily compensated for. Posterior projection can only occur when there is extensive destruction of bone. While the antero-posterior deformity is insisted upon by all authors, we must not overlook the fact that in the early stages considerable *lateral* deformity may be present (see Fig. 10). When, however, the disease has advanced so far that considerable erosion of the bodies has ensued, the features of the lateral deviation are sometimes merged into, and lost in those of the general displacement of the column. The extent of the erosion and actual destruction of the bodies varies widely. It may be so slight, however, that little, if any, deformity is necessarily produced, or it may be so severe that the upper part of the spine is placed at a right angle to the lower (Fig. 6). True dislocation rarely occurs, but merely a bending forwards, since the arches and articulating processes are seldom involved and usually maintain their relative positions. With the absorption and disappearance of the bodies, unless extremely rapid, a widening of the bony walls of the spinal canal results, so that it is very unusual to find the cord compressed by bone. An instance, however, of combined bony and granulation pressure is seen in Fig. 7. So far as the bone is concerned, its loss involves very little danger to the nerve

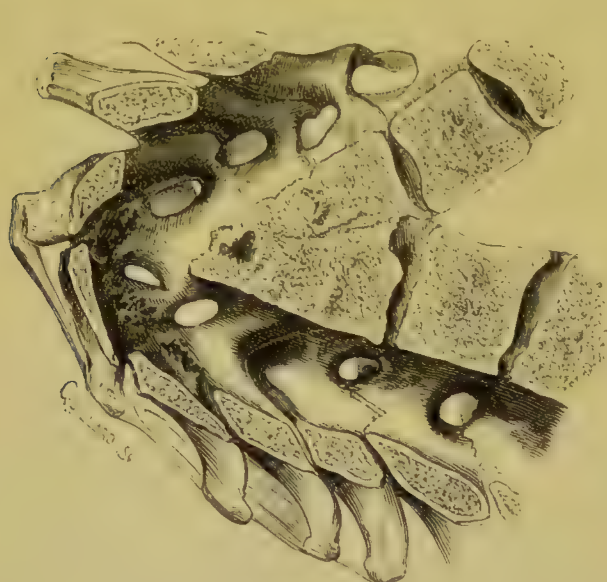


FIG. 6.—Extensive destruction of the bodies of the vertebræ producing extreme deformity (Rédard).

structures. Widely different in its effects, however, is the production of granulation tissue in the spinal canal. It is the most fruitful cause of "compression" paraplegia. Hereafter we shall deal more particularly with this portion of our subject, but the old saying, "The less the deformity, the more the paralysis," has a ring of truth about it. But like all such sayings, it is apt to mislead. In some instances, notably in the cervical and lumbar regions at the commencement of the disease, and due to muscular spasm, the normal curves of those parts are exaggerated, and there is in the lumbar spine marked lordosis. In other cases the normal anterior curve is lessened or a "flatness" of the back exists. But wherever the disease may be situated, a slight prominence of any one vertebra, with rigidity of the muscles, should excite grave suspicions and ensure prompt treatment.

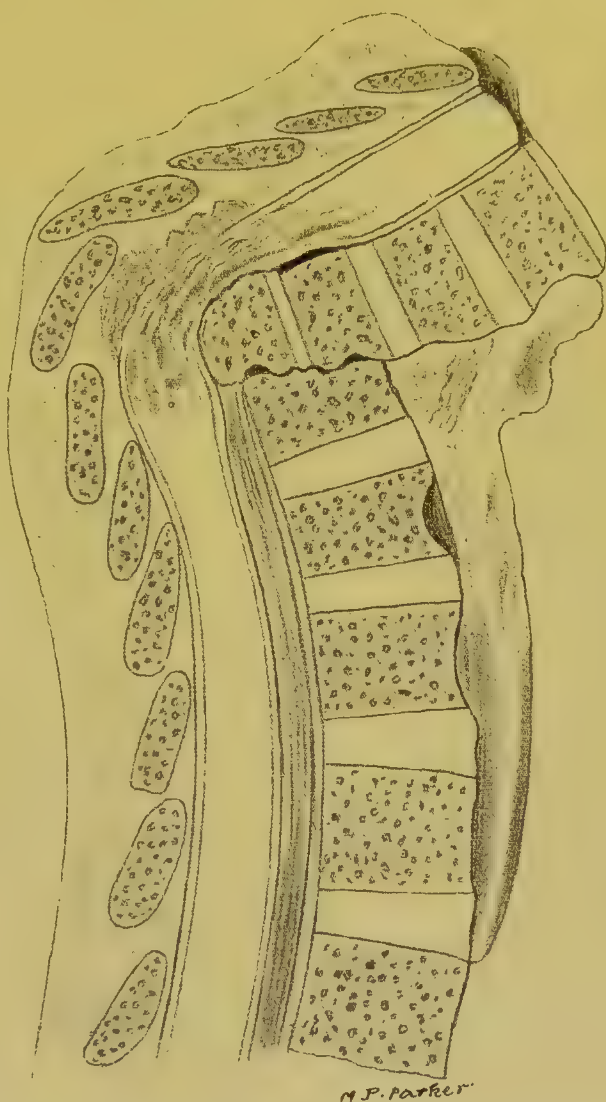


FIG. 7.—Caries of the spine. Compression of the cord partly by displaced bone and partly by granulation tissue (Guy's Hospital Museum).

Reference has already been made to the occurrence of *lateral deformity*, and later on the diagnostic signs of this from scoliosis are given (p. 36). Such deviation can only occur when one side of a vertebra is affected more than the other (Fig. 8). It may be noted early in the attack and then disappear, or it may be evident from first to last. Some lateral deviation is seen in the case of Alfred K—— (Fig. 10). A most excellent article on "The

Presence of Spinal Distortion in the Early Stage of Spondylitis," by Dr. Bernard Bartow, appeared in the *Annals of Surgery*.[1] The author claims that not only is there deviation, but also actual rotation, as in scoliosis. But an examination of the figures illustrating the article fails to convince me of the existence of rotation in several of the cases, and it is just in these instances that his diagnosis of Pott's disease seems to me doubtful, at least, judging by the recorded symptoms. In one instance figured[2] there is undoubtedly lateral deviation. I give notes of a case from Dr. Bartow's article.

FIG. 8.—Lateral deviation of the spine (Guy's Hospital Museum, 1004^{92}).

CASE 5. *Lateral Deviation in Pott's Disease* (Bartow).—"A boy, aged 8 years, had suffered for six months. During the latter half of that period there had been three paroxysms of painful spasm of the lumbar muscles, following bending movements of the spine. There was no history of traumatism, but one of family tuberculosis. Pain was referred to the dorso-lumbar and abdominal muscles, and there was well-marked rigidity of the dorsal and lumbar vertebræ during the execution of ordinary movements. There was seen a general deviation of the whole spine to the right, commencing in the lumbar region; elevation of the right shoulder, prominence of the right scapula, and falling away of the right arm from the side, with approximation of the left arm to the trunk."

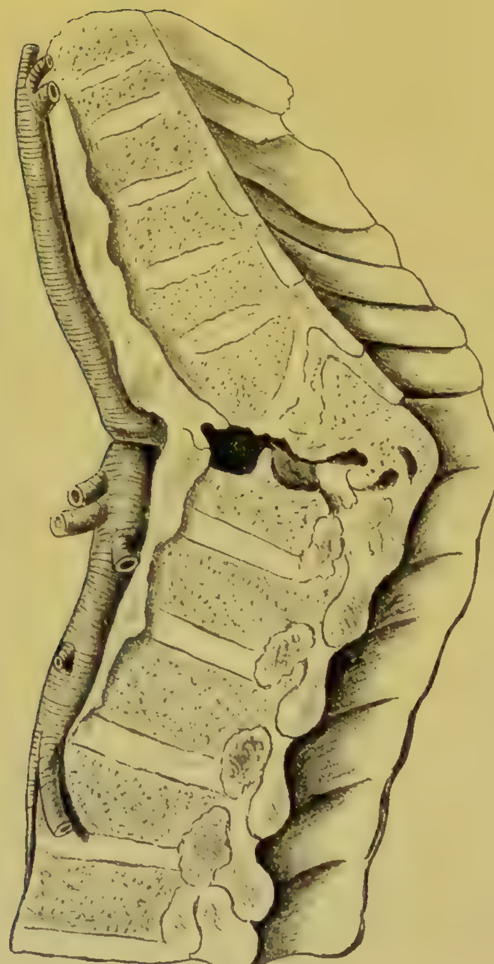
Some authors are of opinion that the lateral deviation is very common, but during the past four years at the Evelina Hospital for Sick Children and the National Orthopædic Hospital I have met with only four instances of this deformity in Pott's disease. It is, however, best seen in advancing cases, and diminishes as the case is getting well.

An old-standing antero-posterior deformity is usually rounded, and presents a bursa of considerable size and density over the most prominent points. In advanced cases, especially if in the

[1] Vol. ix. p. 48 *et seq.*

[2] Nos. 5 and 5′, *ibid.*

PLATE I.



KINKING OF THE AORTA IN SPINAL CARIES

Section of the spine showing extensive caries of the vertebræ with angular deformity. The last four dorsal vertebræ are greatly diseased, the two middle are nearly destroyed, and the portions of the upper and lower have fallen together. The other dorsal vertebræ are also affected on their anterior surfaces. (Guy's Hospital Museum, 1290.)

dorsal region, the shoulders are elevated and droop forward, the sternum prominent, the ribs compressed from side to side, the scapulæ raised, the neck shortened, and the head is thrown forward (Fig. 2). Projection of the head must occur, as a compensation to the displacement backwards of the spine. With these structural changes considerable alterations in the position of the viscera take place. Thus I have observed the apex beat just at the nipple, and in one instance of eleven years' standing I felt it in the third intercostal space in the nipple line. Hilton Fagge[1] drew attention to the "kinking" of the anterior wall of the thoracic aorta (Plate I.), with hypertrophy of the heart in cases of very marked posterior projection of the dorsal spine. The lungs frequently become compressed, leading to the peculiar grunting respiration, and later on to the incidence of tubercle; while the abdominal viscera, notably the liver and stomach, are pushed downwards; and the abdomen is very prominent in bad cases, with much derangement of digestion. It is essential to keep some record of the deformity from time to time. This is best effected by using a strip of sheet-lead, moderately stout, of not less than one foot in length. With the child lying prone, the lead can be adapted to the curved spine. On removal the lead is turned sideways, and serves as a ruler for an ink tracing on the record sheet. A better plan in place of the ink-mark is to place the lead sideways as before on a piece of cardboard, and use the lead as a guide to cut out the curve in cardboard; then placing the cardboard against the spine, to see if the outline fits the spinal curve. If not quite correct, it should be gradually trimmed.

If the patient is seen early, deformity may be averted in the cervical and lumbar regions; and in all cases, if already declared, it should be prevented from becoming worse. Some recession of the deformity may, in careful and thorough hands, be obtained.[2] In the dorsal region deformity is almost sure to occur in spite of treatment. "A sudden chafing of the skin, developing under a brace or jacket which has always fitted well, should lead to the suspicion that the deformity may be increasing, although that is not necessarily the case."

The conditions which give rise to *increase in the degree of curvature* are two; and they occur in two totally different stages of the disease. Firstly, when the excavating process is going on quickly in the bodies, the deformity must necessarily increase

[1] Guy's Hospital Reports, 1872.

[2] H. L. Taylor. Cf. *New York Med. Rec.* 8th January 1887.

rapidly. Secondly, when active disease has ceased, and healing is taking place, the bodies settle down on the newly-formed tissue, so that a further development of the posterior projection follows. That such increase will occur during treatment, in spite of the most approved appliances, must be pointed out by the surgeon at the commencement of the treatment, otherwise he may incur blame on account of the increased deformity, although in other respects the patient is doing perfectly well. It should be clearly stated that firm union of the affected parts and consolidation of the spine can only be effected in severe cases by approximation of the healthy parts.

Abscess.—Briefly it may be stated, from a consideration of the data collected by various authors, that abscess occurs in about one patient in five suffering from Pott's disease. My friend and colleague, Mr. E. Muirhead Little, found that among the in-patients at the National Orthopædic Hospital, many being admitted on account of the abscess, this complication was present in 21 of 133 cases; among 133 cases treated as out-patients, only 7 cases of abscess are recorded.[1] W. R. Townsend[2] tabulated 380 cases of spondylitis; 75 were found to have abscess, distributed thus—in the cervical region 8 per cent, dorsal 20 per cent, lumbar 72 per cent; these correspond closely with the data given by Michael and Parker.[3] The latter surgeon found that 8 per cent of his dorsal cases suppurated, 30 per cent of the lumbar, and 70 per cent of the lumbo-sacral. These figures strikingly exemplify this point, that the liability of the various regions of the spine to abscess increases from above downwards. So too do the total range of movements and amount of weight borne. These factors undoubtedly, then, influence the onset of abscess, but there must be others which we are not able to determine so precisely. We cannot determine the exact constitutional equivalent of any one patient; why in one case there should be entire immunity from, and in another the onset of profuse suppuration. We can only speak of the individual degree of "recuperative power." An estimation of the severity of the injury does not help us. All we can say is that, given a patient with a strongly-marked phthisical parentage, abscess is more likely to occur than in one free from hereditary taint. Bradford and Lovett[4] remark, "The earlier the treatment is begun, and the more efficiently it is carried out, the less liable are abscesses to

[1] *Lancet*, 23rd July 1892. [2] *Trans. Amer. Orthop. Assoc.* vol. iv. p. 164.
[3] *Roy. Med. Chir. Soc. Trans.* 1884. [4] *Op. cit.* p. 30.

form; but it must not be assumed that the occurrence of abscess is evidence of incomplete treatment. In many cases an abscess cannot be avoided." In the majority of abscesses having a fatal termination, tubercle is found elsewhere in the bones. On the other hand, while abscess is most frequently the condition which precedes the end, we must not always assume that those cases which do not suppurate are non-tubercular, since, owing to recovery, we have no means of verifying our assumption. While in a few cases abscess may exist without giving rise to definite symptoms,[1] in by far the great majority its existence soon becomes evident.

Anatomical Considerations influencing the Position of, and Direction taken by Spinal Abscesses. In the Cervical Region.—The point of exit of pus is greatly dependent on the disposition and arrangement of the deep cervical fascia. Attached behind to the spinous processes of the vertebræ, it is continuous with the layers of connective tissue investing the trapezius and deep muscles of the neck. It then crosses the posterior triangle, and dividing into two layers, ensheaths the sterno-mastoid muscle. The layers unite at the anterior border of that muscle, and meet the fascia from the opposite side at the median line. A process of the layer beneath the sterno-mastoid muscle passes down in front of the thyroid gland and trachea and depressor muscles of the hyoid bone to the great vessels and pericardium. Pus extending beneath this layer has been known to open into the lungs, trachea and bronchi,[2] notable but rare events. The præ-vertebral fascia covering the muscles of that name, and separating them from the pharynx and œsophagus, may confine the pus for a time, and then by its increase and the pushing forward of the posterior wall of the pharynx, a retro-pharyngeal abscess arises, causing dyspnœa and dysphagia.[3] Occasionally the abscess bursts into the pharyngeal cavity, or opens into the œsophagus, or it may track down into the posterior mediastinum and open through an intercostal space following the posterior branches of the intercostal arteries. If the præ-vertebral fascia be traced outwards, it is found to form, or become continuous with, the back of the carotid sheath, and is then prolonged outwards and downwards over the scaleni muscles. Pus arising from diseased cervical vertebræ frequently passes laterally between the longus colli and scaleni muscles, and opens posteriorly

[1] Case of A. E. Barker's, quoted in note to p. 62.

[2] Cossy, *Bull. Soc. Anat.* 1877, p. 541; and Gamlet, *Bull. Soc. Anat.* 1878.

[3] Cf. case, Hilton's *Rest and Pain*, 3rd ed. p. 135.

to the sterno-mastoid muscle. Occasionally the abscess bursts through the deep fascia, and appears at the sides of the cervical spinous process.

CASE 6. *Cervical Caries, Suppuration, Cervical Abscess.*—B. H., aged 7, was seen by me at the Evelina Hospital for Sick Children in July 1893. He was an undersized sickly boy, one of eleven children. Four years ago his head was pulled suddenly while playing with one of his brothers. In a few days pain set in, followed by "stiffness of the neck." Subsequently the head was drawn to the left shoulder, and a large swelling appeared on the left side of the neck. He was then taken to St. Thomas's Hospital, placed in the recumbent position, and the abscess opened. A jacket with an occipital head-piece was applied, and he went out much improved. He was subsequently admitted there for what the mother states was lung trouble, the precise nature of which I was unable to determine. When first seen by me there was rigidity of the neck, some flattening of the normal forward cervical curve, and slight thickening at the back of the neck over the third and fourth cervical vertebræ, but no posterior projection. About one inch above the clavicle, and in the posterior triangle, there was a discharging sinus, from which thin pus was oozing. In November 1893 some minute pieces of bone came away. In February 1894 the sinus had healed, although the boy was unable to leave off his support. He is now suffering from phlyctenular ophthalmia.

In the Dorsal Region.—The strong fasciæ binding the ribs together influence largely the pointing of the abscess. In the upper and mid-dorsal spine pus finds its way between the posterior ends of the ribs, following the posterior branches of the intercostal arteries and then gives rise to a dorsal abscess. More rarely does a dorsal abscess encroach on the cavity of the chest or the pleural cavities. In lower dorsal and often in mid-dorsal caries pus gravitates either by the sides of the vertebræ beneath the intercostal fascia, or passes beneath the ligamentum arcuatum internum, and forms a psoas abscess. In some cases the abscess is said to reach the psoas sheath by passing between the anterior spinal ligament and the bone, and then perforating the diaphragm.

In the Lumbar Region.—The site of origin of the disease in the bodies of the vertebræ is important as to the course of the abscess, taking into consideration at the same time the peculiar disposition of the psoas and lumbar fasciæ. The sheath of the psoas muscle is a thin layer continuous, above with the ligamentum arcuatum internum, below with the iliac fascia, behind with the anterior lamella of the lumbar fascia, and is attached to the bodies of the vertebræ internally.

The lumbar fascia is composed of three layers; the anterior and middle attached to the transverse processes, the posterior to the spinous processes of the vertebræ. The anterior layer is very thin, and offers but slight resistance to abscess. Pus, following the course of the posterior branches of the lumbar arteries, may track through this layer. J. K. Young[1] has insisted on the importance of this layer of fascia, and would divide spinal abscess into two varieties, internal and external according as they do or do not perforate this layer. The middle layer lies between the quadratus lumborum and multifidus spinæ muscles, and gives origin to the transversalis and internal oblique muscles. The posterior layer completes the sheath of the erector spinæ muscle. At the outer edge of the latter structure is a weak spot in the abdominal wall, the triangle of Petit, bounded anteriorly by the posterior edge of the external oblique muscle, and below by the iliac crest. It is in this triangle that lumbar abscesses often point.

If the disease begins in the bodies of the vertebræ (*a*) anteriorly to the attachment of the psoas, or fails to enter the sheath of the psoas, it passes behind the aorta, and thence along the great vessels to the iliac fossa, giving rise to an iliac abscess; or it may not stop there, but gravitate into the pelvis, and passing out of the great sacro-sciatic foramen, form a gluteal abscess. Ashby and Wright[2] quote a case of abscess bulging at both sciatic foramina, so that fluctuation could be felt across the cavity of the pelvis. (*b*) If very near or at the attachment of the psoas, it enters the sheath of the psoas, and passing beneath Poupart's ligament, presents either at the inner or outer side of the femoral vessels, or following the course of the internal circumflex vessels, points behind the great trochanter. Rarely it may present lower down in the limb; (*c*) it often burrows through the anterior and other layers of the lumbar fascia, and appears in Petit's triangle as a lumbar abscess, or (*d*) rarely wanders about in the fascial layers till it presents in the anterior abdominal wall. It is this persistent burrowing, the irregularity of the abscess cavity, and the difficulty of ensuring efficient drainage that make lumbar abscess so serious a complication. It is remarkable, however, that it seldom bursts into the peritoneum, intestines or bladder.[3] But occasionally it invades the spinal canal.

[1] *Trans. Amer. Orthop. Assoc.* vol. iv. p. 175 *et seq.*

[2] *Op. supra cit.* p. 563.

[3] Instances, however, are recorded. If it burst into the peritoneal cavity a rapid and fatal termination of the case ensues. If into the bladder, so long as the urine remains sweet, the abscess may discharge entirely in this way, and the disease be

The *contents* of the abscess vary. Sometimes they are serous and sero-purulent fluid with caseous masses. In old-standing cases they are often cheesy. In almost all cases fragments of carious and necrotic bone are found. The wall of the abscess is frequently lined with feeble grey granulations, which may become infected with tubercle before or after the opening of the abscess.

Future course of the abscess. It may burst when not under surgical supervision; and such an event is most disastrous. In too many instances the abscess track becomes septic, and then persistent suppuration, with hectic fever and lardaceous disease, set in—a rapid course to the inevitable end. I am not aware personally of any cases where it has been possible to render the cavity entirely "sweet" again, although such a desirable result has been claimed by Treves and others, and I know of instances to the contrary. Much may, however, be hoped from free incisions, if possible from the lumbar region, and thoroughly scraping and rubbing the abscess wall.

It may be *duly and antiseptically opened*, as detailed under the heading of treatment, with the best results. On the other hand, after opening with all possible care, a discharging sinus is left, which closes only after further operations, or, in some cases, not until necrosed bone has been extruded.

In other cases *absorption* occurs, giving immunity from illness to

cured. The possibility of tubercular infection of the bladder must not be lost sight of. Bearing upon the interesting question of discharge of bone-abscess with favourable result through the bladder, I may mention the case of Miss H. N., aged 7 years. In September 1893 I operated upon her for mastoid abscess, secondary to scarlet fever. Whilst it was healing some tenderness developed over the middle of the left iliac crest, but this subsided for a time. On 21st November 1893 I was again asked by Dr. Hayman of Clapham to see her. The day before she had complained of great pain on micturition, and had passed urine containing much pus. On examining her I found a large iliac abscess occupying the whole of the left iliac fossa, and extending below Poupart's ligament, with fluctuation on the outer side of the femoral vessels. Finding that the urine was sweet, and that pus continued to be discharged freely, I advised that we should wait rather than again operate on her; she had already, before I operated on her for mastoid abscess, been seen by a surgeon for acute cellulitis of the neck, which had necessitated free incision. A plaster of Paris spica bandage was adjusted on 21st November. Dr. Hayman wrote to me in January 1894 to the effect that the urine had remained sweet throughout, that no pus had been passed by the urethra for three weeks, and the swelling in the left iliac fossa had disappeared. She is now, March 1894, entirely free from any trouble. I take it that the opening of an aseptic abscess into an aseptic bladder is by no means an event to be deplored. Sweet urine cannot infect an abscess, if the pus directly gravitates into the bladder. In such a case it would have been, I venture to say, very harmful to catheterise the bladder, as the risk of introducing decomposing matter into the bladder, and thence into the abscess cavity, was too great.

the patient for some years; but too often it lights up into some other form of tubercular disease.

Abscesses occur on both sides in one and the same patient,[1] and occasionally communicate. In such instances it is best to open both at once, to prevent the possibility of one leaking over into the other.

The prognosis, diagnosis, and treatment of abscess receives fuller consideration later.

Compression-Paraplegia.—Considering the immediate proximity of the spinal cord and nerves to the site of the disease, it is a matter of surprise that this complication does not occur more often. It is equally surprising that so many cases treated on the expectant plan of recumbency, with or without extension, recover.

It may at once be said that no very definite relation can be traced between the presence of deformity and paraplegia. On the contrary, the latter may exist without any posterior projection. Nay more, in some cases the signs of bone disease may not be evident until some time after the onset of paraplegia. Nor is paralysis dependent either on the amount, character, or duration of deformity. It is found with equal frequency in large, medium, or slight projections; it in some cases comes on simultaneously; in others not till months afterwards; in yet others distortion appearing in early life is not followed by paralysis until adult life. This want of relationship is explained by the morbid anatomy of "compression." Very rarely is it due to bone alone. In the majority of cases the active agents are pressure of inflammatory material and pachymeningitis. So that symptoms of slow compression should invariably lead to a very careful examination of the spine, with a thorough inquiry into the patient's antecedents, and any doubtful points carefully considered, especially in the case of children. The formation of an abscess outside the spine often relieves pressure within the canal, either by the breaking down of an inflammatory material or by the gradual removal of carious and displaced bone. If abscess and paralysis coexist for any length of time, the prognosis is necessarily very serious, as the disease must be very extensive in both the bones and the vertebral canal, and may be outside the range of operative procedures. In illustration of these remarks I quote a case recorded by Dr. Swan in the *Brit. Med. Journal*, 4th February 1893.

[1] Cf. a case of bilateral lumbar abscess recorded by J. K. Young, *Trans. Amer. Orthop. Assoc.* vol. iv. p. 174, which was successfully aspirated on one side and opened on the other at one sitting, with complete cure.

CASE 7. *A Fatal Case of Compression-Paraplegia.*—"A girl, aged 17, was brought to him with partial paraplegia, marked muscular inco-ordinating movements of the body, hyperæsthesia, and unilateral spasm. The deep reflexes were exaggerated; an abscess had discharged behind on a level with the lower two dorsal vertebræ. From this a portion of the twelfth rib and an adjoining piece of the vertebral body were evacuated. Soon afterwards complete paraplegia supervened, with loss of the deep reflexes, gangrene of the skin over the projecting points, and ultimately death from exhaustion. The *post-mortem* examination revealed not only the impossibility of drainage, but also the futility of operation."

In by far the majority of cases the spinal cord does not suffer. The reasons are these. Actual dislocation, although one or more of the bodies may be totally destroyed, is rare. When deformity sets in, the anterior part of the spinal column, the bodies, falls together, it is true; but this is due to loss of their substance, so that frequently there is widening of the canal at the affected spot sufficiently great to accommodate not only the cord, but a very considerable quantity of inflammatory material and thickened dura mater. Then, too, as the spine is shortened from above downwards, the cord becomes relaxed, and is therefore able more readily to accommodate itself to its altered conditions. The cord is gradually curved, not abruptly bent or displaced. Ascending and descending degenerations set in from "compression." As soon as symptoms of degeneration appear operation is called for.

The paralysis is usually bilateral; in rare cases it is unilateral. It affects the legs generally, although the arms may suffer later; so both may be paralysed. Dr. Gowers[1] quotes a case of a child of 3, who had presented for two years indications of disease of the cervical vertebræ, and in whom the power of moving the legs was lost in the course of twenty-four hours; during the second day the left arm became paralysed, and at the end of a week the right arm. In instances such as this the cervical vertebræ are necessarily affected, but in the majority of cases the legs alone suffer. Both legs, as a rule, suffer equally. Dr. Gowers, however, gives a case of unequal affection of the legs.[2]

CASE 8. *Compression-Paraplegia, Unequal Affection of the Legs.*—"A boy, in childhood, developed angular curvature; at 16 there was an attack of weakness in the legs, which passed away at the end of three weeks; at 17½ years the patient sprained his back. Pain in it followed;

[1] *Dis. of Nervous System*, 2nd ed. vol. i. p. 247. [2] *Ibid.* p. 248.

and six weeks later the right leg gradually became weak, and a year and a half later presented intense spastic paralysis, the left leg being very little affected. He ultimately recovered."

Frequently the dorsal cord becomes affected; and if the disease be above the lumbar enlargement, the condition of the legs is generally spastic when the destruction of the cord is not excessive.

Dr. T. Halsted Myers[1] has analysed 1570 cases of Pott's disease with reference to the onset of paralysis. Of these 270 were sooner or later paralysed. The site of disease was as follows: 16 in the cervical, 12 in the cervico-dorsal, 105 in the dorsal region about the eighth vertebra, 40 in the lower dorsal, 19 in the dorso-lumbar, 18 in the lumbar, and 9 not stated. The average duration of paralysis in which recovery took place was twelve months in the cervical region, nine and a half in the upper dorsal, six in the lower dorsal, and eight in the lumbar. Eighteen of 218 cases had repeated attacks of paralysis, viz. two had four attacks, and many three attacks with a good recovery; but in two cases the patient passed through two attacks and finally died paraplegic. The average duration of the disease before the onset of paralysis was, in the cervical or upper dorsal region, thirteen months; in the lower dorsal, fifteen; and in the lumbar, eighteen months. The upper extremities were affected in seven cases; of these, three were not treated, three were cured, and one died after operation; of cases affected elsewhere, thirteen recovered without treatment.

I have inserted these statistics on account of their great interest. But I am inclined to think that the proportion of 270 cases of compression-paraplegia in 1570 is too great. That they were treated as out-patients at the New York Dispensary may account for this. That one case in seven should suffer appears remarkable to me. It infers that paraplegia is nearly as frequent as abscess in spondylitis. This is certainly not the case. In mixed in- and out-patient practice the proportion is much less. My colleague, Mr. E. Muirhead Little, has collected from the records of the National Orthopædic Hospital 133 cases, and in only 10 of these was there definite paraplegia.

It will be convenient here, before describing the symptoms generally of Pott's disease, to review briefly the pathology, signs, and course of "compression-paraplegia."

Pathological Anatomy of Compression-Paraplegia.—Inflammation in the bodies of the vertebræ extends, and finally causes a

[1] *Trans. Amer. Orthop. Assoc.* vol. iii. p. 209 *et seq.*

perforation of their posterior surfaces, accompanied by a destruction of their periosteum, and of the posterior common ligament. The epidural space, composed of loose fatty or vascular material situated immediately behind the ligament, is next invaded by the tubercular material, either in the form of granulation material or abscess, or less frequently obliterated by displaced bone. So that practically in most cases a peri-pachymeningitis arises, which is accompanied later by a chronic meningitis of the dura mater and other thecal structures — in fact, a pachymeningitis. For a long time the morbid process is limited by the tough dura, but ultimately perforation takes place if the patient live long enough, and then all the symptoms of acute tubercular meningitis with inflammation follow, and the patient rapidly succumbs. More usually, however, the spinal cord suffers slow compression, being flattened by the pressure of granulation tissue, and becomes œdematous and vascular, *i.e.* softening of the cord occurs with myelitis. This is accompanied by increase of the neuroglia; sclerosis ensues with partial or entire destruction of the nerve elements and ascending and descending degeneration. At the same time too the nerve-roots suffer from pressure and exudation of new material around them.[1]

FIG. 9.—Extensive deformity of the spine from caries, with much compression of the cord (Guy's Hospital Museum, 1024[85]).

The spinal cord may be indented or flattened, as above mentioned, or cylindrical but much reduced in size. It has even been found as small as a crowquill. Some narrowing of the cord is not incompatible with recession of the paraplegia, since in such cases the cord has been found considerably narrowed, when the patient has died from some other cause. In a case of compression-paraplegia at the National Orthopædic Hospital, on which I operated,

[1] For the description of the microscopical changes in the cord and nerves, standard works on Diseases of the Nervous System should be consulted.

the spinal cord was so much compressed by the arch of the tenth dorsal vertebra that it was impossible to pass a fine probe between the bone and the cord. It was necessary to pick the bone away with a fine pair of bone forceps.

So that, to sum up, the six following conditions account for the symptoms: (1) Pressure arises from the gradual formation and squeezing backwards of the granulation material, as the sound bone above settles down to fill up the gap. (2) The nerve-roots are affected by the granulation tissue, and involved in the pachymeningitis. (3) The cord is suddenly pressed upon by displaced bone. (4) More or less acute myelitis sets in. (5) Acute tubercular meningitis from sudden diffusion of infective material in the sub-dural space rapidly carries the patient off. (6) Immediate compression of the cord is very occasionally due to extravasation of blood after an incautious movement, sufficient to rupture a blood-vessel.[1]

Symptoms of Compression-Paraplegia.—These necessarily vary with the site of disease. The *onset* is in some cases very sudden, and is due then to displaced bone, rupture of a blood-vessel, or acute myelitis, or tubercular meningitis. As instances of this rapid loss of functions Gowers mentions several cases. In one of them, a child of 3 years of age, slight weakness existed for three weeks, and then the power of standing was lost in a single night. More often it is gradual, and not without warning in the form of slight paresis.

Several of the salient points in the history are illustrated by the following case, which came under my care for in-patient treatment.

CASE 9. *Compression-Paraplegia, Gradual Recovery during Recumbency.*—J. H. F., aged 5 years, was admitted on 5th January 1892. The back had "grown out" two and a half years previously, and the child had lately become "weaker on its legs." Beyond these details the mother could give no information. On admission the child was pale and weakly, and entirely unable to walk. There was a large posterior curvature in the dorsal region, extending from the seventh dorsal to the first lumbar vertebra. The projection was rounded. Partial anæsthesia was

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[1] Such an event may have occurred in one of Dr. Gowers' cases. "A woman, aged 45, who had suffered from pain in the spine, one day, while walking, sneezed violently three times, and immediately felt 'pins and needles' in the right knee, and subsequently in the foot. The right leg became powerless during the next three days, the left leg followed suit, and at the end of six weeks both legs were motionless." She died six months later.

present from the ninth rib downwards on both sides, but sensation to painful impressions was still retained; he felt slightly the forcible prick of a pin; as he lay in bed the legs were extended and rigid, with considerable adductor spasm and muscular wasting. He could move the legs slightly, making some attempts at flexion and rotation. The knee reflexes were present and exaggerated. There was some incontinence of fæces when the motions were loose, and imperfect control over the bladder; at night he passed urine in his sleep; and in the daytime he must relieve himself directly he felt the desire. Temperature was 98·4° F., and no abnormal signs were found in the chest. The child was placed in bed with an extension-collar beneath the chin and occiput, and the head of the bed raised three inches. It was noted, on raising the child into the sitting position and placing one hand over the lower part of the sternum and pressing with the other firmly over the prominence behind, that there was considerable yielding forwards in the spinal column ("pressure with the palm of the hand" test).

26*th January*.—The spine was more consolidated, but with no improvement in the bladder symptoms, nor in muscular power.

11*th February*.—He was now sensitive to touch in both legs.

16*th March*.—Could flex knees and ankles freely, and raise the legs two inches from the bed. The fæces were completely retained, and the urine did not escape so freely.

1*st June*.—He attempted to raise himself in bed, the adductor spasm had completely disappeared; he held his water well, and kicked his legs about in the bed with freedom. The spinal column had increased in firmness, and the child was fatter.

28*th September*.—He could walk a few tottering steps without support, and the back was quite firm.

6*th December*.—He was quite able to walk alone. He was discharged wearing a poroplastic jacket with a head support, and the extension apparatus to be used at night at home.

For convenience of description I have arranged the symptoms, not in the order of their onset, but from a functional point of view.

(*a*) Motor.—The patient complains of getting tired easily, and soon the legs begin to drag, and the toes to catch in walking. With these signs there are loss of equilibrium and complete inability to stand alone, since both legs usually suffer equally; and finally the child lies in bed, quite unable to move the lower extremities. If the disease is in the cervical region, the arms suffer before the legs. Occasionally it happens that in occipito-atlantal disease the diaphragm is paralysed, oftentimes suddenly; and the spinal accessory and hypoglossal nerves too are affected.

(*b*) Sensory.—Dull aching pain is common in the early stages, both in the body and limbs. In the body the most usual form is girdle-pain or pain in the "pit" of the stomach.[1] These pains around the body are due to irritation of the nerve-roots. Oftentimes there is no anæsthesia, or it occurs occasionally without motor symptoms. Sensation is at times regained when motion remains absent. Anæsthesia dolorosa scattered in patches is not uncommon, and hyperæsthesia is found above the lesion.

(*c*) Reflexes.—The superficial reflexes are exaggerated, and so too are the deep, especially the knee and ankle. If the lumbar enlargement is involved, the reflexes are absent. When degeneration has set in they are lost as in disease in other regions of the cord.

(*d*) Sphincters.—Incontinence of urine and fæces occur in severe cases. But I do not share the opinion that they indicate any excessive gravity or inability for recovery.

(*e*) Trophic.—The affected muscles waste, and the "reaction of degeneration" is more or less marked. Before wasting sets in, distinct spasm of muscle is found, notably if the disease is in the dorsal cord. Herpes zoster has been seen along the course of the irritated nerves (Gowers). Acute bed-sores are not uncommon.

(*f*) Vaso-motor.—The limbs are often cold, and sometimes perspire persistently.[2]

(*g*) Special to various regions.—In the cervical region the pupil may be dilated, in the dorsal the intercostal muscles are affected; hence with diminution of breathing capacity and horizontal decubitus, acute bronchitis and broncho-pneumonia form serious complications.

Diagnosis.—The pain of compression has been referred to all manner of causes, but it avails little to tabulate these. Suffice it to say that it should be an invariable rule to examine carefully the back if any of the above signs are present, and this rule is the more urgent if we are dealing with a child whose history is tubercular. Although a projection may be absent, this should not negative the existence of Pott's disease. It has happened that the paraplegia has disappeared when a projection has formed. As stated above, the nerve symptoms may declare themselves before the bone symptoms. The practical deduction is, examine a child back and front, and so avoid the vexation of having the cause of the paralysis pointed out by a more discriminating surgeon.

[1] The writer is acquainted with the case of a child who for two years was erroneously treated for "liver and stomach" trouble. On further advice being sought, a large projection, hitherto unnoticed, was found in the lower dorsal region.

[2] Gowers has seen persistent sweating of one half of the forehead in cervical caries, due to interference with the cilio-spinal centre.

Prognosis.—The general tendency of the great majority of cases is towards complete recovery without operation. Mere recumbency with extension is often sufficient to induce an immediate change for the better. Some cases, as mentioned previously, recover without any form of treatment. Recurrent attacks are dangerous, but not so *per se.*[1] Cystitis and bronchitis are grave complications, but I have known some of such cases recover, and the presence of these troubles should not urge one to hasty operation. The value of laminectomy will be dealt with under the general heading of treatment.

To complete the list of the complications of Pott's disease, I have only to mention localised pleurisy, due to direct extension of the morbid process from the vertebræ and mediastinal abscess. A general condition of asthenia from the caries itself occurs, in which, however, the reflexes are normal, so determining the absence of true paraplegia. Digestive disturbances are not infrequent, and crises gastriques occur.[2] At any time acute tuberculosis in one clinical form or another may arise.

[1] Cf. a most instructive case of Gowers, *op. sup. cit.* p. 248.

[2] Cf. the persistent and dangerous attacks of vomiting associated with Infantile Paralysis.

CHAPTER II

CARIES OF THE SPINE (ANGULAR DEFORMITY)—(*Continued*)

Symptoms of Uncomplicated Caries—Method of Examination—Diagnosis from Rhachitic Kyphosis, Senile Kyphosis, Hysterical Spine, Scoliosis, Malignant Disease of the Spine, Hip Disease, etc.—Prognosis of Spinal Caries without and with Abscess as to Age, Sex, Family History, Social Condition, and Danger to Life—The Prognosis of Abscess as to Region of the Spine involved, Sex, Age, Presence of other Complications and Methods of Treatment.

The Symptoms of Spinal Caries.—The later conditions having already been discussed under the heading of complications on the ground that deformity, abscess, and compression-paraplegia are rather results than signs, it remains to describe the onset of the disease more particularly. The *history* may generally be regarded as untrustworthy if it speaks of slight blows; any severe accident, such as a fall from a height, will always be graphically described, and the date accurately remembered with all the attendant circumstances. In such instances, if the child be otherwise healthy, reliance may be placed on the account given, but much discrimination must be used if the history is vague. At the same time the careful surgeon will not neglect to inquire into the patient's antecedents, especially as to presence or absence of tuberculosis; and the replies given, together with his own deductions, will necessarily assist him in forming a prognosis.

Method of Examination.—(1) The attitude and mode of progression should first be carefully observed. I cannot do better than quote the graphic description of Professor Sayre[1]: "When walking about the room, the child will reach with his hands from one article of furniture to another, making careful calculation that he shall not be deprived of the support furnished by one article before he receives support from another. If he cannot obtain support by

[1] *Op. cit.* p. 364.

catching hold of various articles within reach, he will rest his hands upon his thighs, in order to transmit the weight of the head and shoulders through the legs to the ground, thereby giving them support without bearing upon the diseased vertebræ." I have often noted, when seeing out-patients, that children in the progressive stage will clutch at once at the writing-table as soon as released from the mother's support; and on the converse I always take it as a most encouraging sign after a course of treatment when the child, on being brought for examination, stands alone for a minute or two. The mother will often tell one that the child is more readily tired than previously, that he wants to lie down; or in resting, adopts unwonted attitudes, such as leaning the arms upon a chair or seat, holding the head with the hands, or putting the hands on the front of the thighs and stooping or squatting according to the region affected. The attitude assumed is due to an effort on the part of the patient to prevent any jarring of, or increased pressure upon, the affected part. He places himself, as Professor Sayre says, in a "muscular splint." If the upper cervical vertebræ are affected, the head is oftentimes drawn to one shoulder, and the case may be mistaken for wry-neck, due to contraction of the sterno-mastoid. Error may be avoided by noting that in spinal disease the face is not turned away from the affected side, as it is in ordinary "wry-neck." If the lower cervical or upper dorsal region be diseased, an effort is made to balance the head as much as possible; the chin is pushed forwards, suggesting "the position of a seal's head when out of water" (Bradford and Lovett). The attitude when the disease is in the mid-dorsal region is described above. An early affection of the lumbar region is often characterised by some lordosis, and a curious sidling gait is not uncommon, due to irritation and contraction of the psoas and iliacus muscles; but marked contraction of the psoas, giving rise to persistent flexion, should be regarded as evidence either of distinct psoitis or abscess. In the effort made to avoid jarring, the patient often walks on his toes with flexed knees in a condition of muscular attention. The child should now be stripped; in an adult it is convenient to have a loose skirt hanging from the hips, and put on after removal of the ordinary garments. We may now proceed to test for the other symptoms.

(2) *Muscular rigidity*, which causes impairment of the natural mobility of the spine and other parts. Of all signs this is the most valuable. It is present from the first, and can be ascertained

by the following manœuvre. If in a normal spine the hand be placed palm-wise on several vertebræ, and the patient be directed to bend forwards, the spinous processes move individually, and when the body is brought back to the upright position, the vertebræ are felt to come successively into position. Now in a diseased spine this is not the case. On placing the hand on the spine, and examining it carefully in the manner described, when the affected region is reached, three or four vertebræ are felt to move *en bloc;* they move forwards and come back *in one mass.* With practice this sign serves to detect even the earliest cases. If the muscles on either side be felt, they are noticed to be slightly stiffer and firmer than elsewhere. This rigidity is the "advanced patrol" of disease, and the mobility should always be tested if the patient complain of pain in the abdomen or chest, and no cause be found there.

In more advanced cases the rigidity is demonstrable by the common manœuvre of inviting the child to pick up a small article from the floor. To quote Professor Sayre again, "If the vertebræ are diseased, he will begin by bending the hips and then the knees, and finally will squat down and pick up the object, and rise up in the same careful way that he went down, keeping the back as nearly straight as possible, and allowing no movements in the spinal column which he can prevent." A very noticeable symptom due to muscular rigidity is the short grunting, almost spasmodic respiration of these children when standing or sitting, especially if the disease be in the lower cervical or upper dorsal region. This grunting is at once relieved by laying the child across the surgeon's knees in the prone position, with the arms over one thigh, and the legs over the other. The surgeon then separates his thighs gradually, thus making extension on the patient's spine, and taking off the pressure on the intercostal nerves, with the result that the breathing becomes at once tranquil and somewhat full. On closing the limbs again, the jerky respiration returns.[1]

In early cases it is advisable to test the extensibility of the spine by laying the patient on his face on a couch and *gently* lifting the child up by the feet. To test the flexibility of the spine, the child should be seated with the legs extended, and should endeavour to touch the toes with both hands, at the same time flexing the head fully. If the psoas or quadratus lumborum are affected,

[1] I consider this is a very valuable sign, and have often proved it; for this we are again indebted to Professor Sayre.

extension of the back in the way just mentioned is nearly or quite impossible, and any attempt gives rise to pain. It should not be forgotten, however, that the movements in the lower cervical and upper dorsal portions are naturally limited, and unless careful examination here be made, rigidity may be overlooked.

(3) *Pain.*—Subjectively this is present in the majority of cases. Occasionally it is absent altogether, even with considerable rigidity of the back; or there may be merely weariness and slight aching. "Reflected" pain in spinal caries is often a misleading symptom. It assumes the form of headache over the occiput in cervical disease, or of shooting pains in the arms; of sternal pain or "neuralgia in the side" in dorsal disease; of dry "belly-ache" or girdle pain[1] in the dorso-lumbar, and of growing pains in the legs in the lumbar form of the affection. These pains are essentially "nerve root" in origin. When they occur the whole course of the affected nerve or nerves must be examined with precision. The pain is sometimes acute, more often sub-acute, but liable to sudden increase; hence the sudden startings, especially at night; although it must be admitted that "night cries," or rather "early evening cries," in Pott's disease are comparatively rare as compared with other chronic bone and joint affections.

Objectively, pain is elicited by pressure over the individual spinous process. The value of this sign is overrated, and is not to be compared for diagnostic efficiency with rigidity. It is often absent in well-marked cases, while an hysterical girl will complain of pain on being touched; and if pressure be made on the processes alone, a faulty conclusion will be formed. Another method of testing for pain is to use a sponge wrung out of very hot water; this being brought over the site of disease gives rise to a sudden sensation of pain. Ice applied is said to do the same. Neither of these latter tests are reliable. Their absence does not exclude caries, their presence is often due to conditions other than caries. It is possible that a very sensitive surface-thermometer might indicate some local rise of temperature, but I have had no personal experience with this method. By gentle movements of flexion, extension and rotation, some pain is often elicited. The method of jarring the spine by sudden

[1] Cf. Hilton's *Rest and Pain*, 3rd ed. p. 93: "A gentleman whom I saw from the neighbourhood of Norwich with a disease of the spine, in detailing his case to me, said: 'Did you ever see any of those Italian fellows, with monkeys on boards, dancing to music, with a cord or piece of leather strapped tight around their belly and loins? That is just how I felt'; giving one an idea of the pinched and contracted condition of the abdomen which he had experienced."

pressure on the vertex in the erect position is as cruel and unnecessary as the jarring of the extended thigh in suspected coxitis. If disease is present, other symptoms have already decided the issue; if absent, sudden pressure on the top of the head is very uncomfortable and displeasing to the patient. Ashby and Wright[1] remark: "In a few instances we have found herpes zoster occurring in connection with caries of the spine; and it is worth while to examine the spine in cases of shingles, since they may be a result of lesions starting in the spinal column." A sudden increase of pain is often symptomatic of formation of abscess, increase of deformity, or the beginning of paralysis.[2] When treatment is effectual the first result is gradual decrease with final loss of pain.

(4) *Irregularity of the Spinous Processes, or Projection of one or more of them. Alteration of the Normal Curvature, either Flattening or Increase.*—The advanced conditions of deformity have already been fully dealt with. It remains, however, to speak of slight displacements. If with rigidity of a portion of the spine and pain, one or more spinous processes be unduly prominent and the angle altered relatively to the neighbouring processes, then the disease may be said to have declared itself. The sharper and more localised the projection, the greater the probability of Pott's disease. A projection of one spinous process is seen occasionally in scoliosis at the point of intersection of two opposing curves (see Figs. 11 and 39). Such a projection is quite unlike the sharp knuckle of a displaced spinous process of caries. The natural prominence of the seventh cervical and neighbouring spines should not be forgotten, nor the difficulty of feeling the bony tips in fat children. In any case the projection of one or more spinous processes is best marked in the dorsal region, as the natural curve has its convexity backwards, while the converse is the case in the cervical and lumbar regions; considerable displacement often occurs before a spinous process becomes prominent, owing to the thickness of muscles and the natural anterior curve.

(5) *Thickening around the affected vertebræ* is absent in the early stages, but, in my own experience, is generally to be felt whenever there are one or more outstanding spines. It is useful to recognise it, if any doubt exists as to the diagnosis between Pott's disease and scoliosis; such thickening is almost unknown in scoliosis. It should always be carefully felt for in every case, as it affords

[1] Ashby and Wright, *op. cit.* p. 567.

[2] Cf. Bradford and Lovett, *op. sup. cit.* p. 21.

evidence of considerable extension of the morbid process to the soft tissues. Later in the disease the bones themselves become thickened when repair is taking place.

(6) *Yielding of the Spine on Pressure.*—In the aggressive stages of caries if the palm of the hand be gently and firmly pressed over the posterior projection, the bones are felt to yield somewhat. As repair and healing take place, the yielding is replaced by a distinct resistance, which eventually becomes complete. This sign is of value in the following directions. If the yielding is great, it means that several vertebræ are affected and the prognosis will be guarded. When resistance is complete, the treatment may be relaxed and supports lessened.

To sum up the method of examination. Note the patient's aspect and walk on entering the room; observe the attitude he assumes at rest: remove the clothes as far as possible; test for rigidity, and regard it as the first and most important symptom, the "patrol" of disease; trace pains to their sources; search for any irregularity of the vertebræ; estimate the resiliency of the spinal column at the affected part; place little reliance on the history; and be on the look-out for abscesses and paralysis.

Other symptoms are sometimes present. We have dwelt on the peculiar grunting respiration. In addition, cough is not unusual, dyspnœa, gastric disorders, flatulence, obstinately recurring vomiting, and bladder troubles.[1] Dilatation or contraction of the pupil has been observed by Charcot and Gowers in cervical caries.

The *general condition* is one of malaise or distinct illness. Loss of appetite, sleeplessness, inability to get about are the cause of this, in addition to the depression of the vital powers, produced in tubercular cases by the production of several distinct foci of disease. The temperature is often raised slightly in the evening, and a hectic appearance may be seen.

The *onset of abscess* aggravates all these symptoms. Diarrhœa and wasting often ensue, and the temperature assumes a pronounced hectic character; the pain is increased and the general irritability is more pronounced. Dysphagia may follow from pressure on the pharynx and œsophagus; extensive abscesses in the chest give rise to physical signs such as dulness, etc.; abdominal abscesses are frequently accompanied by much flatulence and gastric disorder.

[1] Cf. Bradford and Lovett, *op. cit.* p. 20: "In one notable instance the operation for stone in the bladder—lateral cystotomy—was performed. No vesical trouble was discovered, but at the autopsy caries of the lumbar vertebræ was found."

The Diagnosis of Spinal Caries.—When the angular deformity is pronounced, no possible doubt can arise, but in the earlier stages it is possible either to overlook or totally mistake the condition. Experienced surgeons have frequently been at fault, owing to the peculiar complexity of symptoms in an individual case. Gibney quotes a case in which the malady was first thought to be a sprain, and five months later to be a subacute dorso-lumbar meningitis or coxal neurosis; two years later it was pronounced to be lumbar caries with psoas abscess, and at the time of writing the diagnosis was doubtful. Reeves,[1] quoting this case of Gibney's, says, "I mention this case to show not only that the symptoms may be obscure, but that they will vary according to the stage of disease causing it." Herein lies the whole truth. One may tabulate symptoms and give general rules, but cases are seen which set rules at naught and defy calculation.

In infancy and early childhood *rhachitic kyphosis* is not uncommon. But the general yielding of every part of the back, the absence of localised pain, the evenness and disappearance of the curve on suspension or lying down, with the presence of other signs of rickets, are sufficient points of distinction. In young adult life, especially in girls and young women, occasionally in neurotic boys, and in men notably after railway accidents, we find the *hysterical* or *neuro-mimetic spine*.[2] Here there is much pain and not seldom stiffness. But it should be noticed that the pain is "patchy," not following the course of nerves, but limited to certain localised areas with more than one point of special intensity; it is superficial as well as deep, and may change its seat. There are no spots of anæsthesia. Gowers[3] says, "There is more danger that caries of the spine in a young woman may be passed as hysterical paraplegia than of the opposite error. Especially when the subjects of caries present distinct symptoms of hysteria, there is risk, as experience shows, that unequivocal signs of caries may be overlooked." Unsuspected watching of the case, careful and repeated examination of the back are necessary. In any case let the surgeon beware lest he let the words "spinal disease" slip lightly from his lips when seeing neurotic women, if the symptoms at first sight appear doubtful. In those past middle life a natural or *senile kyphosis* sets in. As previously stated, the onset of Pott's disease is very

[1] *Bodily Deformities*, p. 138.
[2] Sir J. Paget, *Clinical Lect. and Essays*, Lecture v.
[3] *Op. sup. cit.* p. 252.

rare past middle life, but it has been recorded several times. *Syphilitic* curvature will be dealt with later.

The diagnosis from *scoliosis* or *lateral curvature* is generally easy; the presence of marked rotation from the first, the absence of rigidity and pain are sufficient points of distinction. Lateral deviation (as distinct from curvature) is not so uncommon in Pott's disease. Dr. Bernard Bartow has written an admirable and well-illustrated article on this subject,[1] although I am unable to agree with him as to the frequency of rotation. That such, however, does occur is well shown by the following case figured on p. 37.

CASE 10. *Pott's Disease with Lateral Deviation.*—Alfred K——, aged 10, was seen by me at the Evelina Hospital in April 1894, on account of a projection in the back and pain. Four years ago he fell across the rail of a bedstead, and experienced considerable pain at once. The next day he was taken to St. Bartholomew's Hospital, and some liniment was applied. He lost the pain and was able to get about well until the last few weeks, when he began to suffer, and was noticed to be walking unevenly.

On examination, there was a posterior projection extending from the eleventh dorsal to the second lumbar vertebra. The summit of the projection was deviated a half to one inch from the middle line. The lumbar curve below the projection was flattened, while above the prominence a distinct lateral deviation to the right was seen, embracing the whole dorsal region, but best marked from the ninth dorsal vertebra to the site of disease. There was no compensatory curve above. The attitude was erect and military, and there was rigidity of the right erector spinæ muscle, and he was unable to touch his toes with the knees extended. Pain was felt in the course of the first, second, and third left lumbar nerves, but no "girdle pain" was present, nor paralysis of the lower limbs. Distinct thickening about the lumbar vertebræ was present. He slept well, but could not turn in bed on account of the pain. There was no history of phthisis in the family, and no signs of phthisis were present in the patient. A plaster of Paris jacket was applied, and the boy lost the pain and was able to get about well.

Lovett,[2] in writing on this subject, sums up as follows:—

1. "Lateral deviation is common, especially in advancing cases, but absent in those getting well and those cured; the early cause is muscular irritation, the later, unilateral absorption of bone.

2. "Rotation is not a prominent factor.

3. "The distortion is not that of scoliosis, viz. a sinuous curvature, but a distinct leaning of the body from one side to the other.[3]

[1] *Annals of Surgery*, vol. x. p. 48. [2] *Trans. Am. Orth. Assoc.* vol. iii. p. 182.

[3] The upper part of the body, in those cases I have seen, appears to be sliding off the lower at the affected spot.

4. "The deformity of the chest in lateral deviation from Pott's

Fig. 10.—Caries of the spine, with lateral deviation (Case 10).

disease does not follow the same rule in scoliosis; in the latter the ribs rotate backwards on the convex side, in caries on the concave side; cervical cases show the least lateral deformity.

5. "With the onset of marked lateral deviation a great increase of all the symptoms occurs, and pain is much greater on one side than before, but disappears with the diminution of the deviation under treatment."

6. Bartow specially notes that the patient is unable to overcome the distortion by any effort of his muscles that he is able to exert.

FIG. 11.—Lateral curvature of the spine, with marked prominence of two spinous processes.

7. Another feature of the deformity is its reluctance to yield, except in a slight degree, to extension force that is rapidly applied, while the patient is in the erect position.

As a rule it may be said that other signs of Pott's disease are present and sufficient to clear up the diagnosis. That at first sight the matter is not so simple as it may appear is shown by Figs. 10 and 11. In both cases there is a limited projection of the lumbar spines, in both there is lateral deviation, in both pain; but in Fig. 10, the boy with Pott's disease, there was present the "tell-tale" rigidity below the prominent spine and the local thickening; while in the girl (Fig. 11) this was absent.

Curvature in some cases is due to *syphilitic disease.* It occurs in adults much more than in children, and affects the upper part of the column rather than the lower. The only clue to the cause of the deformity is the presence of other syphilitic symptoms. *Malignant disease* of the spine simulates caries in some instances. A fuller notice of cancer in the spine will be given later. The diagnostic differences are as follows, which I take from a clinical lecture of Mr. Howard Marsh[1]: "The symptoms of malignant

[1] *Lancet*, vol. ii. 1893, p. 791, "Bye-ways in the Study of Diseases of the Spine."

disease of the spine bear at first sight a very close resemblance to those of acute Pott's disease. The deformity which occurs is the same, and pain in the column and in the course of the intercostal nerves is also similar in the two affections, yet a closer study will usually disclose certain differences which are sufficient for a correct differential diagnosis.

"In the first place, pain is generally much more severe from the first—altogether a much more prominent symptom—in malignant disease, than it is even in the most acute cases of Pott's disease. In some cases it amounts to agony.

"Secondly, the disease advances much more rapidly than caries, so that deformity generally makes its appearance very early—in the course of a few weeks—and then very rapidly increases.

"Thirdly, paralysis at first of a single limb, or even of a single group of muscles, but soon becoming extensive, is very commonly present within the first few weeks; and instead of tending to pass off, as is the case in paralysis due to Pott's disease, when the spine is placed at rest, in malignant disease it tends steadily, and often rapidly, to become worse and worse.

"Fourthly, incontinence of urine and fæces is soon developed, and bed-sores quickly form.

"Fifthly, the patient, instead of improving and gaining flesh, as is the case when he is placed at rest for Pott's disease, rapidly loses flesh, and becomes feeble and cachectic.

"Sixthly, the course of the case is a steady and usually a rapid progress from bad to worse; so that, generally speaking, the patient does not survive for more than six or eight months.

"Lastly, there is in many cases evidence of primary carcinoma in the breast or elsewhere; a circumstance which, in any case, he, who would avoid mistakes, must obviously be determined not to overlook."

It may be added to these signs so ably presented by Mr. Marsh, that in malignant disease of the spine, when a projection is found, it is usually more rounded and less sharp than in caries; neither does a "malignant" projection carry on it a bursa. It is too rapidly formed.

In cervical caries the head, as previously mentioned, is displaced to one side, and may be confounded with *wry-neck*. Fortunately for the diagnosis, considerable thickening of the soft tissues occurs early in cervical disease, and the back of the neck is flattened. In true wry-neck the head is rotated to the opposite side, though drawn down to the shoulder on the affected side. In displacement from caries, the head is fixed laterally, but not rotated; and the deep muscles as well as the sterno-mastoid are contracted. Movement is very limited or absent in caries, whereas in wry-neck it is free in all other directions, save when the shortened sterno-mastoid is pulled on. Then, too, there are the anxious expression, and the attitude and "military" movement in caries; or in more advanced cases the head is held with the hand supporting the chin.

Hip disease or coxitis may mislead unless careful examination be made. The contraction at the joint and the flexion simulate the psoas-contraction of spinal disease, but special attention to the limitation of movements at the hip-joint, especially flexion, will serve to clear up doubts. In rare instances coxitis and caries coexist.

CASE 11. *Coexistence of Spinal Caries with Double Coxitis.*—W. B., aged 9, when 3 years old attended Great Ormond Street for double hip-joint disease, and weight-extension was applied. The joints ankylosed, and he afterwards went to the Convalescent Home at Highgate, where he stayed a considerable time. A year ago the mother noticed a projection in the back. I saw him at the National Orthopædic Hospital in March 1894. His appearance then was striking; he had the bowed aspect of advanced age: in the back a projection was seen, composed of the spines and transverse processes of the eighth to the eleventh dorsal vertebræ. Both hips were firmly ankylosed, the right at an angle of 30° and the left at an angle of 35°. On examining the spine it was found to be very yielding over the projection, and there was very marked girdle pain and much general distress and illness. A poroplastic jacket was fitted, cod-liver oil ordered, and the mother advised to get him away to the seaside. The case ultimately did well, but there was left very considerable deformity.

From *sacro-iliac disease* the diagnosis is made by the absence of rigidity in the spine, and the persistence of pain over the affected joint, together with the characteristic "sacro-iliac" attitude and the lengthening of one side of the lower part of the body, due to weakening or destruction of the sacro-iliac ligaments. As the disease progresses, swelling appears over the joint, and it may be fluctuation. The latter must not be mistaken for spinal abscess.

Osteo-arthritis and *osteitis-deformans* cause a general and not a limited kyphosis; nor do they give rise to reflected pain, unless it may happen—a rare event, I imagine—that the nerves are pressed upon as they issue from the spinal canal.

Perinephritis and *perityphlitis,* in addition to pain, have one symptom in common with caries — psoas-contraction. In the absence of abscess the diagnosis is made by a practical acquaintance with the symptoms of the several diseases. *Erosion of the spine from aneurism*, although it gives rise to dry caries, can scarcely be mistaken for Pott's disease in the ordinary acceptation of the term. Long before any deformity can occur, other symptoms have generally called for careful palpation and auscultation, sufficient in themselves to render the cause of the persistent pain in the spine evident.

With regard to the *diagnosis of the cause of the paraplegia*, in some instances the latter happens that this precedes deformity, but rigidity and other symptoms of caries are present from the first. As to the other causes inducing paraplegia, such as myelitis, meningeal tumours, gummata in the cord, the reader is referred to the standard works on "Diseases of the Nervous System."

The *advent of abscess in caries* sometimes complicates the diagnostic problem. Renal symptoms may occur from abscesses which are spinal in origin. Mr. Jacobson, writing on the subject of nephro-lithotomy,[1] says, "The great difficulty which may arise in diagnosing between certain cases of spinal caries and renal calculus is not yet sufficiently recognised. G. A. Wright[2] thus alludes to this matter: 'When a local patch of caries of a vertebral body exists, and especially where deep suppuration occurs and presses upon the kidney, as in a case of my own and one or two others which I have seen, nearly all the symptoms of a calculus have been present. In my own case, without any deformity or tenderness of the spine, there was unilateral rigidity, testicular pain, intermission of symptoms, increased frequency of micturition, nausea during the attacks, and oxaluria with local pain and tenderness. Subsequently an abscess developed, and on exploration a small patch of caries was found, and the kidney was felt exposed on the anterior wall of the abscess cavity. Probably, as in floating kidney, obstruction of the vessels and ureter may arise and cause symptoms, so that pressure of the spinal abscess may disturb the kidney, and quite possibly give rise to hæmaturia.'" Erichsen[3] says: "I have, however, seen an abscess dependent on caries of the vertebræ not only assume the perinephritic form, but open into the pelvis of the kidney, thus simulating chronic pyelitis. In this case the diagnosis was made

[1] *Brit. Med. Journal*, 1890, vol. i. p. 117.
[2] *Med. Chron.* No. 6, p. 642.
[3] *Science and Art of Surg.* 8th ed. vol. ii. p. 426.

by a careful examination of the pus, in which molecular masses of carious bone were found. The chemical and microscopical examination of the pus in all cases of doubt should never be omitted."

As psoas abscess in the vast majority of cases presents in the thigh, and numerous other fluid swellings are also found there, it behoves the surgeon to attend carefully to the diagnosis of these conditions. Such may be perityphilitic abscess; iliac abscess arising from disease of the pelvic bones[1]; localised collections of pus in the muscular and areolar tissue; intra-pelvic abscess arising from coxitis; cysts; femoral hernia with fluid in the sac: and bursitis. As Sir John Erichsen points out, if the iliac abscess is superficial to the fascia iliaca, it very rarely passes beneath Poupart's ligament, owing to the firm attachment of these structures together. When the collection of pus forms beneath the fascia iliaca, there is nothing to prevent it extending to the psoas and passing down under Poupart's ligament: and the determination of its origin, whether from disease of the ilium or vertebræ or from a strain, can be made only from the presence or absence of the symptoms of disease of the spine. Psoas abscess also in many cases appears suddenly in the thigh, the patient finding on washing himself in the morning that he has a large soft tumour in the groin: whereas iliac abscess comes on more gradually, and presents in a more diffused manner.

From *femoral hernia* the diagnosis of abscess is not difficult: both give an impulse on coughing, but the gurgling on the return of a hernia and its sudden reappearance when the pressure is taken off are characteristic.

There are several other conditions for which spinal disease and abscess may be mistaken, but a thorough examination on the lines already indicated will almost always enable the surgeon to avoid errors.

The Prognosis of Angular Deformity and Spinal Abscess.—The existence of Pott's disease must necessarily be of serious import to the general health and life of a patient. The severity of the disease itself; the part affected, the spine being the central axis of the trunk; the effect of even uncomplicated caries on the general health; the moderate probability of severe complications, such as abscesses with all their attendant train of evils; the onset of paralysis; the possibility in tubercular cases of the existence of foci elsewhere, must all militate severely against the attainment of

[1] Cf. case quoted in note to p. 26.

moderate health, not to speak of longevity. The outlook, however, is not necessarily so very serious. Many patients recover entirely, and may be seen to acquire fresh strength and health after the disease has passed away. They even become vigorous old men in spite of the deformity, just as many sickly children, carefully reared in their earlier years, survive the wear and tear of early and middle life, and seem to preserve their strength even in declining years. At the sea-coast and in healthy country districts an old man, hale though deformed, is not such a rare phenomenon to the medical man as might be expected by those whose practice lies in towns.

In the first place, let us consider the prognosis in *uncomplicated* cases when seen for the first time by the surgeon. The factors to be considered are the family history, the age, the history of the disease, the present condition, and the social status of the patient. We may then pass on to discuss the elements of prognosis as to duration of the disease and the probability of recovery. Having spoken of simple cases, it remains then to speak of the probable results of abscess, paralysis, and visceral lesions.

Family History.—In a simple uncomplicated case with or without deformity, in which there is no history of tuberculosis in the parents or grand-parents, a favourable opinion may be expressed as to the ultimate cure of the disease, while reserving any definite expression as to the nature of the cure in the direction of deformity and future usefulness of the patient. To quote an example.

CASE 12. *Pott's Disease arising from Injury; Complete Recovery.*—A. G., aged 50, when 9 years old climbed up the rain-water pipe on the side of a house, and fell from a height of fifteen feet. He injured his back severely, and considerable pain followed from the time of the accident. This was succeeded in four months by the appearance of a projection limited to the upper dorsal region. Notwithstanding the pain, the child was allowed to get about, and the deformity then became much greater. Subsequently, however, complete cure without abscess followed, and the patient is now perfectly healthy and strong, and able to enter into all the duties of active life. His great-grand-father attained the age of 78, his grandfather 93, his grandmother 85, his father is alive aged 75, and his mother recently died aged 77. Other members of his family are well and strong.

On the other hand, a tubercular family history is almost always, if not entirely, an unfavourable element, and minimises the prospect of complete recovery; while it increases the probability of extensive disease of bone, abscess and the development of tubercle, visceral or arthritic, under the prolonged strain of the disease itself, and the tedious course of treatment necessary.

The Age.—In children the prognosis is less favourable than in adults; because phthisis is much more likely to develop in the former than in the latter, and the opinion as to cure of the disease and the length of treatment must be more guarded in children on account of the more extensive bone destruction.

In a careful article[1] on Pott's disease and pregnancy, Dr. T. Halsted Myers points out that the gravity of the prognosis is much increased by *pregnancy*, even when the caries is apparently cured. The weight of the gravid uterus in active disease increases the probability of abscess-formation, especially when the disease is lumbar. If the disease be entirely cured, the disturbance of the circulation induced by pregnancy tells upon the heart, and some patients succumb from cardiac failure. Dr. Myers quotes seven cases in which active disease complicated pregnancy. Four were dorsal and three dorso-lumbar. In six of these pregnancy either originated or greatly increased the severity of the disease. In the remaining case, pregnancy and parturition were harmless.

The History of the Disease and the present Condition of the Spine.—I have previously advocated that little reliance can be placed upon the history unless it is absolutely clear and circumstantial, and when the disease dates from a distinct injury of a severe nature in a non-tuberculous child, a more satisfactory prognosis may be expressed than in dealing with a tubercular case. With reference to the condition of the spine, the following points should be carefully observed; the amount of rigidity, the number of vertebræ affected, the state of the spine as to yielding, the size of the projection, and the number of foci of disease[2]; these will serve as guides in forming the basis of an opinion.

The Social Condition.—Much must depend on the amount of care and attention that the patient can command. It may at once be said that the children of the poor, bandied about as they often are from one person's care to another, suffer more acutely, recover more slowly, and stand the strain upon the vital powers less readily than the children of the well-to-do, who can command all those hygienic measures of good food and fresh air which are so essential to their recovery while under surgical treatment.

[1] *Trans. Am. Orthop. Assoc.* vol. iv. p. 124.

[2] In Fig. 12 is seen the representation of a case in which the spine is affected both in the upper dorsal and dorso-lumbar regions; there is also considerable tubercular affection of both lungs, and the prognosis is therefore very serious.

An opinion will necessarily be sought as to the *duration* of the case. Each case must be judged on its merits. It is only possible to give the average duration of a number of collected cases. Any statistics bearing on this point should be received with reservation, owing to the likelihood of apparently cured cases creeping in and swelling the total. Some patients must be watched for many years before a complete cure can be said to have taken place, and unless one has noted very carefully a series of cases, it is not possible to fully appreciate the frequency of relapse. It may be said that with thorough treatment, the duration of cervical disease (excluding atlo-axial disease) is shorter than dorsal, and dorsal than lumbar, on account of the less size of the bodies of the vertebræ, the comparative fragility, and the superincumbent weight being less in the upper parts of the spinal column. Bradford and Lovett[1] remarked that "relief from symptoms is early obtained; but to establish a complete cure, so that there be no latent disease, requires protection and treatment for years. Roughly speaking, it is always possible to predict a course of treatment which shall last not less than three years, and probably longer." I take it, these data refer to both complicated and uncomplicated cases, and I do not think that even in the latter hypothesis they are at all beside the mark.

FIG. 12.—A case in which the vertebral column was affected in two regions (Percy E——, aged 3 years, National Orthopædic Hospital).

The Probability of Recovery and Danger to Life.—Reliable

[1] *Op. cit.* p. 50.

statistics as to the percentage of recoveries are difficult to obtain, since the cases must be watched through so long a period. Billroth and Menzel report 23 deaths in 61 cases; Jaffé noted 22 deaths in 82 cases; and Mohr, 7 deaths in 72 cases. In autopsies of 702 cases, Billroth and Menzel found tuberculosis of other parts in 56 per cent, amyloid degeneration was present in 15 per cent, and fatty degeneration of the kidney in 22 per cent. Bradford and Lovett quote Neidert's[1] investigations on the ultimate cause of death in patients with angular deformity, the result of caries which has been cured. Many with severe deformity die of heart lesions, those with medium-sized curves die of phthisis, while those with slight deformities have a good prospect of life before them. Neidert investigated 31 cases, and the average age at the time of death was 49½ years: 24 of whom had hypertrophy, some with and some without dilatation of the right side of the heart; 4 had cardiac muscular degeneration; 2 had stenosis of the mitral valve; 1 acute miliary tuberculosis; 8 died of phthisis; 4 of pneumonia, and 1 of carbuncle. The occurrence of narrowing of the aorta in Pott's disease has already been noted (Plate I.).

Causes of Death. — Tuberculosis is the chief, then come marasmus, exhaustion, lardaceous disease, spinal meningitis, and the fatal results of bursting of an abscess into the trachea, pleura, lung, œsophagus, peritoneal cavity, viscera; and in one rare case perforation into a large artery.

The Prognosis of Abscess.—This question may be considered from the following points of view: the region of the spine involved, the sex and age, the extent and position of the bone involved, the presence of other complications, and the influence of treatment.

The Region of the Spine involved.—In the cervical region abscess occurs less frequently than lower down, and its presence is soon manifest, and therefore ensures prompt treatment. It is this call for promptness which is, so to speak, the "saving clause" in cervical abscess, despite the grave possibilities involved in lesions of the cervical cord. In the dorsal and dorso-lumbar regions, the greater movements of the parts, the perpetual action of large muscles, and the lateral force exercised by the thorax in respiration must not only increase the liability to pus formation, but tend to make it spread in many directions when it is once present. Still more, as we approach the lumbar and sacral regions, the number of foci of diseased bone increase; and this, together with the peculiar

[1] *Inaugural Dissert.* Munich, 1886.

lamination of the fasciæ and the fusiform shape of the psoas, affords a wide scope for extension. In the dorsal and lumbar regions of the spine the ribs and transverse processes are sometimes involved, and form large sequestra; while the great depth of the bodies from the surface renders removal of sequestra difficult. In the lumbar region the same remarks apply with increased force, while in both dorsal and lumbar abscess the immediate contiguity of large serous cavities must be borne in mind.

Sex and Age.—Children bear the strain of abscess better than adults. While spinal abscess in a child rarely fails by the urgency of the symptoms to lead to careful examination and early recognition, in the adult it often runs a more chronic course; and it is not unusual for the patient to go about with "lumbago," the cause of which is found, on examination, to be caries with the coexistence of a large abscess hitherto unnoticed. I am inclined to think, from personal experience of such patients, that their cases run a chronic and often downward course, in spite of the most approved treatment.

FIG. 13.—Double lumbar abscess from spinal caries in a child, aged 15 months (the mother's hands supporting the child are not shown in the figure).

The Presence of other Complications.—The condition of cases presenting signs of advancing tubercle elsewhere, especially in the lungs, unfortunately calls for little comment. So, too, if hectic fever be once established, the peril is extreme. Next to abscess the most frequent complication is "compression-paraplegia." *A priori* it would appear that the occurrence of abscess during paralysis can have but one effect on the case. A serious view of the matter is not always justified. It often occurs that an intra-spinal abscess, the cause of compression, finds its way outside the spinal canal and empties itself into the softer tissues, with corresponding relief to the paraplegia. In cases of extreme deformity, when paralysis is due to the displacement of diseased bone, the onset of extraneous suppuration by assisting the breaking down of the bodies has relieved the compression.

The opposite result occurs when an extra-dural abscess forces its way through the sheath of spinal membranes. In such cases the prognosis is immediately bad.

In dorsal caries symptoms of œsophageal obstruction are of grave import. They indicate that the bodies of the vertebræ are extensively involved at the anterior aspect, and that the caseating process has extended to the posterior mediastinum, and that there is implication of the glands. The mediastinum is not a situation in which surgical interference is readily tolerated.[1]

The Method of Treatment.—This must necessarily influence the prognosis very materially, as in all abscesses. But in few is such discrimination of methods and zealous care in carrying them out so vitally essential. I allude more particularly to the question of perfect antisepsis from first to last.

[1] Cf., however, Mr. W. Arbuthnot Lane's cases recorded in the *Annals of Surgery*, vol. xvi. pp. 314-320.

CHAPTER III

THE TREATMENT OF CARIES OF THE SPINE AND ITS COMPLICATIONS

General and Local Treatment of Uncomplicated Caries—Treatment of Abscess, and Discussion of the various Methods — Treatment of Compression Paraplegia, Conservative and by Operation—Atlo-axoid Disease—Syphilitic Disease of the Spinal Column—Malignant Disease of the Spine—Neuromimetic or Hysterical Spine.

In spite of the severe nature of the spinal disease, much good may be done, and cure often effected. If the case comes under treatment in its early stages, deformity may be prevented or reduced to a minimum. In the absence of complications, cure will most readily be obtained in the cervical, lower dorsal, and lumbar regions; less readily and with more difficulty in the upper and mid-dorsal regions. The method of cure is by ankylosis, and when the disease is treated early and thoroughly the number of vertebræ ankylosed is small, the patient having a very useful back. I know of one who is able to climb difficult mountains, despite ankylosis of the four upper lumbar vertebræ. In his case there is no deformity. The treatment may extend over years; but the ultimate results are often such as to give solid satisfaction to the surgeon. Treatment may be described as general and local.

General Treatment.—Fresh air and sunshine are most valuable, particularly in tubercular cases. It is the deprivation of them, together with insanitary surroundings and bad food, that renders the treatment of poor patients so tedious. When the necessity for recumbency has ceased, the patient should be sent away to Margate or one of the East Coast resorts, or failing those, to a somewhat elevated dry place in the country. But Margate air in tuberculosis is nearly a specific in itself. Through the agency of various kindly persons we are enabled to secure six weeks or two months in the country from time to time for patients, and the good effect is most marked. The food should be regular and plentiful, avoiding saccharine and starchy constituents in excess. The stomach and bowels must be regulated and constipation prevented. The best laxative in children is pulv. glycyrrhizæ ʒss.-ʒj. at bedtime. Cod-liver oil, cream, or one of the malt extracts are useful, and we may from time to time give iron in the form of syr. ferri phosphatis co., or syr. ferri iodidi ʒj. thrice daily. In tubercular cases such general treatment is essential. In non-tubercular cases it assists their recovery most markedly.

Treatment directed to the Spine.—The principles of treatment are three in number:—

(*a*) To fix the vertebral column, and to place it in the best possible circumstances for healing.

(*b*) To remove the weight of the upper part of the body from the diseased vertebræ.

(*c*) To prevent, as far as possible, unnecessary deformity by supporting the trunk, especially in front; and if deformity has occurred, to limit its increase.

To carry out these principles we have two methods at our disposal, viz. recumbency and the use of retentive appliances. They may be employed separately or in combination in individual cases, but can never be used indiscriminately. The precise value of each varies according to the age, stage of the disease, and the different regions affected.

Recumbency.—Indications for:—

1. In all acute cases in which there are considerable pain, distress, and impairment of the general health.

2. When, on employing the "palm-pressure" test to the back, it is found to be yielding anteriorly.

3. When paralysis and abscess are threatened.

4. Particularly in cases of severe cervical and lower lumbar caries.

5. In those patients who become easily tired on their feet, and in those who, apparently well supported mechanically, frequently desire to lie down.

6. In children recumbency may be resorted to with less danger to the general health than in adults. The immediate effects of recumbency are good; the pain disappears, the nervous irritability is lost, the face loses its anxious aspect, and the patient often puts on fat, although the muscles of the limbs diminish in size.

The *advantages* are thus evident. The relief of pain: the limitation of the deformity, and in some cases its recession; the gradual clearing up of any paresis, and the cessation of increase in the size of an abscess, are all good points.

The *disadvantages* are, that in adults there is, after a comparatively short improvement, a marked decline in the general health; anæmia and constipation ensue, and wasting again appears. In the case of children these are not marked. Provided the room be airy and sunshiny, young patients bear the prolonged lying down better than adults. But as caged animals are found to be liable to tubercular affections, so children deprived of their liberty will be unable to recover as rapidly as desirable from tubercular troubles. Formerly recumbency was persisted in for years, but now after a time we have the opportunity of giving patients more liberty by the use of plaster of Paris corsets, or some mechanical support such as a poroplastic jacket. It must be clearly borne in mind that when recumbency is demanded, it must be absolute so long as it lasts.

The *duration of recumbency* can scarcely be specified in set terms of months. Each individual case must be judged on its merits. At the National Orthopædic Hospital I am accustomed to keep children recumbent until all pain has disappeared; until the palm-pressure test shows the back to be consolidated; and until, with a little support from the nurse, the child can be sat up carefully for a few minutes, such raising to the vertical position not being accompanied nor followed by pain. In cases which are doing well, the patient becomes restless, moving his arms and legs freely and fidgetting constantly, or even attempting to turn over. One finds, however, that unless the case is past treatment, the condition of the spine has markedly improved in three to nine months.

Points to be noted in placing a Patient in the Recumbent Position.—1. The mattress should be of horsehair, firm, flat, and not too hard, pillows beneath the head being dispensed with.[1]

2. Air-beds or water-beds are best avoided, on account of their

[1] Bradford and Lovett, *op. cit.* p. 55, describe a simple way of arranging a bed-frame so that the child can be moved readily in it and the bed-pan used without disturbance. Dr. Schapps, *N. Y. Med. Journal*, 21st Oct. 1893, has devised a very cheap and useful form of couch for cases of Pott's disease. The frame of the couch is made of gas-pipe and the body of canvas, stretched as tightly as possible, in which a hole is cut at the point over which the anus will be situated. On each side of the spinal curve, and across the sacrum, small sausage-shaped pads are sewn, to prevent undue pressure on bony points and to steady the body. Straps are also fixed to the bed, which pass over the shoulders from the axillæ, and buckle to the bed as near the root of the neck as possible. By means of a weight attached to the ordinary Sayre head-piece, traction is made on the spine. The bed should run on rubber-tired wheels.

instability. They are of doubtful service if the patient is very thin, and bed-sores threaten. These may be obviated by alternating between the prone and supine positions.

3. It is necessary in most cases to employ some retentive arrangement to prevent movement. In cervical and dorsal cases a band across the chest, or a knitted-wool strap passing across the chest with circlets for the arms, and fastening to the sides of the bed, is desirable. In disease of the lumbar region it is necessary to supplement the upper band by a lower one across the abdomen. In older children the band acts as a moral rather than physical restraint. In younger children it is really necessary. An excellent arrangement, a bed-frame (Fig. 14) designed by my colleague Mr. F. R. Fisher, is described in the *Lancet*, February 1878. It is sometimes sufficient to pin the night-dress to the sheet, which is firmly fixed at the sides of the bed, or to use sand-bags.

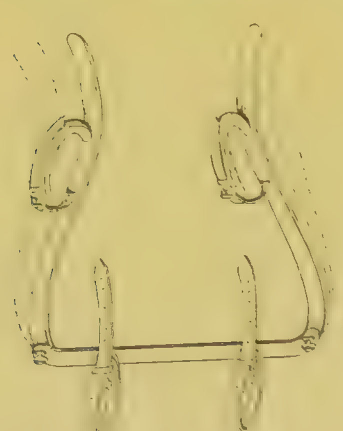

FIG. 14.—Mr. F. R. Fisher's bed-frame for cases of spinal caries.

4. Should extension be used at the same time? If it be used with the idea of pulling apart the diseased vertebræ, the idea is erroneous, as a very large amount of force is necessary to separate the bodies; but if it be employed to relieve the pressure between the adjacent parts of the diseased and partially-collapsed bodies, brought about by the action of irritated muscles, then its adoption is rational and necessary. In the cervical and upper dorsal forms of disease a leather collar and pulley may be fixed, and a weight of one to two pounds suspended, the head of the bed being raised one to two inches. The weight also serves to fix the head; or sand-bags may be used in addition if the case is an urgent one. In the mid- and lower dorsal and lumbar regions, pads of soft felt may be placed beneath the body in the region of deformity, bearing on the soft tissues at the sides of the median line, and not on the spinous processes themselves; when the trouble is lower dorsal or lumbar, extension may be applied to the legs, the foot of the bed being elevated slightly. Such measures seem to me to answer most requirements, and I have not found it necessary to use Rauchfuss' suspensory cradle, although its merits are largely dwelt on by German and French surgeons.

5. In private cases it is desirable to have a couch or bed which

can be moved and placed in a carriage, so that the patient may obtain fresh air. In poorer patients a Phelps' box (Figs. 15 and 16) answers the same purpose when the acuter symptoms have passed away.

6. The choice of positions—prone or supine? In the majority of cases, the supine is preferable, although it may be replaced by the prone for a short time, to avoid bed-sores. Obviously in cervical disease where extension is necessary, the supine position alone is available. Rédard[1] strongly advocates the prone position in those dorsal cases where the deformity is commencing, where there is a

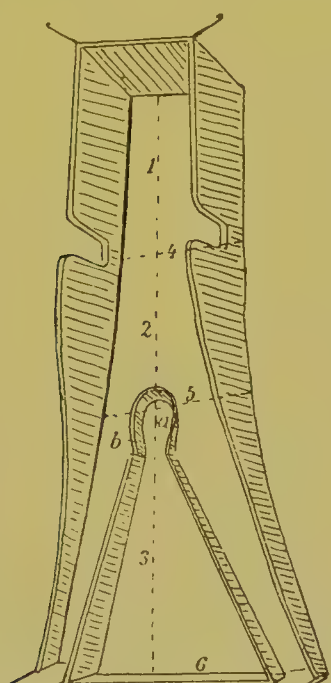

FIG. 15.—Phelps' box for spinal caries.

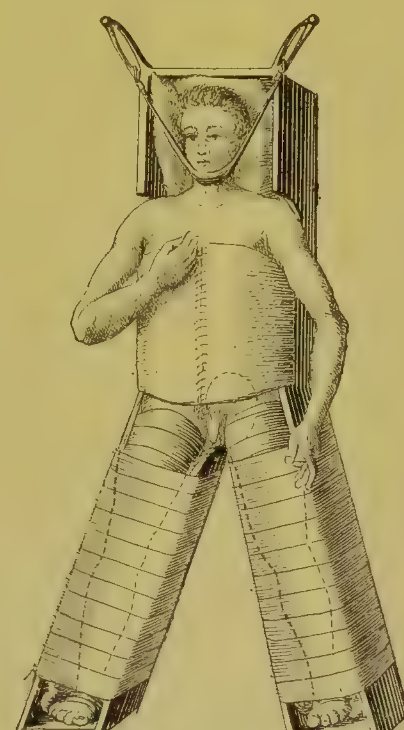

FIG. 16.—Phelps' box for spinal caries.

good deal of irritation and contraction of the muscles, and paralysis is setting in rapidly. He claims that in four out of eight cases he obtained a considerable diminution of the prominence, and in three that the deformity was not increased. He further states that the irksomeness of the position was soon overcome, and the general condition remained good with no loss of appetite. The prone position has certainly the advantage in that it places the congested spine uppermost; but the disadvantages of it are that a specially-constructed couch is necessary, and more continuous attention to the patient is required.

[1] *Traité de Chirurgie Orthopéd.* pp. 244, 245.

When the surgeon is satisfied that the severer symptoms have subsided, the spine is firm, and the probability of abscess or other complications is slight, it is well to adopt a combination of the methods of partial recumbency and fixation-appliances. This may be done by using either a double Thomas's hip-splint and crutches, if the disease is low down in the spine, or the patient can be firmly supported by one of the mechanical means to be detailed below. So that at first he is allowed to move about in the upright position for a few minutes daily, and the time is then gradually extended, more locomotion being allowed and less recumbency enforced; care being always taken that movement stops short of fatigue, and that during the time he is recumbent the horizontal position is strictly enforced. Various complicated arrangements are figured in books and are in use, but I fail to see that they have any advantage either in the amount of movement allowed or support given over the simpler poroplastic or plaster jacket.

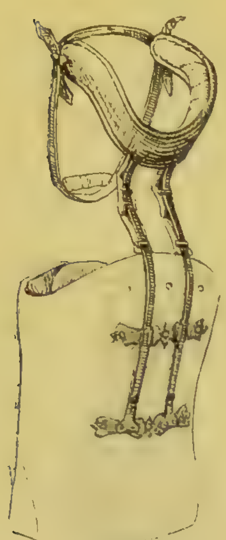

FIG. 17.—Poroplastic jacket with occipital head-piece for cervical caries (Ernst).

Suspension.—A few words are not out of place in dealing with this matter. It is absolutely essential in cervical disease, and can be easily arranged by carrying the plaster bandages of a Sayre's jacket around the neck and forehead, leaving the face and vertex exposed. Naturally this is unsightly and cumbrous, but it affords excellent support. Or a jury-mast may be fitted to plaster or a poroplastic jacket. In the treatment of out-patients I am accustomed to use a poroplastic jacket carrying a stem accurately adjusted to the dorsal curve and bearing an occipital head-rest, with a sling supporting the chin (Fig. 17). Another method is to supplement the felt jacket by a helmet and neck-piece, so making a complete cuirass after Walsham's plan. In lower cervical cases which are approaching cure, it is often sufficient to continue the poroplastic material around the neck, and still later a simple felt or Thomas's leather collar may be used.

Suggestions as to the Employment of Suspension.—Suspension or support of the head and shoulders is necessary if the disease be above the fourth dorsal vertebra, and support of the shoulders alone if the disease be at or above the eighth dorsal. It is needful to insist upon this point, since one frequently sees cases of disease of the upper dorsal vertebræ brought to the hospital with nothing but a jacket on. The resulting increase of deformity is inevitable. In the dorsal region the natural backward curve is aggravated by the erosion of the bodies, and when the disease lies between the shoulder-blades, they are separated from one another, the shoulders are displaced forwards, and the weight of the arms pulls the upper part of the vertebral column rapidly forward. It appears to be a simple matter to speak so decidedly about, but its frequent neglect too often leads to serious consequences. An idea is too prevalent that for spinal disease anywhere except in the cervical region a Sayre's or poroplastic jacket is sufficient. Support and, in early cases, backward traction of the arms are most essential to prevent unnecessary deformity of back and chest.

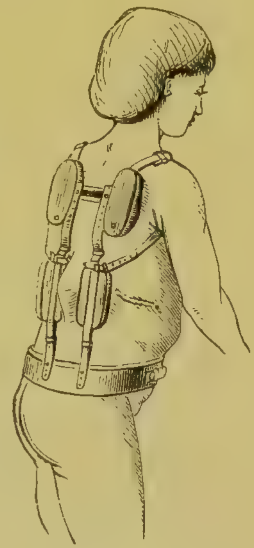

Fig. 18.
Taylor's brace.

Fixation and Supporting Appliances, and their Principles and Tests of Efficiency.—1. All complicated arrangements are to be avoided. In the plaster of Paris jacket properly applied, and to a considerable extent in the poroplastic jacket all the needful requirements are fulfilled. Taylor's brace (Fig. 18) is largely used in America, and has received the stamp of Sir J. Erichsen's approval, and so merits notice. With the jackets either of plaster or felt I am content. The complexity, weight, and intricate mechanism of the apparatus described in some books would almost make one believe that their designers were about to return to the days of Ambrose Paré's hammered brass cuirass, with steels and springs superadded.

2. They must firmly fix the site of disease.

3. All weight must be taken off the affected region by transference of pressure from diseased to healthy spots.

4. They must be comfortable, cleanly, and readily removable.

5. Pressure on the skin and chafing must be avoided.

6. The idea that they are to act permanently as extending apparatus as well as fixation, must be avoided. Extension of the normal physiological curves takes place when jackets are first adjusted, and at that time only. Whatever lessening of the actual deformity is sought for, should be previously secured by strictness in enforcing the recumbent position. When the time comes for a

jacket, the diseased bones should be so firmly consolidated that no extension force short of danger can alter their position.

7. They must be inexpensive and such as can be readily applied by the surgeon himself. More particularly should this be the case in dealing with poor patients.

Plaster Jackets.—These serve merely as fixation appliances, only temporarily and during suspension as a means of traction. To put it more succinctly, the plaster jacket is applied to the patient when suspended and in an improved position. If care be taken that the jacket hardens rapidly, the spine is fixed in the improved position, in so far that the normal and compensatory physiological curves are straightened out; but the deformity cannot be directly lessened by the jacket.

Advantages of Plaster Jackets.—1. When properly applied they are efficient in suitable cases.

2. The surgeon is independent of the instrument-maker.

3. They cannot be removed at the whim of the patient.

4. Their cheapness.

Disadvantages.—1. They are uncleanly. This drawback is obviated by sprinkling some insecticide powder beneath them, or by stitching a second vest to the lower hem of that beneath the jacket, and drawing the second garment up into position by pulling on the first. Sayre, by splitting the jackets down the front before they are quite dry, and applying laces to the front, has succeeded in overcoming this difficulty. They thus lose slightly in efficiency but gain in cleanliness and comfort, and can be kept firmly applied to the figure by the lacing. A better plan is to split them longitudinally down one flank, and then lace them. When removed from time to time they do not so readily break as when they are split in the middle line in front.

2. They are apt to become loose and badly fitting after a time. This can be obviated by care and attention, and seeing that the lower part of the jacket goes sufficiently low on the trunk.

3. They are apt to irritate the skin, especially over the prominences. This may be avoided by careful padding around, but not over the prominence.

4. The condition of the back cannot be watched, nor examination made for the formation of abscess.

5. If a discharging sinus is present, it is difficult to keep it antiseptic with a plaster jacket in position.

Experience shows that with due care most of the objections to a plaster jacket may be overcome.

The Application of a Plaster Jacket.—The patient's clothes are removed, and a thin tight-fitting seamless vest is put on, a little insecticide powder being sprinkled first over the skin. Pads of cotton wool are made, one to be placed over the abdomen—"the dinner-pad," this is to be subsequently removed; and others are made to fit round the projection; the remainder are to be packed over the crests of the ilia to prevent chafing. The patient is suspended by the apparatus commonly used in all large hospitals, and care is taken that too much strain is not thrown upon the neck, additional bands passing beneath the axillæ. He is raised gradually so that the heels are off the ground and the toes are just touching. A modification of this method of suspension is to place the patient in a thin cloth hammock, and apply the plaster around the hammock, the ends of the latter being subsequently cut off. Or he may be suspended from the neck, the trunk and limbs resting on an inclined plane.[1] In practice the first method is the most useful. Crinoline muslin is the best material for bandages, and the plaster should be rubbed in evenly throughout the bandage, plaster of the best quality and quite dry being used. A little alum may be added, as the plaster sets quicker.

Plaster bandages having been previously put into water till they are thoroughly wet, are then wound smoothly and horizontally around the trunk. There are three fixation-points—the pelvis, the seat of disease behind, the front of the chest above. Therefore begin to put the bandage low down, *i.e.* well below the crests of the ilia, and make a firm pelvic band first; now carry the bandage lightly round and round the trunk to beneath the axillæ. Now strengthen the jacket by passing the bandage obliquely, at first from the front of the pelvis below to the upper lumbar region, and then with increasing obliquity over the projection and above it, so that two fixation-points are now firmly guarded. It remains to form the third fixation-point—over the front of the chest. This is effected by carrying the bandage to the front of the chest, and passing it obliquely around the trunk from the chest in front to the pelvic band behind, and then with turns of decreasing obliquity around the lumbar region and over the projection, taking care to keep it always thick over the upper part of the front of the chest, the folds of bandage here lying one on another. It may now be

[1] Cf. Lorenz's arrangement; and Rédard, *lit de plâtre, op. cit.* p. 251.

finished off by encircling the whole trunk horizontally from above downwards. Plaster should be rubbed in with the hand from time to time, especially around the pelvis, and over the back, and at the upper part of the chest. The patient should then be laid flat, and the dinner-pad removed. When the jacket is nearly set, it may be rapidly cut up along the front or on one side, removed slowly, and bandaged at once to prevent warping. Laces are fixed across the opening, the patient again suspended, and the jacket finally applied. If the projection is high up in the dorsal region, the folds of plaster should also encircle the axillæ in a figure-of-eight, but then, of course, it cannot be cut up. If this proceeding is necessary, shoulder-straps may be fitted in place of the plaster around the axillæ.

Poroplastic Jackets.—These were introduced to supersede plaster of Paris.

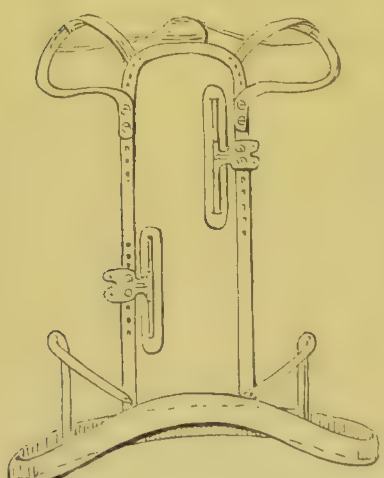

FIG. 19.—Dick's spinal apparatus.

Advantages.—1. Lightness and porosity.

2. Easy application in skilled hands.

3. Durability; they last for a year to eighteen months.

4. They permit greater cleanliness, and allow the skin to be watched, and so chafing is prevented.

5. They set more rapidly than plaster, requiring only five minutes, and hence fixation is complete before release from suspension.

6. Their plasticity, taking the shape of the figure exactly, and ensuring a perfect fit.

7. The same jacket can be remoulded as often as necessary.

Disadvantages.—1. They are somewhat costly and out of the reach of poor patients.

2. They require considerable skill in adjustment, as they set so rapidly.

3. They are weak on the anterior aspect of the chest and over the crests of the ilia, *i.e.* two fixation-points are not sufficiently firm. The felt not being impregnated with resin over the mammæ, the lower part of the abdomen, and the crests of the ilia, they are weak at those spots. They are split in front; hence the weight of the body above the projection bears unduly on the lacing, which stretches considerably and requires careful attention. This may be obviated

somewhat by carrying up strips of steel behind and firmly fixed to the jacket, and by adding shoulder-straps.

Taylor's brace, Fig. 18, "is an apparatus of great utility, more especially in the advanced stages of angular curvature of the spine where ankylosis has taken place between the diseased vertebræ. It has a tendency, in consequence of the upright iron dorsal rods being jointed backwards, to uplift the head and shoulders, and thus often improves the attitude of the patient considerably. But this very advantage in the later stages becomes a source of inconvenience, if not of positive danger, in the earlier periods of the disease, as it tends to separate vertebræ in process of consolidation" (Erichsen).

Can Recession of the Deformity be obtained?—Taylor, in the *New York Med. Record*, gives instances in which decrease of the deformity has resulted after the use of the brace. In one instance the spine, which had been bent almost to the right angle, was brought nearly to the vertical position, and no harmful complications ensued. But the brace can only be used in selected cases, and then with great discrimination and judgment, and a correct estimation of the condition of the vertebral column. In ankylosed spines the brace can only flatten out the normal physiological curves, and so render the deformity less apparent.

When may Treatment be dispensed with in Spinal Caries?—
1. The absence of pain is no test, since pain naturally ceases if a support be worn; but if pain ensue on removal of the support, the jacket must be put on again.

2. When the spine is firmly fixed and the deformity has remained stationary for some months.

3. If a recession of the deformity has been gained and maintained for some months.

4. If a compensatory lordosis just below the kyphosis is well established.

5. Dorsal caries is very rarely cured in one year; cervical and lumbar may require less.

6. If the improvement in the general health is sustained.

7. Supports must always be worn much longer in tubercular cases. If the support has been worn too long the muscles atrophy rapidly. In any case, begin to dispense with the support gradually, especially if the patient is increasing in weight (Ryan [1]).

[1] *Trans. Amer. Orth. Assoc.* vol. ii. p. 223.

The Treatment of Complications

Abscess.[1]—Abscesses complicating Pott's disease constitute a grave source of danger to life. There can be no doubt that abscesses and their sequelæ are the most frequent cause of death in spinal caries. The form of abscess may be psoas, lumbar, iliac, and pelvic. In gravity they may vary from a small collection of pus coming to the surface as directly as possible from the site of bone disease, and readily amenable to treatment, to enormous cavities containing pints, and extending beneath muscles and between planes of connective tissue in so devious a manner as to baffle all attempts at radical treatment. When such abscesses burst they form several discharging sinuses. One or more of these occasionally heal, and a new outlet is formed for the pus at some other spot, perhaps not so favourably situated for drainage and antisepsis as the previous opening. There is no type of case so formidable to the surgeon as this. To give details of such an one:—

Case 13. *Extensive Caries, large Abscess tracking in several Directions.*—M. P., aged 12. On admission there was extensive angular deformity occupying the dorsal region from the seventh to the twelfth dorsal vertebræ. The boy was sallow and cachectic. Pus was discharging from one opening in the right iliac fossa, and from a second on the outer side of the thigh two inches below the trochanter major. Fluctuation extended on the right side from the crest of the ilium over the buttock to the thigh just above the lower sinus, and laterally from the anterior to nearly as far as the posterior superior iliac spine; it was also felt over an oval area of about one inch in its long diameter just above the middle of the iliac crest, and again doubtfully one inch external and to the right of the last dorsal vertebra. On pressure over the right iliac fossa curdy pus welled up. An attempt was made to cleanse the discharging sinuses and cavities. The collection in the gluteal region was freely evacuated. Great difficulty was experienced in finding the communication between the smaller collection above the crest of the ilium and that in the gluteal region, but it was subsequently effected. A second incision was made in the space between the last rib and the iliac crest; but the abscess cavity could not be tracked further. Looking at the large extent of the deformity and its general rounded appearance, it was evident that several vertebræ were extensively diseased. It was probable that pus had made its way downwards from the dorsal spine to the crest of the ilium, and had then extended in two directions, externally into the gluteal region, and internally to the iliac fossa. After opening the posterior collections

[1] Reprinted by permission of the editor of the *Hospital*, from an article on this subject by the author in that journal.

freely and rubbing and sponging the abscess walls, the sinuses were dressed carefully. It was out of the question to attempt any radical treatment of an abscess extending over such a large area, and with such probable extensive disease of the vertebræ.

Cases such as the one I have quoted require great skill in dealing with them. Mr. Symonds,[1] speaking at the discussion at the British Medical Association Meeting on the "Treatment of Spinal Abscess," quoted the following details. He alluded to a case in which he had opened a large psoas abscess in the thigh, groin, and lumbar region, and obtained primary union. A sinus formed later, and a second abscess was dicovered on the other side. The sinus was scraped, the second abscess cleaned out, and the patient became quite well.

Lumbar and iliac abscesses constitute a more formidable danger than even psoas abscesses; the possibilities of their rupture into dangerous regions are greater, and their future course is more uncertain. It often happens that they sink into the pelvis, and burst into the rectum or bladder, or in the perinæum.[2]

Such is the worst side of the picture. Fortunately there is a more favourable aspect. The methods of treatment open to us are six:—

1. The expectant, leaving the abscess to become encysted or absorbed.
2. Aspiration.
3. Aspiration with the injection of antiseptics.
4. Incision and drainage, with or without washing out the cavity with antiseptics.
5. The method variously advocated by Treves and others.
6. Complete removal of the sac by dissection.

Dr. Townsend[3] of New York has carefully tabulated the results of treatment of seventy-five cases of spinal abscesses, and I take the liberty of producing his figures in full. The value of the table would have been enhanced if the position of the abscesses had been stated.

[1] *Brit. Med. Journ.* 1892, vol. ii. p. 1423.

[2] Michel states that of forty-eight iliac and lumbar abscesses, pus was also found in the pelvis in thirty-nine. *Nouveau Dict. de Med. et Chir.*

[3] *Trans. Amer. Orth. Assoc.* vol. iv. p. 169.

Analysis of 75 Cases of Abscesses in Pott's Disease (Townsend)

Expectant Method.

No treatment by brace:	abscess disappeared	3	
,, ,,	abscess *in statu quo*	8	
,, ,,	abscess increasing, child doing well	8	
,, ,,	abscess increasing, child doing badly	2	
		—	21

Aspiration.

Abscesses disappeared after aspiration	11	
Abscess opened spontaneously after aspiration failed	3	
Abscess incised after aspiration failed	4	
Abscess *in statu quo* after aspiration failed	1	
	—	19

Number of aspirations in each case from 2 to 6, average 3.

Incision and Scraping of Sac.

With use of iodoform emulsion or peroxide of hydrogen	14
Results—Good, 11.	
Bad, 3.	
Opened spontaneously	21
Results—Good, 15.	
Bad, 6.	
	—
	75

Deaths.

Tubercular meningitis	2
Lardaceous disease	2
Suppression of urine	1
	—
	5

1. *Absorption of Abscess—The Expectant Plan.*—Formerly there were but two methods of treatment: to leave the abscess alone, or to allow it to burst. That abscesses do disappear gradually no one is prepared to deny. Spinal abscesses may or may not give rise to symptoms. A remarkable instance of the latter event is the case given by Mr. Barker.[1] We may take it that the course of events in absorption when pus has formed is as follows. The patient is

[1] *A System of Surg.* (Holmes and Hulke), 3rd ed. vol. ii. p. 418. A psoas abscess had become reduced to a dry, tough, cheesy mass, with calcareous plates scattered through it.

placed at rest, the spinal column is fixed, the intervertebral pressure is relieved, and pus ceases to be formed. Gradual diminution of the fluid part of the abscess takes place, and there results a cheesy mass, which becomes firmer and tougher, and may partially or entirely calcify, and be surrounded by a firm fibrous capsule. In the non-calcareous parts and in the outlying parts of the capsule numerous tubercle bacilli are found. Their presence always constitutes a distinct menace to health and life, and may at any time light up fresh local, or break out into general tuberculosis.

The *indications* for the expectant treatment are—

1. When the abscess is apparently single, and not tracking in two or more directions.

2. When the recumbent position is followed immediately by cessation from pain, and improvement of the general health.

3. The expectant plan should be persevered with, if after a short trial the abscess ceases to enlarge.

4. It is evident that if pus is near the skin and pointing, it is better to open antiseptically, and so avoid the risks of spontaneous opening.

5. A large collection of pus is no hindrance to the trial of this method, provided that the appetite is good and the temperature is normal; in fact in those abscesses which were formerly designated as "cold." At the present moment I am watching the course of a large lumbar and iliac abscess.

CASE 14. *Spinal Abscess burrowing into Thigh, and evacuated there. Good Result.*—A girl, aged 8 years, was admitted to the National Orthopædic Hospital on 19th December 1893, with a posterior projection of the spine extending from the tenth dorsal to the first lumbar vertebra. A large abscess was felt in the right iliac fossa. It reached internally as far as the umbilicus, and fluctuation was felt on the outer side of the femoral artery in Scarpa's triangle. She was placed in bed, extension applied, and she was given cod-liver oil. On 2nd February 1894 the abscess was found to have diminished sensibly, and did not extend beyond the mid-point of a line drawn from the anterior superior iliac spine to the umbilicus, with corresponding decrease in other dimensions. On 30th April all fluctuation had disappeared from below Poupart's ligament; the abscess was limited to the iliac fossa. The child became fat and ruddy, and put on fifteen pounds in weight. In October no fulness or fluctuation could be felt in the iliac fossa, but a large collection of pus was found at the outer and posterior aspect of the right thigh. This was opened in three places on the outer side of the thigh, the sac carefully cleansed and rubbed out with iodoform emulsion. Healing by primary union took place. Some pus again accumulated in the thigh. It was evacuated, and during the past eighteen months the child has been quite well.

But unfortunately good results on the expectant plan are the exception and not the rule. Apparent diminution in the abscess may take place from the pus sinking into the pelvis. If absorption take place, the result for the immediate present may be regarded as satisfactory, but there is always the possibility of a recrudescence of the tubercular process. In any case, time is gained; and when the abscess lights up again, as so many do, opportunity is afforded for other and more radical modes of treatment. Personally, I should be inclined, if the indications mentioned above so point, to give the patient the chance of absorption on the expectant plan. One's hand is still free to adopt other measures later.

2. *Aspiration.*—It is evident that evacuation by this method can only be of service when the contents of the abscess are entirely sero-purulent. But the contents of spinal abscess are very rarely so. In the great majority, large caseous clots are found. Aspiration fails to remove these. All it effects is to remove the more liquid and least harmful part of the pus. It is urged in favour of aspiration, that it may favour absorption; by what means I know not; and repeated aspiration at one spot may assist the pointing of pus at that spot. The risk run in introducing septic material is by no means small, although theoretically nil.

3. *Aspiration with Injection of Fluids.*—It is difficult to know what can be effected. If the conclusion with regard to aspiration is correct, that its application is very limited and unsatisfactory, in so far that it leaves caseous masses behind, then I fail to see how the injection of carbolic acid, corrosive sublimate, sulphurous acid, peroxide of hydrogen, or iodoform solutions can be efficacious. Can we expect that the caseous masses will be rendered inert, and the abscess walls cleansed by applying antiseptics? I think not. Apart from these speculations, one definite danger is attached to the injection of fluids into spinal abscesses, particularly iliac and lumbar. Bradford and Lovett[1] record a death in a boy of 5, after washing a small cold abscess from hip disease with a few ounces of 1 in 40 carbolic acid. I have witnessed dangerous collapse in a man aged 22, who had very extensive iliac abscess. It was aspirated, and a considerable amount of creolin solution injected. The patient, who had hitherto been taking the anæsthetic

[1] *Op. cit.* p. 92. Cf. also Fränkel, *Wien. Med. Wochenschr.* 1884, p. 34; and Vincent, *Med. Press and Circ.* 1887, vol. xxiv. p. 529.

very well, suddenly became livid and pulseless. After considerable perseverance in methods of resuscitation such as artificial respiration and the injection of brandy, the patient was brought round.

4. *Incision and Drainage with or without washing out the Cavity with Antiseptics.*—The character of abscesses differs very largely. It may be that we have to deal with a localised abscess which is pointing, in which the spinal disease is quiescent and the track from the spine healed; or, on the contrary, we may have to deal with one which tracks beneath fasciæ, which has numerous pockets connected with it, overflowing from time to time into the main cavity through minute openings, the sinuses being found with exceeding difficulty or not at all at the time of operation; or finally, some may be almost entirely post-peritoneal and pelvic. The localised forms are readily dealt with, and do well. Of the others, at the best, the outlook is doubtful. One essential point in the treatment is strict antisepsis from first to last. As some abscesses go on discharging for months, and it may be for years, the maintenance of strict antisepsis until the last drop of discharge has ceased is problematical, and in some cases well-nigh impossible. But such a result must be aimed at in all cases, to avoid the deadly risk of septic infection of the abscess walls, with its results of profuse discharge, hectic fever, and lardaceous disease. It is interesting to note that Bradford[1] relates a case of tetanus following incision and drainage. If the abscess be present on both sides, it is better to make a bilateral opening, since a small communication often exists, and pus wells over from the side which has no free exit.

Cervical abscesses are best opened from the side of the neck at the posterior border of the sterno-mastoid or the anterior border of the trapezius, unless there is urgent dyspnœa and dysphagia calling for instant treatment from the pressure of a retro-pharyngeal abscess. An exit for pus may then be obtained through the posterior wall of the pharynx, the child being placed face downward, or the head hanging well over the back of the table. Dorsal abscesses should be opened where they point, generally to one side of the middle line of the back. The incision for lumbar abscess is made along the outer side of the transverse processes, and carried down through the quadratus lumborum till the sac is reached. In dealing with iliac and psoas abscesses, it is essential that the incision be away from the groin and upper part of the thigh. In

[1] *Trans. Amer. Orthop. Assoc.* vol. i. p. 11.

children it is almost hopeless to expect to keep the discharge sweet when the incision is near the genitals. Even when fluctuation

Fig. 21.—A view of the chest showing the changes in its shape accompanying caries of the spine.

Fig. 20.—Advanced dorso-lumbar disease with right lumbar abscess (Grace L——, aged 14 months).

is present below Poupart's ligament, an opening should be made in the lumbar region, if possible, and pus evacuated there. This plan has the advantages of securing efficient and safe drainage; and sequestra, if loose and lodged in the upper part of the cavity, are easily removed. Such a stroke of good fortune as finding large and loose sequestra, is rarely met with even by those who have considerable experience in spinal abscess. The only occasion when an opening near the groin is permissible is in conjunction with a lumbar opening, to aid in clearing and thoroughly cleansing the cavity, the groin opening to be sewn up before the dressings are applied. Treves has pointed out that the lumbar incision is not possible when deformity exists such as to bring the ribs close to the iliac crest. Nor is it easy in the case of a very tall and fleshy adult. In adults an opening below Poupart's ligament has the advantage of securing efficient drainage, if the patient progress sufficiently well to be allowed to get up and go about with a jacket on. In any case it is wise, in dealing with children, to cover the dressings, wherever they may be, with waterproof material, to prevent external contamination of them.

5. *The Method variously advocated by Treves, Barker, and others.*—The object of this procedure is to place the treatment of spinal abscess on the same footing as that of caries of bone elsewhere, viz. removal of the source of trouble and thorough cleansing of the abscess cavity. In 1882 Israel[1] of Berlin, operating on an abscess in the lumbar region, removed part of the twelfth rib, scraped out the carious portion of the diseased vertebral body, and opened up the vertebral canal from which a quantity of pus escaped. In 1884 Treves read a paper before the Royal Medical and Chirurgical Society, urging that psoas abscesses should be evacuated through the loin, and he gave the steps of an operation by which the psoas muscle could be reached at the outer margin of the erector spinæ by means of a vertical incision cutting through the sheaths of that muscle and the quadratus lumborum, so reaching the psoas. The psoas sheath is incised and the vertebræ examined by continuing the operation on the deep aspect of the muscle. In one case portions of diseased vertebræ were removed. Treves[2] quoted three operations, after all of which the patients recovered well.[3]

The great advances made by Mr. Barker[4] in the treatment of

[1] *Berlin. klin. Wochenschr.* 1882, No. 10.

[2] *Brit. Med. Journ.* 12th Jan. 1884.

[3] Much insistence must be placed upon the rarity of the cases in which it will be possible to remove portions of necrosed bone.

[4] *Brit. Med. Journ.* 19th Jan. 1889 and 1st Nov. 1890; also *Med.-Chir. Trans.* 1889 and 1891.

cases of tubercular disease of the hip, in which, by means of scraping and flushing with hot water, primary union was obtained, led to the application of this method to spinal abscesses. In his article[1] dealing with the question Barker says: "It is only lately that thorough evacuation has come to mean not only the removal of its fluid contents, but also of all solid and semi-solid caseous or calcareous débris; and not only of this, but of that lining of half-organised exudation-material which covers the whole inner surface of the abscess formerly called the 'pyogenic membrane.'" The method is as follows: "Taking the case of a large psoas abscess in which the bone lesion is apparently stationary, or, perhaps, healing, but where the pus is steadily increasing, an incision is made over the lower part through sound structures and the liquid pus evacuated. By means of the well-known flushing scoop (Barker's) hot water at a temperature of 103° to 105° F. is sent into the cavity from a reservoir, and carries in its reflux the remaining contents of the abscess. The flushing scoop is then used as a scraper, to dislodge the more solid portions of the caseous matter which are washed out by the flow of hot water. The walls of the cavity are gently scraped until all the soft lining is removed, and the water allowed to flow till it emerges clear from the cavity. The scoop is withdrawn, excess of water squeezed out from the sac, and sponges on sticks are used to dry out the last traces of moisture. Then two or three ounces of fresh iodoform emulsion are poured into the deepest parts of the abscess, sutures placed in position, all excess of emulsion squeezed out, the wound closed and dressed."[2] Several successful cases are quoted. G. A. Wright[3] has dealt with tubercular abscesses on the same lines, except that an ordinary Volkmann's spoon and solution of perchloride of mercury, 1 in 3000, are used. He gives notes of twelve cases of abscess, nine of tubercular joints, and three arising from spinal caries. The results were favourable in ten, including all the spinal cases. In a clinical lecture delivered by Treves[4] at the London Hospital, on the "Treatment of Spinal and other Tubercular Abscesses," he gives details of eight cases. By means of the finger and sharp spoon and large quantities of perchloride of mercury solution (1 in 5000) the cavity is entirely cleared and the lining membrane is removed. "After the scraping and flushing

[1] Barker, *Brit. Med. Journ.* 1891, vol. i. p. 275.

[2] Abridged from Mr. Barker's account.

[3] *Brit. Med. Journ.* 1891, vol. i. p. 905. [4] *Ibid.* 1892, vol. i. p. 1122.

have been persevered with until all the lining membrane appears to have been removed, then comes what I believe to be the most important part of the operation—the rubbing of the abscess wall with sponges and the thorough drying of the cavity. . . . It is surprising what a quantity of inflammatory material, in the form of the slimy lining membrane, and even cheesy pus, comes away upon the sponges."

The evacuation of pus from the spinal canal, and even from the posterior mediastinum and thoracic cavity, has been effected during the performance of laminectomy by Mr. Lane and others, and has resulted in a more rapid cure than would otherwise have taken place.

The Removal of Sequestra.—The diseased bone may with comparative ease be removed if the laminæ, transverse processes, and ribs are affected. But it cannot happen often that large sequestra arising from the vertebral bodies are so accessible and so loose that a pair of forceps or the fingers working through a lumbar incision can dislodge them. Many attempts have been made, notably by Ashurst, to get rid of carious bone by cutting down on to diseased vertebræ and scraping with a Volkmann's spoon. This can only be done in the lumbar region, and then not without exceeding difficulty and danger; while the operation is not often of much benefit. A few cases are on record attended by brilliant success, but it would be well to have the failures recorded as well.

6. *Complete Removal of the Sac by Dissection.*—This is very rarely possible. Mr. Watson Cheyne alluded in a paper on the "Treatment of Spinal Abscess"[1] to a case in which he was able to dissect out the sac and remove the spinous processes, and the wound healed by first intention. Mr. Symonds in the discussion which followed also spoke of a large abscess over the trochanter in which this had been done.

To sum up the treatment of spinal abscess.

1. "Receding abscesses and quiescent foci are best treated on the expectant plan.

2. Aspiration is to be avoided, unless in the case of a small residual abscess following a previous attempt by the radical method to obtain primary union, and when the abscess is so deeply situated and in such immediate contact with serous membranes and viscera that further scraping is dangerous."

3. Cervical abscesses should be opened through the pharynx

[1] *Brit. Med. Journ.* vol. ii. p. 1422.

when dyspnœa and dysphagia are urgent, but otherwise at the side of the neck.

4. Psoas and lumbar abscesses are best treated by the method of Barker, Treves, and others.

5. The radical method is more likely to be successful if the bone disease be quiescent or healing.

6. Openings in or near the groin are not permissible in children, and drainage tubes are sources of trouble both from the danger of septic infection and the risk of converting the track of the tube into a tubercular sinus.

7. "The merits of the lumbar incision are great, but its application is limited, and very frequently an incision as for the ligature of the external iliac artery by Astley Cooper's method is preferable.

8. The possibility of removing large sequestra of bone by cutting down on the vertebral column is very problematical; and in a large number of cases no such proceeding is called for, the diseased bone being simply carious or caseous on its surface."

9. Dissection out of the sac is not often possible, but should be attempted when feasible.

The Treatment of Compression-Paraplegia.—Treatment is of two kinds, conservative and operative by laminectomy: a hybrid term and one that might be replaced by rachiotomy, as suggested by Mr. Davies-Colley, or by lamnectomy, according to Lloyd.

The Expectant or Conservative Plan.—In estimating the merits of the two plans attention should be directed to the eminently favourable results of the expectant plan in paraplegia. Dr. Halsted Myers[1] in his account of 218 cases states that the prognosis is distinctly good—55 per cent were known to have recovered, 26 per cent were not treated at all and passed from observation, presumably well; 3 per cent died of intercurrent disease, and in 16 per cent the lesion was unknown. Of the cases of paralysis studied by Taylor and Lovett the percentage of recovery was 100 when the paralysis came on under treatment; and in any event more than 83 per cent recover under conservative treatment.

So that the necessity for operation is not at all urgent, especially if it be remembered that many cases get well even after very prolonged paralysis of one to two years' standing, and when the condition has at one time or another appeared hopeless.

The conservative treatment requires complete recumbency on a flat bed. It is better to use some extension, applied either to the

[1] *Trans. Amer. Orth. Assoc.* vol. iii. p. 209.

head or feet, as it prevents excessive settling down of one vertebra on another and limits pressure on the spinal cord. In severe cases my colleague, Mr. Fisher, uses a suspension couch. This in its essentials is a firmly padded board placed obliquely, and fitted at the top with a suspension apparatus for the head. The apparatus is placed in the bed, and the child rests against, and is supported by, the padded board, while the vertebræ undergo more extension than in the recumbent position, owing to the use of the suspension apparatus. The time needed for recovery varies from a few weeks in paretic cases to a year or fifteen months in severe examples. A second or even a third attack may ensue and yet the patient finally recover. Bed-sores should be carefully guarded against.

Rachiotomy (*Laminectomy*).—This operation has been dealt with by several writers, notably by William White,[1] Thorburn,[2] Chipault,[3] Bullard and Burrell,[4] and Arbuthnot Lane,[5] and at some length in an article by S. Lloyd[6] of New York, who has tabulated and analysed seventy-five cases, the details of which he was able to obtain, representing all the recorded cases to July 1892.[7] The article is very exhaustive and the subject skilfully handled. For many of the following remarks I must express my indebtedness to Dr. Lloyd's paper.

The morbid conditions which give rise to paraplegia in Pott's disease must be clearly borne in mind in discussing the advisability of operation. It is clear that pressure is caused by extra-dural

[1] *Annals of Surgery*, vol. x. p. 1—"The Surgery of the Spine."

[2] "The Surgery of the Spinal Cord," and *Brit. Med. Journ.* 23rd June 1894.

[3] *Archiv Gen. de Med.* Oct. Nov. and Dec. 1890.

[4] *Trans. Amer. Orth. Assoc.* vol. ii. p. 241.

[5] *Lancet*, 1890, 5th July; and *Brit. Med. Journ.* 1891, vol. i. p. 1227.

[6] *Annals of Surgery*, vol. xvi. pp. 289-335.

[7] Since that date the following cases have been reported, viz.: 6 by Alfred Parkin of Hull; of these, two were brilliant successes, one was improved, two subsequently suffered from psoas abscess, and in one, although power of locomotion was regained, the patient died two months afterwards of tubercular meningitis (*Brit. Med. Journ.* 29th Sept. 1894). It is, however, permissible to differ from Dr. Parkin in the remark that extension and counter-extension of the spine, however carefully applied, have little or no effect on cases of paraplegia.

Dr. Andrew Grey (*Brit. Med. Journ.* 13th April 1895) records a very successful case of laminectomy, in which the arches of the fourth, fifth, and sixth dorsal vertebræ were removed, and sensation and voluntary movement commenced to return a day after the operation.

In a very inveterate case of two years' standing of my own, which has not been published, as the operation was performed as late as January 1896, the return of sensation after laminectomy occupied two months, and at the end of that time there was some return of voluntary movement. But as the case is still under observation, I refrain from giving further details, except that I had six months previously to the laminectomy performed costo-transversectomy without success.

thickening around the cord in the greater number of cases, less often by displaced bone; and rarely by newly-formed fibrous tissue, a condition of pachymeningitis (Macewen). Removal of the arches has revealed many diseased states of the soft parts. Wright[1] noted that on removal of the prominent dorsal arches a "leathery substance" covered the cord, which did not pulsate after removal of this tissue. Duncan[2] found the membranes adherent to bone by granulation tissue which was scraped away. Abbe[3] removed a dense mass of connective tissue and detritus from the posterior part of the dura mater. Gerster[4] in a successful case evacuated extra- and sub-dural abscesses, and found extensive thickening of the soft tissues adjoining the intervertebral focus, in which were embedded the anterior and posterior spinal nerve-roots; the transverse processes of the fifth, sixth, seventh, and eighth dorsal vertebræ on the right, and the fifth, sixth, and seventh on the left side were carious and the costo-vertebral joints destroyed. These and the heads of the corresponding vertebræ were removed, together with the bodies of the sixth and seventh vertebræ, which were much disintegrated. Arbuthnot Lane[5] in a case, which, so far as the paraplegia is concerned, is practically well, found the cord compressed by an abscess, which was very extensive and passed into the chest, where a cavity existed nearly as large as an orange, the walls of which were in great part bony. Lloyd's[6] case revealed the cause of the compression to be due to two firm bands, which were found on dissection to be the thickened interspinous ligaments; which, in consequence of the separation of the posterior part of the spinal column by the curve, had slipped down until they caused firm compression of the cord. Of 75 cases of operation collected by Lloyd, 20 were adults, 39 were children, and in the remainder the ages were not quoted; 13 of the adults died, and 16 of the children. In 58 of the cases the region was noted. Of these 53 were dorsal, giving 18 recoveries, 7 improved, 8 not improved, and 19 deaths. There were but 5 cervical cases, 2 of which were cured and 3 died. One case involved the upper dorsal and cervical regions and one the dorso-lumbar, and both died. In the lumbar region there is one case, cured.[7] The question of improvement must necessarily turn

[1] *Lancet*, 14th July 1888, pp. 64-66.
[2] *Edin. Med. Journ.* 1889, p. 829.
[3] *N. Y. Med. Journ.* 24th Nov. 1888.
[4] *Annals of Surg.* vol. xvi. p. 315.
[5] *Ibid.* p. 318.
[6] *Ibid.* p. 303.
[7] Mr. Thorburn, "Lectures on the Surgery of the Spinal Cord and its Appendages," *Brit. Med. Journ.* 23rd June 1894, estimates that the true operation mortality of laminectomy is about 20 per cent. He says: "We shall probably obtain the fairest conclu-

on the presence of and the extent of the myelitis with the resulting degeneration. In Pott's disease this is much less frequent than in injury, as the spinal cord becomes "accustomed" to the pressure, but it is important to recognise its existence before an operation is undertaken. Lloyd came to the following conclusions:—

"The operation is contra-indicated—

1. In cases where there are other tubercular lesions.

2. In cases where mechanical treatment has not been applied.

It is indicated—

1. In cases where posterior spinal disease is made out as the cause of paraplegia.

2. In cases where the lesion seems to indicate the failure of mechanical treatment.

3. In cases where, during the employment of intelligently applied apparatus, the symptoms continue to increase in severity.

4. In cases where, after a certain period of careful mechanical treatment, say eighteen months, the condition has remained stationary.

5. In cases where pressure-myelitis threatens the integrity of the cord. The first sign of this demands immediate operation. The operation can be applicable to less than 50 per cent of the cases of paraplegia from Pott's disease, as proven by the statistics of Gibney and Myers, and even of this number its application is limited again to those cases where the compression has not produced a complete degeneration of the cord."

To Dr. Lloyd's conclusions I might add that the operation is indicated when cystitis and chronic bronchitis are present, while paralysis of the sphincters of the bladder and rectum do not by any means imply a serious prognosis so far as the ultimate recovery of the cord is concerned.

The Operation of Laminectomy (*Lamnectomy*).—Before operating it is well to see, in view of the danger arising from shock, that the limbs are warmly enveloped in wool. During the operation as little as possible of the patient's back is exposed,

sions if we refer only to the statistics of a few surgeons, who have reported the whole of their cases, and for this purpose I have added together the cases of Macewen, Horsley, Lane, and myself in this country, and of Abbe, Chipault, and Schede from abroad. We thus find a record of 70 cases, with 12 deaths due to or hastened by the operation, yielding a percentage mortality of 17·1. This being so, I think I may repeat the conclusion to which I arrived in 1889, viz. the dangers of the operation are not great, especially in view of the conditions which it is intended to relieve. The cause of death in the great majority we find to have been shock."

and hot-water bottles may be placed by his side. A subcutaneous injection of brandy during the operation is of value. Ether should be the anæsthetic unless bronchitis be present. An incision is made slightly to one side of the median line, to avoid pressure on the scar during after-recumbency. The arches of the vertebræ are laid bare, as completely as possible within the field of operation. Then with a Hey's saw, laminectomy chisel, or fine bone-forceps, the laminæ are divided and lifted out, and the dura mater exposed. At this stage great care is required. The theca may then be examined, and any inflammatory material or thickening removed, exposing thereby the spinal cord if necessary. The latter may be gently drawn aside with a blunt hook, to seek for caseous material on its anterior aspect. The opportunity should also be taken of removing any sequestra seen or felt, and by taking away the transverse process and the head of a rib, an abscess cavity on the front of the vertebræ may be opened. The amount of hæmorrhage is small. The chief difficulty in old-standing cases is to remove the laminæ without injury to the cord. In a case of mine the arch of the tenth dorsal vertebra so closely impinged on the cord that the bone had to be picked away piecemeal from above.

Occipito-Atloid and Atlo-Axoid Disease.—The able writer (A. E. J. Barker) on this subject in the *System of Surgery*, 3rd edition, has condensed much that is known in a few pages. He points out the following remarkable differences in disease affecting this region of the vertebral column from lesions elsewhere in the spine.

1. "It is a comparatively rare disease now. No single instance was found by him among his notes of fifty cases of caries of the spine treated as out-patients at University College. In twenty-five volumes, 1849-1874 inclusive, of the *Pathological Society's Transactions* the disease has only been brought under notice five times in five of its volumes, only eight[1] cases being presented for consideration.

2. In former times it would appear to have been noted more frequently, perhaps because syphilis was allowed to run on un-

[1] Another instance is given in *Path. Soc. Trans.* 1889, vol. xl. p. 264, by Mr. L. A. Dunn. The anterior and posterior arches of the three upper vertebræ were so welded together as to present a slightly undulating but otherwise uniform surface. Mr. Dunn remarks: "The fusion of the three upper vertebræ, I take it, results from disease in early life, whilst the changes in the articular processes are probably due to pressure produced by the altered position of the head. However, no history of the case could be obtained."

checked for longer periods, or was treated too freely with mercury. Thus Rust,[1] writing in 1817, saw 13 cases.

3. It differs from the commoner forms of disease in being met with in adult life in a large proportion of cases. Thus in 24 cases Mr. Barker had been able to collect, in which the age is indicated, only 6 were under 20 years of age (and 2 of these had reached 18) before the disease had manifested itself, while 18 were adults.

4. It is in many cases more distinctly traceable to injury, and occurs thus in persons to all appearances in good health, without any scrofulous tendencies.

5. It appears capable of advancing very rapidly in destructive change, and under treatment, of repairing itself as rapidly and perfectly.[2]

6. The process is more manifestly due here than lower down to syphilis, . . . this syphilitic disease starting in the pharynx or in the vertebræ themselves.

7. The disease affects the joint surfaces of these bones more frequently than the anterior segment."

The *symptoms* are pain in the neck, worse at night, increased by cold, by swallowing, and on deep inspiration. The pain is referred often to the larynx, and radiates over the area of distribution of the branches of the second and third cervical nerves.[3] It is greatly augmented by movements of the head, especially lateral or rotatory, so that when the patient requires to look round he has to move his whole body.

Later, the head droops forward, the sterno-mastoids become prominent, and the expression anxious. The anxiety is increased by any attempt at movement, and the patient takes the utmost care to support the head upon the hands while so doing. Some time before the head has drooped forward, deep palpation immediately below the occiput reveals an acute tenderness. When the head is projected a fulness is noticeable behind, just under the occiput, and in the middle line, caused by inflammatory exudation and the prominence of the spinous processes of the atlas and axis (Fig. 22).

Disease in this region of the vertebral column has acquired special significance from its proximity to the medulla, and the

[1] *Arthro-kakologie*, 1817, p. 6.

[2] Hilton, *Rest and Pain*, 3rd edition, pp. 100-107.

[3] Cf. Mr. Jacobson's note, *Rest and Pain*, 3rd edition, p. 95, on the question of pain being present when the sub-occipital nerve is pressed upon.

fatal result that ensues when softening of the ligaments occurs and the odontoid process is displaced backwards. Such displacement may be gradual or sudden. As instances of gradual displacement, we may refer to two specimens exhibited at the Medical and Chirurgical Society[1]; in one the odontoid process had approached within two lines, and in the other within $\frac{3}{10}$ of an inch of the posterior wall of the canal. Again, some movement causing increased strain on the softened ligaments is immediately followed by fatal results. Such instances are recorded by Hilton[2] and others. The case of a little child recorded by the former is particularly striking. Disease in this region had existed for some time before advice was sought. With rest in the recumbent position for a fortnight, much improvement occurred. "The nurse specially appointed to attend the child, finding that her rest at night was now so calm and quiet, that she was so free from pain and fever, that her appetite and power of swallowing were so much improved, as well as her temper, and thinking she was altogether so much better, and willing no doubt to mark her own penetration, as well as to please the mother by telling her in the morning what had been done by her little charge, instead of giving the child her breakfast as usual, without disturbing the head or neck in the least degree, desired the child to sit up to breakfast. The child did so, the head fell forwards, and she was dead."

FIG. 22.—The position assumed by the head and the fulness of the neck in cervical caries (Holmes' *System of Surgery*).

[1] *Med.-Chir. Trans.* vol. xxxi. p. 259.

[2] *Rest and Pain*, 3rd edition, pp. 109-112.

Dyspnœa, dysphagia, and a peculiar smallness of the voice, due in some instances to the pressure of a retro-pharyngeal abscess, and in others to implication of the pneumogastric, spinal accessory and hypoglossal nerves, are frequent. Erichsen observes that "when the posterior wall of the pharynx is pushed forwards against the posterior nares the voice acquires a peculiar nasal tone."

The direction taken by the pus which often forms in the course of the disease has been sufficiently indicated in the section dealing with spinal abscess. If it be confined to the spinal canal it may produce compression of the cord, or set up spinal or cerebral meningitis.

When recovery occurs, complete ankylosis of the bones accompanies it. Sometimes large portions of the atlas and axis are cast off through the abscess cavity (see Fig. 23). It is remarkable that such severe cases recover. Instances are recorded by Wade, Keate, Hilton, and Sir J. Paget.

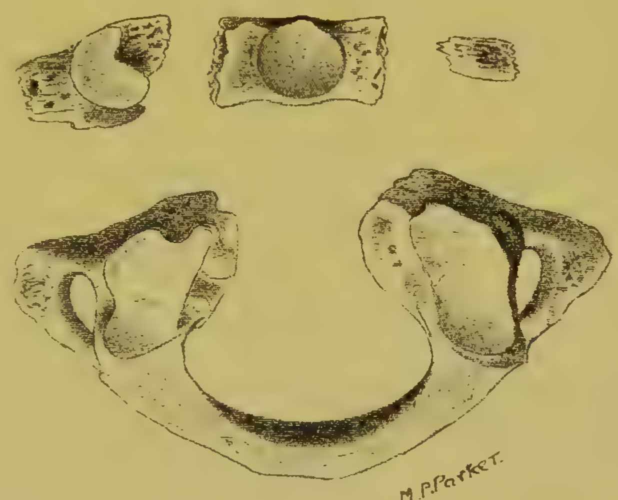

FIG. 23.—Odontoid articulation of the atlas separated by ulceration. An atlas is placed below with the corresponding portion broken off to show the relationship of the separated part of the anterior arch. The three fragments were expelled from the mouth during a fit of coughing (Guy's Hospital Museum, 1018[15]).

The *treatment* must be conducted on the same lines as in disease of the spine elsewhere. Complete recumbency in the earlier stages, followed later by the use of a plaster of Paris or poroplastic jacket, with a firm occipital head-piece and chin support, are essential. Sand-bags efficiently maintain the head at rest during recumbency. The general treatment consists in the administration of tonics and cod-liver oil; and when practicable the patient should be placed on a specially-constructed carriage and taken out of doors.

Syphilitic Disease in the Spinal Column.—In dealing with the causes of Pott's disease much stress has been hitherto laid on the shares taken by injury and tubercular disease, but there is ample clinical evidence that syphilis may and does give rise to considerable posterior curvature secondary to caries and necrosis.

In the *cervical* region, the part most frequently affected, numerous cases of syphilitic spinal disease are recorded in surgical literature. The frequent occurrence of disease in this part may be due to a spreading of syphilitic ulceration from the pharynx, but more often the process originates in the bodies of the vertebræ themselves.

A case is recorded and the specimen figured by Hilton[1] in *Rest and Pain.* The disease was situated between the occiput and atlas, and between the atlas and axis. The probable history of the specimen is that "the man to whom it had belonged had been long the subject of syphilis, had suffered great pain in the neck, and that, after eating his dinner, his head fell forwards upon the table and he died instantly."[2] Another probable instance is recorded by Dr. Dunlop[3] of Jersey. In this case, although the cause is not stated to have been syphilis, yet the occurrence of swellings in the buttock, chest, and back of hand simultaneously with disease in the first and second cervical vertebræ and the anterior part of the second lumbar vertebra point to tertiary specific disease. This suspicion is strengthened by the woman's age, 58 years, when she first suffered from pain in the neck and loins.

An instance occurring in the *dorsal* region is given by Mr. Howard Marsh.[4]

CASE 15. *Syphilitic Deformity of the Spine* (*Howard Marsh*).—"A man, 45 years, came to St. Bartholomew's with tertiary syphilis, from which he had suffered severely at intervals for upwards of fifteen years. He now had several broken-down gummata on the skull, with severe hemicrania and numerous syphilitic scars about his face, trunk, and limbs. He complained of severe nocturnal pains in his back, and said that his spine was becoming bent and so stiff that he could not stand uprightly. On examination, the dorsal curve of the spine was found to be considerably increased, so that the shoulders were very round and the head was bent forwards. On iodide of potassium, gradually increased to 20 grains three times a day, he rapidly improved, and the gummata were absorbed. He has had fresh outbreaks of tertiary syphilis since, and each attack has left the spine more arched and more stiff, and when I saw him last he was unable to raise his head above the level of his lower dorsal vertebræ."

Reeves[5] mentions a case of syphilitic caries in a boy under his

[1] *Op. cit.* p. 111.

[2] Mr. Jacobson alludes to other instances, one quoted by Collis, *Pract. Observ. on the Venereal Dis.*; another by Wade, *Med.-Chir. Trans.* vol. xxxiii.

[3] *Brit. Med. Journ.* 1893, vol. ii. p. 1380.

[4] *Ibid.* p. 793.

[5] *Op. cit.* p. 133.

treatment at the London Hospital, who coughed up portions of vertebræ which had penetrated the lung.

As illustrating the incidence of syphilitic disease in the *lumbar* region of the spine, I may cite with advantage the following case of Fournier's.[1]

CASE 16. *Syphilitic Lesions of the Spinal Column and other Parts* (*Fournier*).—A man, aged 56, tall and well developed, was admitted into the Hôpital St. Louis in July 1876. "He had been losing health for some time, and suffering from pains in the loins and lower limbs. Examination showed marked evidence of syphilis of long standing, *e.g.* syphilitic sarcocele, ten cutaneous gummata, as also in the muscles, and a gummatous ulceration of the great toe, and a macula on the thigh. In spite of treatment this man's condition soon became worse, and he died in October 1876."

Post-Mortem.—In addition to the above lesions, there were found characteristic cicatrices in the spleen, a gumma on the fourth lumbar nerve, multiple and considerable lesions of Pott's disease, affecting the lumbar vertebral column, especially the third, fourth, and fifth vertebræ of that region (Fig. 24). These consisted of denudations of bones, thickening or destruction of the periosteal and ligamentous structures, sclerosing osteitis with caseous and purulent infiltration, almost complete destruction of the intervertebral fibro-cartilage, and a vast hollow mass in the lumbar column, also an abscess in each psoas muscle. A careful microscopical examination showed the deposit in these bones to be clearly gummata in various stages of degeneration, also there were gummatous nodules in the nerves passing off from this region.

From the details of the cases quoted above we can gather that syphilitic caries of the spine offers a close parallel to tubercular or traumatic caries. In all the varieties of Pott's disease we have similar symptoms. In syphilitic caries the following points are particularly striking:—

1. It begins later in life than other forms of caries.

2. It affects the cervical region by preference, notably the atlas, axis, and third cervical vertebræ.

3. It is accompanied by rapid destruction of bone, which in some cases is succeeded very rapidly by repair.

4. When caries is present, other signs of tertiary syphilis are well marked.

5. It occurs rarely in congenital syphilis.

Ridlon, writing on syphilitic spondylitis in children in the *Trans. Amer. Orth. Assoc.* vol. iv. p. 118, says that "it differs in no way from syphilitic joint disease elsewhere, except that it is

[1] *Annal. de Dermat. und de Syph.* Jan. 1881, and quoted by Barker, *Syst. Surg.* vol. ii. p. 421.

deeply situated, since it usually occurs about the anterior surface of the bodies. Its onset appears to be comparatively rapid; if in the dorsal region, kyphosis soon appears, with a sharp angle and sweeping curves above and below. When the disease is well established it follows the rule of all syphilitic lesions, that is, resolution or pus, and the abscess will undergo rapid absorption if the patient is placed under the influence of mercurials." He adds, spondylitis associated with joint-disease in young children under three is more often syphilitic than tuberculous.[1] The most common associated conditions are bone and joint disease elsewhere; and the least common are skin eruptions.

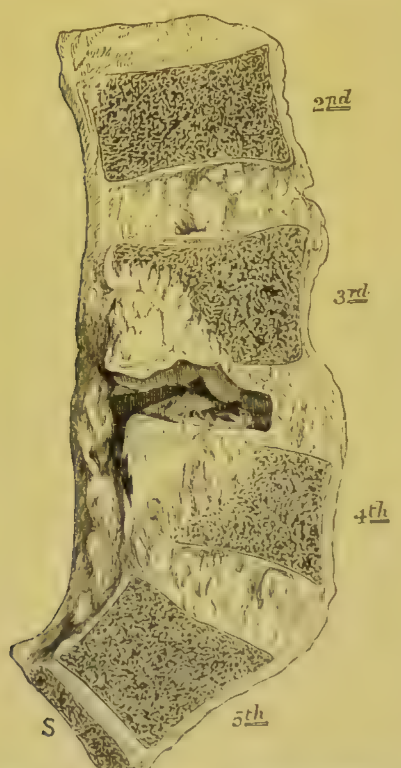

FIG. 24.—Vertical antero-posterior section of lumbar spines showing deposit of gumma in back part of the third and fourth (after Fournier).

Treatment.—This must be conducted on the same principles as Pott's disease arising from other causes, special attention being devoted to the specific taint.

Malignant Disease of the Spine.—The forms of malignant new growth are sarcoma and carcinoma; these are rarely primary, but commonly secondary to neoplasms elsewhere.

As instances of primary sarcoma, Judson[2] quotes three cases which were mistaken for spinal caries. The first case occurred in a boy aged $4\frac{1}{2}$ years, the second in a man aged 35 years, and the third, also in a man, aged 42 years. In one the spinal curves were normal, in the second there was doubtful alteration of the curves, while the remaining case showed a prominent eighth dorsal spine, forming a distinct angle. Gibney mentions in the *Trans. Amer. Orthopedic Association* a case of sarcoma in a man aged 40, the growth being situated in the fifth and sixth dorsal vertebræ; and Howard Marsh alludes to a case in a girl aged 7 years. The form of sarcoma is usually "large-celled," and Michel[3] has described these under the heading of "tumor myeloïdes."

[1] This is not according to the author's experience.
[2] *Trans. Amer. Orth. Assoc.* vol. iv.
[3] *Nouv. Dict. de Med. et Chirur.* xxxix. p. 222.

Examples of primary carcinoma in the spine are sufficiently rare to be pathological curiosities. The majority of cases of malignant disease in the spine are due to secondary carcinoma, following similar disease in the breast, stomach, pancreas, liver, rectum, etc. Hence, if an adult patient complain of excruciating pain in the back coming on suddenly, and he or she be middle-aged, it is always well to examine carefully the sites of primary carcinoma.

Howard Marsh, in "Bye-ways in the Study of Diseases of the Spine,"[1] quotes a case of secondary carcinoma with angular deformity.

CASE 17. *Malignant Growth of the Spinal Column* (*Howard Marsh*).—"I recently removed the breast of a patient who, having found a tumour which she was afraid might be cancer, kept the matter to herself for nine months. During this time the growth steadily increased, and in the last two months she had suffered from very severe pains in her spine at the level of about the fourth dorsal vertebra, and also around the sides of her chest. She had also found great difficulty in walking. When the spine was examined a well-marked angular curvature was found."

Mr. Marsh, after quoting this case, dwells upon the fatal reticence of many patients, especially women with cancer in the breast. Other instances might be given, but I commend to the notice of my readers an excellent article on Malignant Disease of the Spine by R. W. Amidon in the *New York Medical Journal*, 26th February 1887, pp. 225-231.

The *symptoms* have been dwelt upon on p. 38 in discussing the diagnosis of Pott's disease. Suffice it to make the following remarks. The disease is insidious, and occasionally is first revealed at the autopsy. The chief symptoms are pain and paralysis. The pain is intense and excruciating, and out of all proportion to any local signs; but it is nevertheless more accurately limited to the diseased area than in caries. In the latter, local pain is not a prominent sign. The pain of growth is capricious, and it is increased by pressure or motion. It may disappear more or less completely at a later period, according to Edes.[2] Such an instance came under my own notice.

CASE 18. *Cancer of the Spine with Transient Pain.*—A lady, aged 49, who had been twice operated on by Mr. Bryant for carcinoma of the breast, in whom extensive recurrence had taken place, was seen by me on behalf of a friend on account of agonising pain in the lower dorsal

[1] *Lancet*, 1893, vol. ii. p. 792.

[2] *Boston Med. and Surg. Journ.* 1886, 17th June, pp. 559-562.

region. This had lasted for four days, and various remedies had been tried. I injected half a grain of acetate of morphia subcutaneously, and the pain soon disappeared. Nor at any other time did it trouble the patient till her death, three months afterwards. At the autopsy a large mass of secondary growth was found, involving the bodies of the tenth and eleventh dorsal vertebræ.

Paralysis due to spread of the disease to the meninges, or to compression of the cord, may ensue. Bradford and Lovett[1] state: "The occurrence of œdema from thrombosis in paralysis rather favours the theory of cancer as the cause." The prominence, when it is found, is generally more rounded in malignant disease than in Pott's disease. Unfortunately, nothing can be done for these cases beyond alleviating the pain and distress.

When the disease is secondary recognition is easy, but when primary it may be almost impossible. However, intense pain in the back in a middle-aged or old person, unrelieved by rest and ordinary treatment, and requiring powerful anodynes to combat it, is very suggestive of malignant disease of the spine.

Neuromimesis in the Spine, or Hysterical Spine. — Sir James Paget has dealt with this subject in *Clinical Lectures and Essays*, Lecture V. He writes: "The chief things to study in the spine are pain, stiffness, weakness, and deformity. An angular curvature of the spine—I mean such backward outstanding of one or more vertebræ as is due to thinning or loss of substance of their bodies or intervertebral discs—is, I believe, quite inimitable by any nervous or muscular disease." Intense pain is frequently complained of by nervous men and women at one or more spots in the column. Frequently it is situated at two spots, between the scapulæ and at the loin. It is described as keen and boring, as though a nail were being driven into the part. Sir James adds: "At these tender spots the nervous patients cannot bear to be touched; they flinch and writhe when the finger taps or presses them very gently. You may be sure that there is no disease of the spine when you see this, or when the tender parts of the spine are not painful on moving or on coughing or on sneezing. And you may be quite sure, I believe, when a gentle blow or pressure produces more pain than a hard one, or when you find the same pain or flinching if the skin over or near the spine is pinched without pressure on the spine itself. Again, the merely nervous pain is usually variable, though it may be never wholly absent."

[1] *Op. cit.* p. 200.

Other signs, which serve to render clear the diagnosis, are the absence of rigidity, alteration in the general health, fever, and tangible lesion of ribs, spine, or nerves after the pain has persisted with varying intensity for months or years. If these patients are carefully watched, they will, when they think themselves unnoticed, turn in bed or bend the back with an ease totally incompatible with any structural disease. Even if hysterical paraplegia supervene, the absence of deformity will generally make the case clear, since it is rare to get paraplegia without some deformity in Pott's disease.

The chief importance of these cases lies not so much in the fact that their true nature may pass unrecognised, but that other and graver conditions, such as caries, may be classed as hysterical spine.

CHAPTER IV

SOME POINTS IN THE PHYSIOLOGY OF THE SPINAL COLUMN

General Remarks—Division of the Spinal Column into Anterior or Supporting and Posterior or Protecting Columns—The Four Curves, Cervical, Dorsal, Lumbar, and Sacral, and their Origin—Existence of a Curve normally to the Right Side—Movements of the Spine—Centre of Gravity of Spine—Contrast between the Infantile and Adult Spine.

THE physiological rôle of the spinal column is highly complex. It protects the spinal cord; it supports the trunk and gives attachment to the ribs; it transmits the weight of the head and upper limbs to the pelvis; and it is endowed with very diverse movements by the numerous muscles attached to it. It is very flexible, but strong; it is very firm, though composed of many segments; it permits of many deviations from the upright position, but at the same time it affords a complete protection to the spinal cord.

If the spinal column be more closely observed, it is seen to consist of two chief parts—the anterior, or the column of the vertebral bodies, essentially supporting in function; and the posterior, or column of the arches, whose primary function is the protection of the medullary substance, support being a secondary matter. The importance of thus distinguishing between the two portions is great in the consideration of the deformities of scoliosis, and should be kept carefully in mind. It has been pointed out by A. B. Judson[1] that each vertebra consists of two parts, the body which is free to move laterally in the cavities of the chest and abdomen, and the processes which are prevented from the same degree of lateral displacement owing to their being entangled in the posterior parieties composed of ribs, muscles, and fasciæ. So that in a single vertebra as it deviates in motion from the middle line, the body moves $\frac{3}{4}$ inch and the spinous process $\frac{1}{4}$ inch.

[1] *Trans. Amer. Orthop. Assoc.* vol. iii. p. 96.

A vertebra does not, therefore, rotate on its central axis. This statement confirms Adams' observations that the external deviation of the spinous process is no measure of the internal displacement of the bodies. The *length* of the adult spinal column, including the sacrum and coccyx, is 26 to 28 inches. Taking the average measurement of the spine at 22 inches, exclusive of the sacrum and coccyx, one-fourth to one-fifth is due to the interposition of the intervertebral discs. To the latter the column owes much of its elasticity and freedom of movement. It is interesting to note the compressibility of intervertebral discs. There seems some foundation for the statement that "when the trunk has been kept in the erect posture during the day, an adult man of middle stature loses about 1 inch of his height, which he does not regain until he has remained some hours in a recumbent position."

Roughly, the spinal column viewed from the front represents a pyramid, the expanded base resting on the sacrum. If the areas of the articulating surfaces be measured from the second cervical to the last lumbar vertebra, they increase from above downwards, *i.e.* directly according to the weight sustained.

The *physiological curves of the spine* are four in number—the cervical, dorsal, lumbar, and sacral. The first three pass into each other by a gradual transition, but the junction of the lumbar and sacral is marked by a distinct prominence, the sacro-vertebral angle. The curves vary much with the age, the individual, and the nature of the calling. Many authors assert that at birth the spinal column is straight, but Bouland,[1] after very precise research, states there exist at that time (*a*) a cervical curve with its convexity anteriorly, of which the chord subtending the arc is 42 mm. long; (*b*) a dorsal curve, concave anteriorly, formed by the ten or eleven upper dorsal vertebræ, of which the length of the chord is 78·5 mm.; (*c*) the lumbar curve is generally absent. Bouland asserts that the generally prevailing opinion of the straightness of the infantile spine arises from the fact that the curves described by him are appreciable only in the column of the vertebral bodies, while the arch column is quite straight in the recumbent position. He says that the curves of the body column are due to varying degrees of ossification in front and behind in the cervical and dorsal region; while in the lumbar region the forward convexity entirely originates from the greater thickness of the intervertebral discs anteriorly.

[1] Quoted by Rédard, *Traité Pratique de Chirurgie Orthopédique*, p. 207.

Staffel is of opinion that the sacral curve and the inclination of the pelvis arise at the time when the child attempts to sit up or walk about. In the new-born child the centre of gravity of the trunk is situated well in front of a horizontal line joining the centres of the acetabula. At this time the spine forms a more or less straight line. When the child begins to sit up, the spine is curved so that equilibrium is obtained immediately over the hips. To effect this, there appears a convexity backwards in the dorsal region, followed by compensatory lumbar and cervical curves.

With Mr. Treves [1] we believe that, of the four curves, the dorsal and sacral are primary, and due to the formation of the thoracic and pelvic cavities. They appear in fœtal life, and depend upon the shape of the bones. The other two, the cervical and lumbar, are compensatory curves, and depend upon the shape of the intervertebral discs. They appear after birth, and are accentuated by the assumption of the erect position. There are two points supporting this view. Firstly, if we look at a dried spine from which the discs have been removed, the cervical and lumbar curves are nearly lost, and there is but one curve, viz. in the dorsal region, with its convexity backwards. Secondly, when a child commences to sit, the back invariably assumes a kyphotic position, the kyphosis embracing the whole of the dorsal region, and extending into the cervical and lumbar regions. In rhachitic children this attitude persists as a definite form of kyphosis. In weakly, growing girls there is frequently a prominence of two or three lower dorsal spines associated with a general kyphosis, a condition which by the inexperienced or inattentive may readily be put down to Pott's disease.

There can be no doubt that as the walking powers increase, the psoas and iliacus muscles, passing over the brim of the pelvis to their inferior attachments, accentuate the anterior convexity of the lumbar curve. It therefore follows that, of all positions, sitting at ease, by diminishing the angle of inclination of the pelvis and obliterating the normal lumbar lordosis, and allowing full scope to the development of the dorsal kyphosis, is the most prejudicial in weakly children and adolescents.[2]

The presence of *a normal lateral curve to the right side* has been advanced by some authors as a factor in the production of the

[1] *Surg. Appl. Anat.* 2nd ed. p. 541.

[2] Cf. "Researches in the Spinal Curvatures of Children while Sitting. A Study of the Mechanics of the Sitting Posture." Schultess, Zurich, *Zeitschr. f. Chir. Orth.* Band i. Heft 1, 1891.

common or right-sided form of scoliosis. But its existence is very problematical, although it has been dwelt upon by Professors Quain and Sharpey, and by foreign observers, Buhring and Hyrtl. The last-named anatomists went even further, and stated that in scoliosis the dorsal and lumbar curves were due to the spinal column being unequally loaded at the sides in different parts,—on the left in the dorsal region by the heart and great vessels, and on the right by the liver. It was therefore proposed to term the ordinary dorsal curve the "cardiac curve," and the lumbar curve the "hepatic curve." They would evidently explain all curves by the deviation of the spine to one side, so as to counterbalance any undue weight on the opposite side. The existence of the right dorsal curve has been attributed to the increase of space required by the heart and great vessels, or to the passage of the thoracic aorta from the left to the median line. Bichat and Béclard attribute it to the preponderating action of the right arm, as in one or two left-handed individuals the dorsal spine was curved to the left, and others to the attitude of the fœtus *in utero*. The latter view is supported by the authority of Volkmann.

Amongst others, Sappey, Cruveilhier, Little, and Adams are satisfied that no such normal curve exists, and the French anatomists Bichat and Béclard state that the utmost deviation they have found is a mere depression at the spot where the thoracic aorta comes in contact with the spine.

The *movements* of the spinal column take place in all directions, but they are more limited than is usually supposed, especially rotation and lateral flexion. These are supplemented by the free play of the pelvis upon the head of the thigh bones, and by the amount of tilting of the pelvis possible without disturbance of the equilibrium. Movements are of two varieties, partial and complete. The former comprise those delicate oscillations, especially in ordinary locomotion, which maintain the head "eyes-front," and serve to break up the shock arising from the impact of the advancing foot upon the ground. These partial movements are not to be confounded with those of oscillation which occur at the hip joint. The complete movements are as follows:—

Flexion and extension are most free in the cervical and lumbar region, but in the dorsal are limited by the small amount of intervertebral substance and the overlapping of the laminæ. The greatest bending backwards is permitted in the cervical, and the greatest bending forwards in the lumbar region, especially between the fourth and fifth lumbar vertebræ. Other movements are determined chiefly by the articular processes. In the dorsal region a certain degree of rotation is permitted, owing to the direction of the articular processes; hence in scoliosis the rotation is best marked in this region. In the lumbar region rotation is prevented, but the articular processes permit of some lateral flexion; and by a combination of this with antero-posterior flexion, some degree of circumduction is obtained. The cervical vertebræ, owing to the oblique direction of their articular processes, allow of a combination of lateral flexion and rotation.

Lateral flexion of the spine beyond a very limited extent is always combined with rotation. The limitation of lateral flexion is due to the particular arrangement of the articular processes and ligaments. If more than a slight amount of rotation is required, it can be obtained by a combination of antero-posterior and lateral flexion, and the result of the two movements is rotation of the bodies. Or, to put it another way. The intervertebral pressure caused by lateral movements falls obliquely on the upper planes of the bodies. They therefore tend to glide towards the point of least resistance; but inasmuch as the bodies are less readily retained by ligaments than the remaining constituents of the column, the arches, the bodies submit to the maximum of displacement, and in doing so necessarily rotate. That lateral flexion beyond a certain point must be accompanied by rotation, is shown by the excellent and instructive experiment by Judson, to which further allusion is made on p. 142.

The *centre of gravity of the spine*, according to Professor Struthers,[1] lies in the upper lumbar region to the right of the median plane. This may explain the great frequency of primary left lumbar curves and secondary right dorsal curves.

The contrast between the surgical anatomy of the infantile and the adult spine has been well made by Chipault and Daleine.[2] The spine of the fœtus and new-born infant is comparatively longer than that of the adult, owing to the less development in young life of the lower limbs. In the infant the umbilicus is opposite the fourth lumbar vertebra or lower, while in the adult it is opposite the third lumbar spine. The base of the sternum corresponds in the infant to the top of the seventh cervical spine, and in the adult to the second dorsal spine. The spinal cord descends to the third lumbar vertebra in the infant, but only to the first in

[1] *Edin. Med. Journ.* June 1863, p. 1086. [2] *Rev. d'Orthopédie*, May 1895.

the adult. The cauda equina in the infant, instead of forming, as it does in the adult, a cylindrical mass, filling up the whole dural sheath, is arranged in two distinct processes occupying the sides of the canal, separated by an interval of from 3 to 5 mm. The spinal canal may thus be punctured in the third or fourth lumbar space in the infant, without risk of wounding the cauda equina.

Laminectomy may be performed under much more favourable conditions on the infant than on the adult. In the former the laminæ may be easily resected, as the fatty tissue around the dura mater is much less vascular, and the periosteum can be more readily detached from the bone ; and as it is more plentifully supplied with blood-vessels, it is capable of throwing out fresh osseous tissue, thus repairing with greater solidity the breach in the posterior wall of the canal.

CHAPTER V

CONDITIONS AFFECTING THE SPINE OTHER THAN POTT'S DISEASE AND CAUSING KYPHOSIS

Kyphosis of Infancy, Childhood, Adolescence, Adult Life, Old Age—Hereditary Hump-back—Kyphosis from Rheumatoid Arthritis, Rheumatism, Gonorrheal Rheumatism, Occupation, Osteitis Deformans, Osteo-malacia — Spondylitis — Round Shoulders.

The conditions other than Pott's disease causing kyphosis may advantageously be considered from the point of view of the age at which the deformity in the spine commences.

I. *Kyphosis of Infancy*, due in many instances to feeble muscular development and Rickets.

II. *Kyphosis of Childhood.*—Causes.

- α. After Rickets.
- β. The result of Acute Anterior Polio-myelitis.
- γ. Associated with the late stage of Pseudo-hypertrophic Muscular Paralysis.
- δ. Associated with Chest Deformities such as occur with Adenoids of the Naso-pharynx.
- ε. Hereditary Hump-back.

III. *Kyphosis of Adolescence.*

Round Shoulders.

IV. *Kyphosis of Adult Life*, due to

- α. Occupation, *e.g.* cobblers, tailors, and porters.
- β. Muscular and Gonorrheal Rheumatism.
- γ. Arthritis Deformans.
- δ. Osteitis Deformans.
- ε. Osteo-malacia, or Mollities Ossium.
- ζ. Progressive Muscular Atrophy.
- η. Bronchitis and Emphysema.

V. *Kyphosis of Old Age.*

From this somewhat lengthy list it will be seen how very diverse the causes and pathology of kyphosis are; but the classification of the causes I have adopted seems open to the least objection. Another mode of classification is that of Rédard's[1] into kyphosis of adolescents, kyphosis of muscular or nerve origin, kyphosis arising from lesions of the bone.

Some *infants*, as the result either of rickets or of general debility,[2] are unable to sit up long after the period at which children of the same age are accustomed to do so. If these infants are habitually nursed in the upright position, the spine at this period, normally straight, becomes bowed posteriorly, and oftentimes somewhat laterally. Such an instance was the case of C. H., aged 18 months, a very ricketty child in whom both posterior and lateral curves existed, the latter being to the left with much rotation in the dorsal region.

FIG. 25.—Mr. Adams' spinal tray for rhachitic kyphosis.

The treatment of cases when severe, with the back almost powerless, is recumbency. Mr. Adams' plan of directing the child to be nursed as much as possible in the reclining position, or to be carried about in a padded wicker tray (Fig. 25), is very useful.[3] I have proved the efficiency of the wicker tray on many occasions. If the child is able to sit up, but with the spine bent, a back-board of leather, with axillary and perinæal straps attached, is useful (Fig. 26). It gives complete support to the spine and firm fixation. As the spinal curves are not developed till the child begins to walk, it is essential that the back be kept as straight as possible during infancy. The general condition demands attention, and rickets must be appropriately treated.

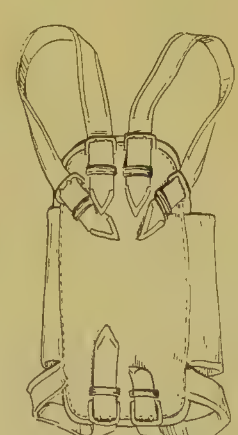

FIG. 26.—Back-board for rhachitic kyphosis.

[1] *Op. sup. cit.* p. 213.

[2] In a child aged 1 year and 8 months, who came under my care at the National Orthopædic Hospital, there was a distinct history of congenital syphilis, and the posterior curvature of the spine was very marked. I do not suggest that syphilis was the immediate cause, but induced rather a general weakness.

[3] *Lect. on Curv. of Spine*, 2nd ed. p. 63.

In *childhood* it frequently happens that the posterior curvature of infancy has been allowed to persist, or rickets[1] has developed later than usual, with the result that there is muscular and ligamentous weakness. Such cases are best treated by a combination of recumbency and support. When the curvature has lessened, frequent douchings and shampooing, with active and passive exercise of the back muscles short of fatigue, serve to correct the deformity and strengthen the muscles. There are two points of importance in connection with this posterior curvature: the one is that there is in such cases a predisposition to scoliosis later; the other that caries of the spine is by no means uncommon in early childhood, and in its early stages is difficult of diagnosis. These latter cases require much care and attention, as the diagnosis is often difficult and uncertain, and not infrequently the termination is destructive disease of the bodies of the vertebræ, although at the time of their coming under observation no direct evidence of Pott's disease is obtainable. But if on suspension or recumbency the curvature persist, then oncoming Pott's disease should be suspected.

Acute anterior polio-myelitis rarely, it is true, paralyses the back muscles; while the later stages of pseudo-hypertrophic muscular paralysis are characterised by such general loss of power that, if the patient be sat up, the spine yields so much that the chin falls forwards on the knees. In nasal obstruction such as frequently arises from adenoids, considerable posterior and some lateral curvature are not infrequent (Fig. 68). This matter will be dealt with under the heading of "Deformities of the Thorax."

Hereditary Hump-back.—Mr. W. Adams[2] has drawn special attention to this form of kyphosis, and quotes a remarkable instance. A man, the father of five children, was "short and dwarfish, with an extreme degree of hump-back. He walked tolerably erect, but his head appeared to sink in between the shoulders, and his chest was much deformed. The spinal curvature in his case began in childhood, and was not the result of caries. The eldest son has proved to be the model of his father; the three next children are free from deformity, but the youngest child exhibited the spinal curvature even at an earlier date than his eldest brother." From the drawing of the cast given by Mr. Adams in his book, it is seen that

[1] Tamplin noted that in some cases of rickets in which the posterior borders of the scapulæ stand out, the occurrence of sub-scapular crepitation is due to the bone riding over the beadings of the ribs. Reeves, *Bodily Def.* p. 110.

[2] *Lect. on Curv. of Spine*, 2nd ed. p. 64.

the curvature affects the whole dorsal region, the natural convexity being greatly exaggerated. I have observed a similar instance in which a parent was affected in this way, and his son showed the bent back as early as the seventh year. It appears to me that but little can be done to remedy this condition. Constant lying down may be suggested by the medical attendant, but he will have a hard task to persuade the parents that such enforced abstinence from exercise and games by an otherwise perfectly healthy child is really needful to prevent deformity. At the onset of puberty the possibility of lateral curvature should be borne in mind.

In adult life the causation of kyphosis in tailors and cobblers is sufficiently obvious, and may almost be considered a trade-mark. Nor is it confined to them; the use of the bicycle has induced the "bicycle-stoop," and I have frequently seen kyphosis in mountain-porters in Switzerland.

Rheumatism, gonorrheal rheumatism, rheumatoid arthritis, and osteitis deformans seriously interfere with the natural mobility of the spine and increase the physiological curve in the dorsal region, while reversing them in the cervical and lumbar region. Collectively the condition which these diseases induce is known as spondylitis deformans.

Rheumatism affects most frequently the cervical region, more often causing in that situation lateral than posterior deviation, and giving rise to a form of torticollis (posterior torticollis). Gonorrheal rheumatism rarely causes spondylitis. Nolen[1] investigated 116 cases, and found two with arthritis of the vertebræ in addition to other joints. One recovered and one passed from observation before he recovered. So that permanent rigidity of the back can rarely be assigned to this disease.

Rheumatoid arthritis plays a large part in the production of spondylitis. Bradford and Lovett[2] state that "the spine is in these cases oftenest primarily the seat of the disease, and the other joints become involved later. In the cases seen by the writers the patients have been young adults and children. In this way it offers a decided exception to the general behaviour of rheumatic gout. And the affection has been clearly a primary ankylosing arthritis of the vertebral column." I have seen it twice in girls aged 19 and 20; in both there was in addition considerable enlargement of the metatarso-phalangeal articulation of the great toe, together with the

[1] *Deutsch Archiv of Clin. Med.* 1882, No. 8, p. 10.

[2] *Op. cit.* p. 191. Cf. also Adams, *Annals of Surg. and Anat.* Brooklyn, 1883, vol. vii. p. 6; and Brodhurst, *Reynolds' System of Med.* vol. i. p. 960.

anæmia and mixed gouty and tubercular inheritance characteristic of rheumatoid arthritis. Mr. W. Arbuthnot Lane[1] has most convincingly shown, however, that many cases of posterior excurvation of the spine associated with osteo-arthritis are due to pressure on the spine either from the nature of the labour being such as to induce long-continued strain on the spine ("labour changes"), or from pressure of adjacent bodies on the intervertebral discs due to faulty position of the patient causing their partial absorption, together with profound alteration in the shape of the bodies and the structure of the ligaments.

The bowed condition of the spine in *osteitis deformans* is familiar to us all from the lucid description of the disease by Sir J. Paget in the *Medico-Chirurgical Transactions*, vol. xlii. p. 77. Bradford and Lovett mention "a rare form of kyphosis seen in osteo-malacia where the whole spine may be bent so that it forms one long arch with the convexity backward. In one case the curve was so great that the chin of the patient rested near the umbilicus."

The *morbid anatomy of osteo-arthritis* of the vertebræ is well illustrated by numerous specimens. Briefly it may be said that the disease is commonest in the dorsal region, especially the fifth, sixth, and seventh vertebræ, but sufficiently well marked in the cervical and lumbar regions. The bodies of the vertebræ are flattened from above downwards at their anterior parts, sometimes to a remarkable extent and often present bony outgrowths; the intervertebral discs are compressed, especially anteriorly, or have disappeared, or been replaced by bone, thus giving rise to complete ankylosis throughout the affected region; the spinous processes are farther apart than normal and the laminæ flattened and shortened. In some cases complete ossification takes place in the ligaments, notably in the anterior common ligament, and between and around the apophyses, also in the intervertebral discs and on the adjacent surfaces of the bodies. Concurrently with the spinal changes the thorax is increased antero-posteriorly and decreased vertically and transversely; and the sternum is often unduly prominent, while the heads of the ribs in severer cases are firmly fixed by bone to the sides of the vertebræ, and respiration is abdominal. The pelvis is much modified, producing a pelvis similar to the kyphotic variety of obstetricians, being contracted transversely and enlarged in the conjugate diameter.

[1] *Guy's Hosp. Rep.* 1886, 1887, p. 278; and 1885, p. 321. See also *Path. Soc. Trans.* vols. xxxvi. and xxxvii.; and *Med.-Chir. Trans.* vol. lxvii.

The *symptoms* of spondylitis are pain in the back, slight or severe, and stiffness, which is general throughout the spine with increase of the natural curves. In Pott's disease the rigidity is more localised to the affected part, and the posterior projection is angular in character and appears early in the disease. Immobility of the ribs is pathognomonic of spondylitis; and the course of the disease is very chronic, curvature appearing gradually, and after pain has been complained of for some years.

Treatment.—Unfortunately, when the disease has reached such a stage that deformity is noticeable, but little can be done. In the treatment of osteo-arthritis the essence of success is to begin early and before destructive change has set in. Among the various methods I would advocate complete rest from work and change of air. No measures promise greater success than a course of treatment at Bath or Buxton, with plenty of good nourishing food, avoiding starchy matters and alcohol, and the liberal administration of iron alone or combined with arsenic and iodide of potash, in the form of liq. arsenici hydrargyri et iodidi. If the disease be purely rheumatic, local manipulation and massage of the back may be of some value, but these appear to be of little value in rheumatoid arthritis. In fact, in the latter disease after the first stages the outlook is very hopeless, and the patient gets steadily worse. In osteitis deformans no treatment is of avail.

Senile kyphosis arises as the result of debility and wasting of the tissues, with absorption of the intervertebral discs. Or the same change is brought about by the nature of the occupation, as in agricultural labourers and in those whose vocation is such as to produce continued fatigue of the spinal muscles, notably in those "who live by the pen." Mr. Adams says he has observed a severe form of kyphosis in old cavalry officers who have seen a great deal of service in India, and he attributes it to the fatigue of frequent and long marches. In many cases the natural stoop of old age is hastened by rheumatoid affections of the vertebral articulations. In the most severe forms of senile kyphosis the body is bent at a right angle, and the patient can only walk with the assistance of sticks. Such cases suffer very severely from difficulty of breathing, dyspepsia, and interference with the normal action of the heart, as evidenced by persistent palpitation. Beyond careful attention to the position assumed when writing or reading, the avoidance of undue fatigue, and daily exercise with light dumb-bells as preventive measures, but little can be done. When the curve has once formed, efforts must be made to prevent its becoming more exaggerated by attention to the points just alluded to.

Round Shoulders.—This deformity is the most frequent example of kyphosis of adolescents. As a preliminary condition we have a "weak spine." Bradford and Lovett make the following remarks on this point: "It can be considered under two heads.

1. It is seen in patients young enough to go to school, where the routine is injurious to them, and where cure is to be effected by a proper division of study and recreation, including muscular exercise, good food, and fresh air.

2. In those who have drawn from their stock of muscular or nerve force in the development of their intellect. After freedom from the restraint of school, their time is devoted to a sedentary life or one of undue nervous excitement. In such cases the great muscles of the back are those most called upon, and give out. In several cases the writers have noticed a slight impairment of the faradic contractibility of the muscles on the convex or weaker side." Some kyphosis and scoliosis often coexist. There can be no doubt that persistent use of the "back-board" in girls' schools in the past generation is responsible for many cases of kyphosis.

The treatment of slight cases consists in the application of cold sponges, massage, light muscular exercise, avoidance of late hours and physical and mental fatigue, faradism, and, if necessary, a light support to the back, but not shoulder-braces.

The more advanced condition of round shoulders which affects the cervico-dorsal region is referable to too rapid growth, chronic illness, and general debility. These result in general weakness of the back muscles, and the spine, sustained only by its ligaments, bends more and more in the direction of its natural curves, this inclination being increased by the kind of work engaged in. The groups of muscles which are particularly affected are the trapezii, the rhomboids, and the serrati magni. Verneuil has observed the coincidence of kyphosis with flat foot of the paralytic variety.

The back shows in the dorsal region an exaggerated curve, the summit being situated about the middle of the dorsal region; the shoulders are drooping and directed forwards, the scapulæ are prominent, the head is in advance of the body, and the chin approximates to the sternum; the chest is often flattened or receding. A plumb line through Chopart's articulation passes behind the horizontal line joining the two external auditory meatuses.

The diagnosis should not be mistaken for that of Pott's disease, which sometimes resembles kyphosis of adolescents at first sight.

The treatment of more advanced cases is conducted on two lines. (1) To strengthen the enfeebled muscles; (2) to correct the existing deformity. These courses must often be conducted simultaneously, as they are inter-dependent for success. In addition every care should be taken to avoid those positions which cause undue strain on the weakened muscles. I allude to faulty positions at school desks and in piano practice. In young girls excessive fatigue from home lessons is often responsible for a curved back. I am not an advocate of the plan of prolonged immobility upon the inclined plane, but I think rest for two or three hours daily upon a firm mattress, with a small well-stuffed cushion beneath the loins, very useful. At night it is advisable to place a pillow beneath the summit of the curve, and the head-bolster should be removed, the patient lying supine.

To strengthen the back muscles, especially the erectores spinæ, the latissimi dorsi, the serrati magni, and the trapezii, the application of the weak interrupted current is very useful, so too is massage for fifteen minutes once or twice daily, and douching with tepid water, to be followed by friction with the towel till the skin glows. At the same time due attention should be paid to the general health, tonics and cod-liver oil are often necessary, and a change to the sea-side for neurotic patients is advisable.

To correct the existing deformity, the chief reliance must be placed on gymnastic exercises.

Artificial supports in the majority of cases are faulty in theory and pernicious in practice. I allude to shoulder braces, back supports, and jackets. They are to be used only when the kyphosis is so established that no treatment alleviates it, and when it appears likely to become worse if the back be left unsupported. Men who are careful of their figures, and are anxious lest their occupation should induce round shoulders, should order from their tailors a very closely-fitting vicuna coat, and be careful to pay a good price for it. The fear of causing the garment to become baggy and ill-fitting and the sensation of tightness across the back will induce them to straighten their shoulders as soon as stooping commences.

Exercises.—These are always to be stopped short of fatigue, so that no definite duration can be mentioned, but each case must be taken and treated on its merits, or rather demerits. The exercises should have two objects, viz. expansion of the chest and straightening of the back.

To expand the Chest.—The patient lies supine on a firm narrow mattress or a long table covered with a thin flat cushion, in such a way that the edge of the table corresponds with the mid-dorsal region, the shoulders, arms, and head being unsupported and hanging over the sides of the table, and he is then directed to make regular and full movements of inspiration and expiration for five to ten minutes. As the pendent position of the head is often irksome at first, the hands may be placed beneath the head, and so better dilatation of the chest is secured. After a few days these exercises may be extended by the attendant bringing the patient's arms above and behind the head, and drawing the shoulders well back, precisely as is done in artifical respiration after Sylvester's method. When the muscles of the shoulder-girdle become stronger, the shoulders may be brought further backwards by dumb-bell exercises in the above-mentioned position. The same results may be effected by fixing two pieces of stout rubber-tubing to hooks on the wall on a level with the patient's shoulders. To the free end of the tubing handles are attached. These the patient, with his back to the wall, grasps; then the arms being fully extended, he makes steady traction on the rubber for a short time, leaning the body forwards. The tension of the rubber is relaxed by extending the spine, and these manœuvres are repeated several times. Exercises with light dumb-bells in the standing position are also useful. These with weakly adults should not at first weigh more than one pound, but increasingly heavier ones may be substituted later.

Removal of the Kyphosis.—The simplest exercise is the following: (α) Let the patient extend the head fully against the pressure of the surgeon's hand applied to the neck. (β) Then the body being inclined well forwards and the knees being straight, full extension of the whole spine and head is gradually made against the pressure of the surgeon's hand on the nape of the neck. (γ) The flexed elbows may be brought as closely as possible into apposition behind the back both passively and actively.

These exercises are demonstrated to the patient by the surgeon, and the attendant is enjoined to carry them out systematically, beginning with the easier and less fatiguing, and taking care that both chest and back receive their due share of attention.

It is unnecessary to describe the various forms of complicated apparatus devised to carry out the above exercises, as the methods indicated are sufficient in even inveterate cases.

CHAPTER VI

LORDOSIS

Static Lordosis—Lordosis of Nerve or Muscular Origin—Compensation Lordosis—Lordosis of Osteopathic Origin—Spondylolisthesis.

Synonyms.—English, *Spinal Incurvation or Anterior Deformity;* French, *Lordose, Dos Ensellé, Dos Creux;* German, *Vorverbiegung der Wirbelsaüle.*

The following varieties of lordosis are considered:—

1. *Static Lordosis.*—This occurs normally in the lumbar region in the women of some races, notably in those of Cuba; and it is present in all pregnant women, and when the abdomen is distended by fat, ascitic fluid, or ovarian tumours. It is also seen in military men, and in those who carry heavy weights on the head.

2. *Lordosis of Nerve and Muscular Origin.*—The deformity may be due either to contraction or paralysis of groups of muscles, or to general diseases, such as osteo-arthritis, rheumatism, or rickets, affecting the spine. As an example of contraction-lordosis, I may allude to a class of cases occurring in infants, in which the head is retracted and the posterior cervical muscles are rigid. I have seen four in practice among my out-patients during the last five years, and the causes in these cases are either partial asphyxia at birth, or reflex irritation due to injudicious feeding. They were cured by a smart purge, such as pulv. scammonii co. gr. iij.-v., attention to diet, and pot. bromidi gr. ij.-v. thrice daily. Such a condition is probably reflex, but it may be mistaken in debilitated infants for the onset of tubercular meningitis. In the cervical region, rheumatoid arthritis and chronic rheumatism also give rise to marked incurvation of the spine. Lordosis of paralytic origin is associated with paralysis of the sacro-spinal muscles, the trunk

being allowed to fall back, so as to oppose by its weight the flexor action of the abdominal muscles. Such a condition of lordosis is seen in pseudo-hypertrophic paralysis, progressive muscular atrophy, and as a result of acute anterior polio-myelitis. If paralysis affects the abdominal muscles, the pull of the powerful posterior dorsal muscles not being counteracted by them produces an aggravated condition of lordosis. In the former condition of paralysis of the sacro-spinal muscles the deformity is mainly in the dorsal region, in the latter it is in the lumbar. Rickets, while manifesting itself chiefly in the bones and ligaments, is so frequently associated with muscular weakness that in some infants in the sitting posture the weight of the trunk and upper extremities bends the spine backwards.

3. *Compensation Lordosis.* — In congenital hip displacement the deformity is very marked; and in acquired hip disease, when the limb is fixed in the flexed position, the patient arches the lumbar spine to bring the affected limb to the ground.

4. *Lordosis of Osteopathic Origin.*—In Pott's disease, especially in the cervical and dorsal region, the anterior convexity of the spine is increased to counterbalance the backward projection at the site of disease. Rickets produce lordosis either by simple weakness of the muscles, the body falling into a position, which is more often kyphosis than lordosis. When the child begins to stand, the heavy pendulous abdomen requires a certain amount of counteracting force so that he may stand upright. At the same time too the angle of inclination of the pelvis to the horizon is lessened, and lordosis must follow.

Spondylolisthesis, in which a subluxation of the lower lumbar vertebræ occurs, is a rare cause of the deformity under consideration. Lordosis of the dorsal region occasionally met with in double scoliosis is due to sinking of the spinous processes. It is pointed out by Adams[1] that "it frequently occurs before any lateral deviation of the spinous processes takes place, and therefore before any lateral curvature has become obvious externally. It probably does not amount to more than a loss of the natural posterior curvature of the spine in the dorsal region, *i.e.* a flattening of the back."

The treatment of lordosis depends upon the cause. In the majority of cases but little can be done beyond alleviating the general condition. In Pott's disease after ankylosis has occurred no interference with

[1] Cf. *Lect. on Curv. of Spine*, 2nd ed. p. 56. A case in point is quoted and a drawing of a cast given.

the lordosis is justifiable, but mechanical support is often necessary to prevent the kyphosis and lordosis assuming a more severe grade while the spine is still soft. The lordosis of rickets calls for general treatment, for support while the muscles are weak, and for exercises and massage to improve their tone.

CHAPTER VII

SCOLIOSIS OR LATERAL CURVATURE OF THE SPINE

Definition—Distinctions between Lateral Deviation and Rotation—Scoliosis, General Considerations, Clinical Aspects—Varieties of Scoliosis—Classification of Scoliosis—Scoliosis of Adolescents, including "Occupation" Scoliosis—Its Causes, Predisposing and Exciting—Methods of examining a Case of Scoliosis—Symptoms and Course of Scoliosis of Adolescents—Stages of Scoliosis—Morbid Anatomy of Scoliosis.

Synonyms.—English, *Rotary Lateral Curvature*; French, *Scoliose, Deviation Laterale de la Taille*; German, *Verbiegung, Seitliche Rückgratsverkrümmung, Bogenförmige Deformität der Wirbelsäule.*

Definition.—Scoliosis is a rotation of the vertebræ around a vertical axis, frequently but not necessarily combined with lateral deviation or bending of the spine to either side.

It must be clearly borne in mind, however, that under the term lateral curvature, two different conditions are frequently included, viz. lateral deviation and rotation. Such loose nomenclature leads to confusion in the recognition of cases and to errors in treatment. The characteristic points of the two classes of cases, one a functional and the other a structural deformity, will be dealt with on a subsequent page. Briefly, deviation alone exists in some cases, while in others deviation beyond a certain degree is always associated with rotation, though the deviation of the spine is often no measure of the amount of the internal curvature.

General Considerations.—*Frequency.*—Of all the deformities which are seen at an orthopaedic hospital, scoliosis is one of the most usual. My colleague, Mr. Fisher, states that of 3000 cases which presented themselves for treatment at the National Orthopædic Hospital, 353 were affected by scoliosis.[1] Drachman examined

[1] Ashurst, *Internat. Encyclopædia of Surgery*, vol. vi.

28,125 children in the public schools of Denmark, and found 368 to be scoliotic.

But the occurrence of scoliosis varies much in different places. It is particularly great in large towns. Berend found 900 cases of scoliosis in 3000 orthopaedic cases, Langgard 700, and Schilling 600 in 1000 orthopaedic cases seen in clinics in large cities. Of 500 consecutive cases of deformity seen by the writer at the National Orthopaedic Hospital, London, 69 presented either scoliosis or deviation of the spine.

Sex.—It is admitted on all hands that the deformity is more prevalent in girls than boys. The proportion differs according to various authors. Eulenberg puts it as high as 10 girls to 1 boy; Kölliker, 5 girls to 1 boy; and the latter may be accepted as a fair statement. Of the 69 cases mentioned previously as coming under my notice, 17 were boys. But, while less frequent in males, I am of opinion that the proportion of severe cases is greater in boys than in girls. Rédard [1] states that, according to his statistics, in children under 5 years of age the proportion is equal in the two sexes, or perhaps is slightly greater in boys. The onset of scoliosis in girls at puberty is associated with much development of the trunk and increase of the adipose tissue, especially in the mammary region, without in many cases corresponding muscular development of the spine.

Age.—Scoliosis is mainly a disease of adolescence. Taking 1000 cases, Eulenburg found 78 cases from birth to the sixth year, 216 between the sixth and seventh years, 564 between the seventh and tenth years, 107 between the tenth and fourteenth years, and in 35 cases the distortion appeared after the last-named year—*i.e.* 57 per cent. between the age of 7 and 14. Authorities, however, of good repute state—and, I venture to think, correctly—that a larger proportion than 3·5 per cent appear after 14. Ketch in an analysis of 229 cases put the number at a considerably larger figure. Rédard, who inclines strongly to the opinion that the lumbar curve is primary, remarks that "a large number of primary lumbar scolioses are not recognised because the deformity is not looked for sufficiently often, nor until the compensatory curves have formed." And it seems that he, guided by this opinion, places considerable reliance upon Eulenberg's statistics, which bring out so prominently the early incidence of scoliosis. For my part, I think that if 1000 presumably normal children were examined, the proportion of them showing some deviation of the spine would be large, but I should

[1] *Op. cit.* p. 283.

not include these as cases of scoliosis, inasmuch as they do not develop rotation. And it is always a serious matter to disturb the domestic peace by pronouncing a child to be afflicted with spinal deformity; rather every effort should be made to minimise than magnify the possibilities of a slight case, both to the parents and in the hearing of the child. A slight spinal deformity is often "treasure trove" to a hysterical lad or girl.

Heredity.—In a recent conversation with the writer Mr. Adams expressed himself strongly on this point, as not having the slightest doubt of its hereditary nature. In his *Lectures on Curvatures of the Spine*[1] he says that among the constitutional conditions should be included an hereditary predisposition to spinal curvature, frequently existing with a consumptive tendency . . . which occurs in girls from 7 to 12 years of age, and sometimes later; in such cases the curvature has a marked tendency to increase rapidly and terminate in conspicuous deformity." As an instance of its hereditary character I quote the following details of a family.

CASES 19, 20, and 21. *Hereditary Scoliosis.*—Albert I——, aged 11 years; Frederick I——, aged 9 years; and Annie I——, aged 8 years, were seen by me at the National Orthopædic Hospital between 1890 and 1893. There are four children in the family, and the father has a scoliosis to the right in the dorsal region. The elder boy has a slight curve to the left in the dorsal region and the sternum is prominent. The second boy, Frederick, has a long C-curve to the left in both dorsal and lumbar regions; while the girl has a very flexible back, which readily assumes any faulty position, and is already developing a curve to the left in the dorsal region. The second boy and the girl proved troublesome cases, and despite rest, exercises, and proper support, have developed compensatory curves and some increase of rotation.

CASE 22.—Harold F——, aged 6, came to me at the National Orthopædic Hospital in 11th May 1893 with a long C-curve to the left extending over the whole dorsal region, and with the corresponding changes in the scapulæ and chest. He suffers much from asthma. A great-aunt, aunt, father, and one cousin are affected with scoliosis.

Vogt[2] goes so far as to say that at least half the cases are hereditary in character.

Clinical Aspects of the Deformity.[3]—Before describing the various aspects of true scoliosis, it will be convenient to dispose of lateral deviation, since the two conditions may be, and often are,

[1] *Op. cit.* 2nd ed. p. 230. [2] Quoted by Rédard, *op. cit.* p. 284.
[3] Reproduced by permission of the editor of the *Hospital.*

confused, lateral deviation being called scoliosis; or a greater error, scoliosis being styled and treated as mere deviation.

Pure lateral deviation occurs in those whose spinal muscles are weakened, either from too rapid growth at the age of puberty,

FIG. 27.—Back view of Case 23, showing long C-curve to the left, and prominence of the spinous processes in the dorso-lumbar region.

combined, in the case of young girls of the lower class, with bad food, want of fresh air, and excessive physical work; or after acute illnesses. In such cases the segmented spine insufficiently supported by the muscles gives way, and insensibly a deviation to one side or the other follows. Still more likely is it to occur in those patients who, from one cause or another, have unequal lower limbs. In many cases the deviation disappears at once if a cork sole be applied to the boot of the shorter limb. As an instance of the combined effect of heavy trunk and bust, impaired health and overwork, I append the notes of the following case, which, commencing as a lateral deviation, subsequently developed into scoliosis associated with a prominent posterior curvature. The present state of the case, owing to the girl being obliged to work for her living in spite of the existence of deformity, is seen in Fig. 27.

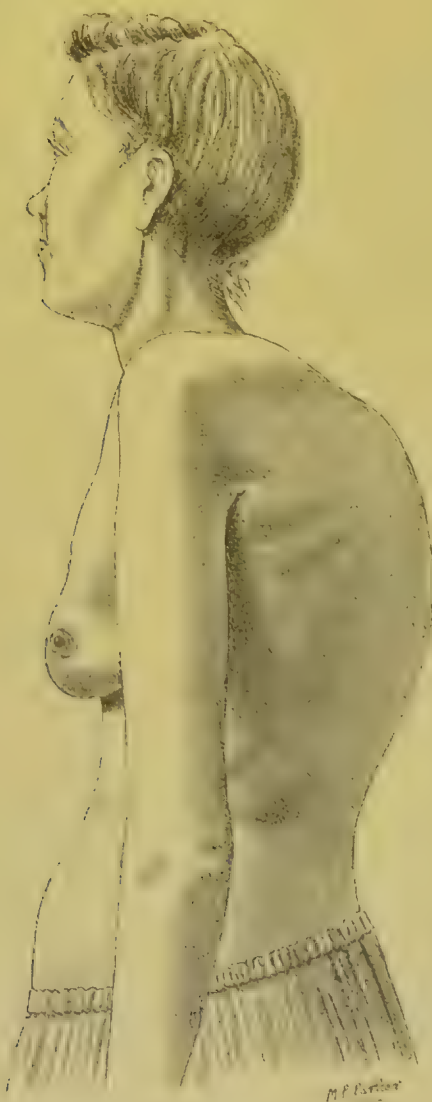
FIG. 28.—Side view of Case 23 three years after onset of curvature.

CASE 23. *Lateral Deviation of the Spine developing into severe Scoliosis.*—A. A., aged 22, has been a nursemaid for the last five years, and has performed in addition the duties of a general servant. She has been accustomed to carry children on the right arm, and for the last three years has noticed that the back has been growing out. There has been considerable pain in the dorsal region, which was temporarily relieved by rest. On examination.—She was a very stout girl, the head and trunk being particularly massive. There was no inequality in the length of the legs. A long C-shaped curve was seen on the left side, extending from the first dorsal to the third lumbar vertebra with but slight compensatory curve. On suspension, this disappeared. She was unable to give up work, and, in spite of supports, a large posterior curve occupying the dorsal region formed, and three years afterwards her condition had become steadily worse, an intractable scoliosis resulting (Figs. 27 and 28).

Mr. Fisher [1] has enumerated with much clearness the distinctions between deviation or "lateral bending" from muscular weak-

[1] *Internat. Encyclopæd. Surgery*, vol. vi. pp. 1067, 1069.

ness and scoliosis, and I place the various points in a table for comparison.

DISTINCTIONS BETWEEN LATERAL DEVIATION AND LATERAL ROTATION (after F. R. Fisher)

	Lateral Deviation.	Scoliosis.
Structural changes in spine and chest	Absent	Present
Effect of flexion of the spine	The deviation disappears	The deformity is more apparent
Horizontal position .	The deviation disappears	The deformity remains
Voluntary muscular effort	The spine can be straightened temporarily	The spine cannot be completely straightened
Raised shoulder and depression just above crest of ilium	On opposite sides of the body	Generally on the same side of the body
Suspension . . .	The deviation disappears	Disappearance of the deformity in initial cases only

It is essential, from the points of view of prognosis and treatment, that no error should arise from the lateral deviation of Pott's disease. For the characteristic features of such deviation the remarks on p. 36 may be referred to.

Having thus excluded simple deviation, let us turn to the varying clinical aspects of scoliosis. Any classification, however convenient, is arbitrary, and cannot cover all the varieties met with; but many cases may be grouped under the following headings:—

Clinical Aspects of Scoliosis.—1. *Cases in which the Curvature is mainly Unilateral or C-shaped.*—The curve may be in the lumbar or dorsal region, or in both. It may be of small extent, or involve the dorsal and lumbar regions.

In the former case it is frequently seen in the lumbar region, and results in but little apparent deformity. It is convenient to speak of curves as dorsal and lumbar. These terms merely imply that the chief part of the curve is in the region named, not that it is exactly limited to it.

FIG. 29.—Lateral deviation of spine from inequality in the length of the legs.

Some authorities believe that in the majority of scoliosis occurring in girls at the age of puberty, the lumbar curve is primary. Benjamin Lee[1] makes the following suggestion: "*Propter ovarium est mulier.*—The menstrual period is associated with considerable backache. To obtain relief from this women lie down, with something hard beneath the back to support the lumbar arch, and so

[1] *Trans. Amer. Orth. Assoc.* vol. ii. p. 80.

allow the psoas and iliacus to relax. The backache is, therefore, due in the same measure to the reflex irritation of the psoas and iliacus. If these muscles on both sides act equally, then no effect is produced, but if on one side the muscles are stronger, then curvature ensues." This seems to me far-fetched, but as Bradford and Lovett pertinently say, "Some writers regard the lumbar

FIG. 30.—Back view of case in Fig. 29 after wearing a boot with a cork sole for one year.

scoliosis as the chief curve and as the most common. The question may be regarded as not settled, though for clinical purposes it may be accepted as a fact that the dorsal curve is the one most frequently requiring treatment."

A single curve[1] or C-shaped curve of large extent is always of

[1] For the maintenance of the head in the erect position there must necessarily be small and somewhat abrupt compensatory curves at the extremities of the chief curve.

serious import because of the number of vertebræ implicated, the influence of the weight of the head and upper extremities continually tending to increase it, and the general weakness of the spinal muscles, which make treatment lengthy and troublesome. In these cases, too, the rotation of the spinous processes is well marked, the secondary effects of the deformity are great, and they are likely to run a more rapid and less favourable course. Such an instance was A. A., Case 23, quoted on p. 106. Generally the curve is in the lower dorsal and lumbar regions; less frequently the upper and middle portions of the dorsal region are affected, *i.e.* the curve may affect the lower or the upper part of the spinal column. A deviation pure and simple may develop into a long C-shaped curve, or more often a double curve forms. Such an instance is the following:—

Fig. 31.—Scoliosis. C-shaped curvature occupying the dorsal region, and general kyphosis.

Case 24. *Lateral Deviation of the Spine developing into Scoliosis with Double Curves.*—F. C., aged 15, who came to me with a general deviation to the left side in May 1892. In November of that year a double curvature had formed, the upper with its convexity to the left, and reaching from the seventh cervical to the eleventh dorsal vertebra, and the lower convex to the right and in the lumbar region.

When the chief curve is long the resulting distortion of the body is very considerable, inasmuch as "the vertebral column, like the keel of a ship, is the foundation of the structure of the trunk" (Fisher).

The mechanism may be grasped by attention to the accompanying diagram, Fig. 32, in which the effects on the ribs of twisting of the vertebræ are figured. For simplicity, let us suppose that the chief convexity is to the right, of large extent and occupying the dorsal region, with a secondary smaller curve to the left in the lumbar region.

The *results* on the trunk are as follows:—

(*a*) *General Appearance.*—The symmetry of the body is quite lost, the right shoulder being elevated, the left depressed. The right arm is closely approximated to the side and the left falls away at a considerable angle. The ribs on the right side are bulging, while on the left they are depressed. On the right side there is considerable hollowing out of the flank, with prominence of the hip, while on the left the flank is flattened and the hip is less in evidence than usual. These are due to the rotation of the bodies in the lumbar curve to the left, and the consequent pushing backwards of the transverse process on that side, with sinking in of the right process and depression of the muscles covering them. So that, according to the patient's description, the right hip is growing out, whereas it is really the flank which is sinking. If, however, the curve is situated so that it extends over the dorsal and upper lumbar vertebræ, then the

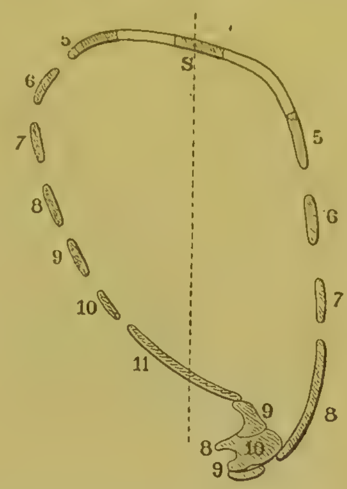

FIG. 32.—Diagram to illustrate the position of the ribs when the curvature is to the right in the dorsal region (after Rédard).

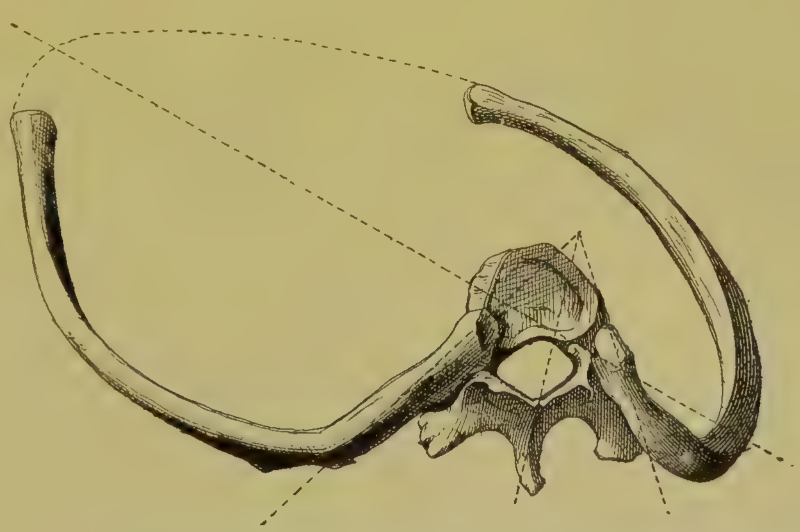

FIG. 33.—Illustrating the alteration in shape of the ribs, and the deviation of the transverse diameter of the thorax (after Rédard).

prominent hip and hollow flank are on the left, inasmuch as the right transverse processes are rotated backwards in the lumbar region, while those on the left are rotated forwards and the muscles covering them sink in, but, be it observed, are not, as a rule, wasted.

(*b*) The *ribs* on the right side behind are prominent, with their angles much increased, while in front they are correspondingly depressed, the whole of the ribs being as it were drawn backwards in the planes in which they lie, and compressed from before backwards and from right to left. On the concave side the ribs are more prominent anteriorly, but less so posteriorly, and the angle is widened. The altered position of the transverse processes sufficiently explains this. On the side of convexity they are more prominent than normal and on the concavity the reverse. In addition the right ribs are more oblique, with the intercostal spaces widened (Figs. 56 and 57).

FIG. 34.—Scoliosis. Long C-curve to the left in the dorsal and lumbar regions—Frank H——, aged 12 years (Evelina Hospital).

(*c*) The *scapulæ* will be found altered from their natural positions. Thus the right scapula, that of the outgrowing shoulder, is raised, less vertical than usual, and in severe cases almost horizontal, so as to give rise to the impression that its inferior angle is dislocated. It is also further away from the middle line than normal. The left scapula appears to have sunk, and its position is just the reverse of the right.

(*d*) The *clavicle* on the right side is much curved, and it has been said that in very severe cases of scoliosis dislocation of the sternal end has occurred.

(*e*) The apices of the *spinous processes* in the dorsal region are twisted to the left, *i.e.* away from the convexity. But the deviation of these processes is no measure of the deviation of the bodies, which is often much greater, owing to the vertical axis of rotation being situated considerably nearer to the tip of the spinous processes than the fronts of the vertebral bodies. This want of correspondence internally and externally is an important point to bear in mind in forming a prognosis.

(*f*) The *transverse processes* on the convex side in the dorsal region are prominent, and depressed on the concave side.

(*g*) As pointed out by Mr. Adams, the *height of the spinal column* is decreased owing to the deviation of the bodies to one side or the other, and to the posterior projection of the spinal column, the result of the general yielding.

The Mammæ.—The left is the more prominent, and the umbilicus is displaced to the left, with corresponding fulness on the right side of the abdomen.

The scoliotic pelvis is described on p. 140.

Such then are the clinical aspects of a case in which the long curve is mainly dorsal and to the right.

Single curvatures in the cervical region are rare, and observed as the result chiefly of torticollis. But the following case, associated with unequal refractive indices of the corneæ, is interesting :—

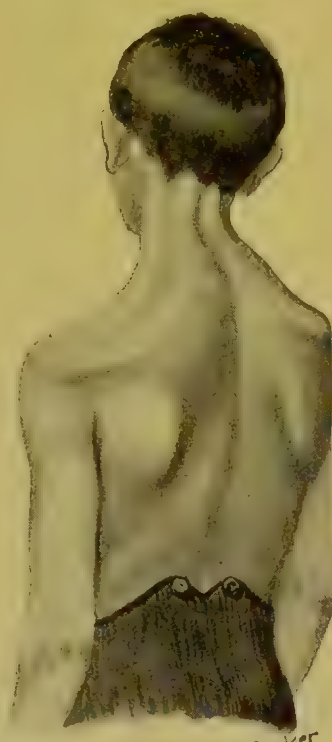

FIG. 35.—Scoliosis. Two curves are seen, one in the cervical and the other in the dorsal region—W. C. S., aged 12 years (Evelina Hospital).

CASE 25. *Unequal Refraction of Eyes, Scoliosis.*—A. B., aged 15, a feeble Jewish boy, came to me at the National Orthopædic Hospital on 21st December 1893. His general muscular development was bad, the shoulders were advanced, the head was drooping, and he was markedly anæmic. He also complained of inability to see clearly. The seventh cervical spine was prominent, and the whole cervical spine deviated to the right. When the eyes were tested they were found to be unequally hypermetropic. The error in the right eye was + 3 D, and in the left + 5 D. He was fitted with suitable spectacles, and with a change of air, exercises, and after a course of iron, he improved in general health, and the deviation in the neck disappeared.

2. *Cases with two nearly Equal Curves present.*—As a rule the curves have their convexity to the right in the dorsal, and to the left in the lumbar or dorso-lumbar region. Rarely, however, the two curves are situated in the cervical and dorsal portions of the column (Fig. 35). In either of the above conditions the characteristic S-shaped curve appears, one limb of which is primary and the second is compensatory. As to which is primary it is not essential to determine on mere pathological grounds, except in so far as the question of correct treatment is concerned, but one may usually take it that the less mobile is the more important curve, and therefore demands the more attention. It may happen that in some cases the S-shaped curvature is reversed in the respective regions, and then the dorsal convexity is to the left and the lumbar convexity is to the right. It is necessary therefore, in depicting the results of the latter malformations, to remember that the distortion will be the reverse of that of the former and more common deformity described below.

FIG. 36.—Scoliosis with two nearly equal curves and considerable dorsal kyphosis (Edith S——, aged 14 years).

That the dorsal convexity to the right is more frequent admits of no dispute. The statistics quoted by Mr. Adams fully support the generally-received opinion. Of 569 cases in the dorsal region, 470 were convex to the right and 99 to the left.[1] As to the reason of this excessive preponderance of right-sided dorsal curves, I believe it is due to excessive use of the right arm in faulty positions involved in occupations and employments, these being such as to elevate the right shoulder and depress the left. Occupations of this nature are clerking among men, painting and sewing in women, and in school children the very absurd position they are forced to assume

[1] Adams, *op. sup. cit.* 2nd ed. p. 160.

in learning to write the "Italian hand." The desk is often too low, and the child is compelled to stoop over it, with the right arm raised and rigid to ensure correct and fine upstrokes, while the left arm is depressed so that the hand may fix the copy-book. Such a case of incipient curvature is the following:—

CASE 26. *Scoliosis from Faulty Posture in Sitting.*—H. T., aged 14, complained of pain in the mid-scapular region, especially severe after school hours. His mother brought the boy to me in July 1894, because she had noticed the right shoulder growing out. I ascertained that for the last two years he had been sitting at a desk too low for him, and compelled to write in the faulty manner just mentioned. On examination, I found a very tender area extending over the spines of the third and fourth dorsal vertebræ, so sensitive to pressure was it as to make one consider the possibility of the case being one of commencing caries. The legs were equal in length, and the boy was on the whole well developed for his age. There was no rigidity of the back on applying the palm-pressure test during flexion and extension (see p. 34), but there were two curves present, the upper convex to the right extending from the second to the ninth dorsal spine, and the lower from the tenth dorsal into the lumbar region, with the convexity to the left. The natural curve backwards in the lower dorsal region was somewhat lessened, *i.e.* there was flattening present, and the left side of the chest projected. He was advised to cease attending school, and to employ a combination of rest and exercises. In October 1894 the back was nearly straight, the shoulders were almost at the same level, and he had entirely lost the pain. In January 1895 the figure was completely restored and all pain had disappeared.

In some cases, however, the scoliosis is due to excessive shortening of one leg, or to the habit of standing mainly on one leg. In such instances the lumbar curve is the first to appear. But as a rule it may be said that the higher in the dorsal region the first curve is, the earlier in life it has appeared.

The deformity in the neighbouring parts is seen to be closely analogous to that already described in curves chiefly single. Thus the right scapula is unduly raised, prominent, and altered in direction; the right shoulder is higher, the ribs stand out even more than when the curve is of greater length, and the hollow of the right flank is also more marked, but the left hip is in these cases of equal curves always the more prominent. The cavity of the chest is more oblique from side to side, owing to the greater projection backwards of the ribs on the convex side; in females the right breast has receded considerably, and the left is unduly prominent. The greater the lateral deviation and rotation, and the more closely it is limited to the dorsal region, the more disastrous are the effects on the shape of the thorax. Another effect is diminution in height of the spinal column, the result of rotation of the vertebræ associated with lateral flexion.

3. *Three or more Curves present.*—In some cases three and even four curves are seen, and are variously distributed in the spine. In that form of scoliosis in which there is one large curve present,

FIG. 37.—Scoliosis. Three curves are present—James P——, aged 16 years (Nat. Orthopædic Hospital).

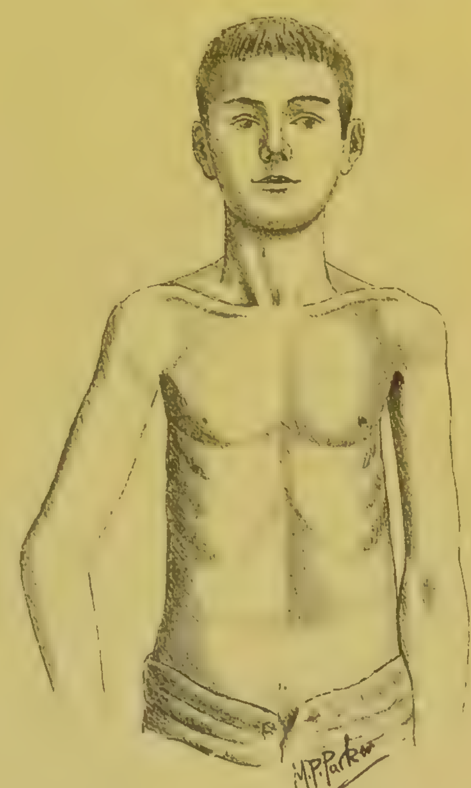

FIG. 38.—Front view of Fig. 37. In spite of the spinal curves, the chest is nearly normal in shape (see text).

there are sometimes two smaller compensatory ones, but this condition is distinct from that now under consideration. Here the curves are often of equal length, and it is difficult to say which one is primary. The chief point on which a decision must rest is that the first curve is the least mobile when the patient is suspended.

When three or even four curves are present, the accompanying distortion in the chest is less, inasmuch as in each curve fewer vertebræ are affected (Figs. 37 and 38). But it would only lead to confusion to enumerate all the resulting deformities, even if it were possible to do so precisely. Suffice it to say that on the convex side of the curve the changes will be in principle those enumerated above, and that the distortion-effects will be most marked in the chest when the curves are chiefly dorsal. On the concave side the reverse conditions will naturally obtain.

4. *Scoliosis associated with Posterior Projection of some of the*

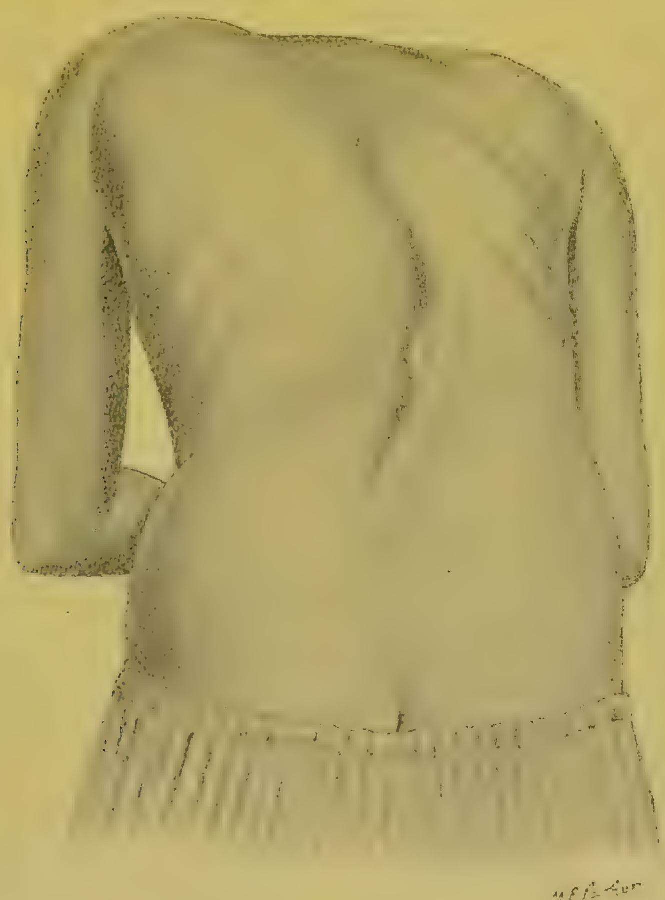

FIG. 39.—Scoliosis with projection of two spinous processes at the intersection of the two curves. The flexibility of the back negatived all suspicion of Pott's Disease (Mary W——, aged 14 years).

Spinous Processes.—This condition is seen when the back presents two curves nearly equal, and the projection is found at the spot where the upper and lower curves intersect (see Fig. 39). The mechanism at work producing the projection is, I take it, as follows: the prominent vertebræ are acted upon by two lateral forces, one above and the other below, *i.e.* "a couple" of equal and opposite forces is made. The vertebræ at the prominent spot are therefore maintained in the middle line, but undergo considerable oblique pressure from above downwards and from below upwards. In some instances they are forced forwards into the cavities of the thorax and abdomen, but occasionally the undue pressure makes them yield backwards, hence the prominence of the spinal processes. A certain amount of apparent projection is also due to the wasting of muscles at the meeting-point of the curves.

FIG. 40.—Scoliosis, limited in extent, with reversal of normal lumbar curve, and posterior projection of the lumbar spinous processes (Henry W——, aged 14 years).

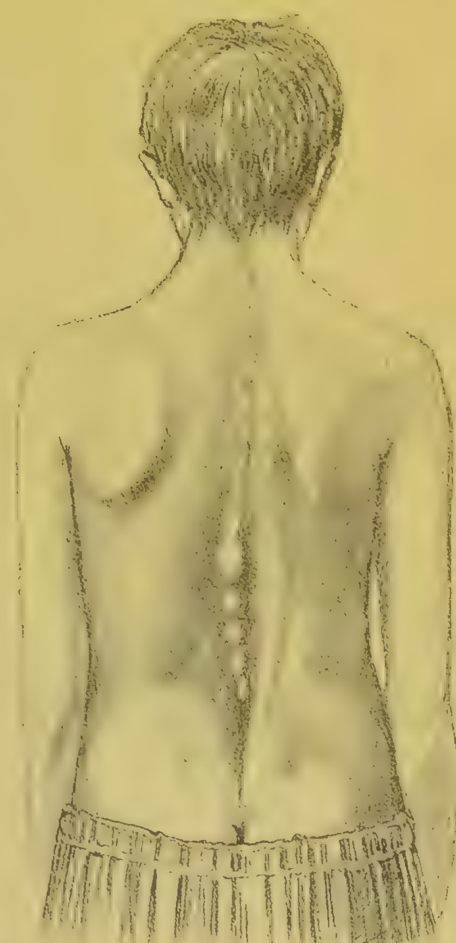

FIG. 41.—Scoliosis with reversal of normal antero-posterior curves.

The chief interest of this class of case lies in the following facts. Projection of the spinous processes is a constant accompaniment of Pott's disease, and lateral deviation is an occasional feature; lateral deviation and rotation of the vertebræ are the distinguishing features of scoliosis, and projection of some spinous processes an unusual occurrence. It therefore happens that at first sight some difficulty may arise in the diagnosis, but the rigidity and fixity of

PLATE II.

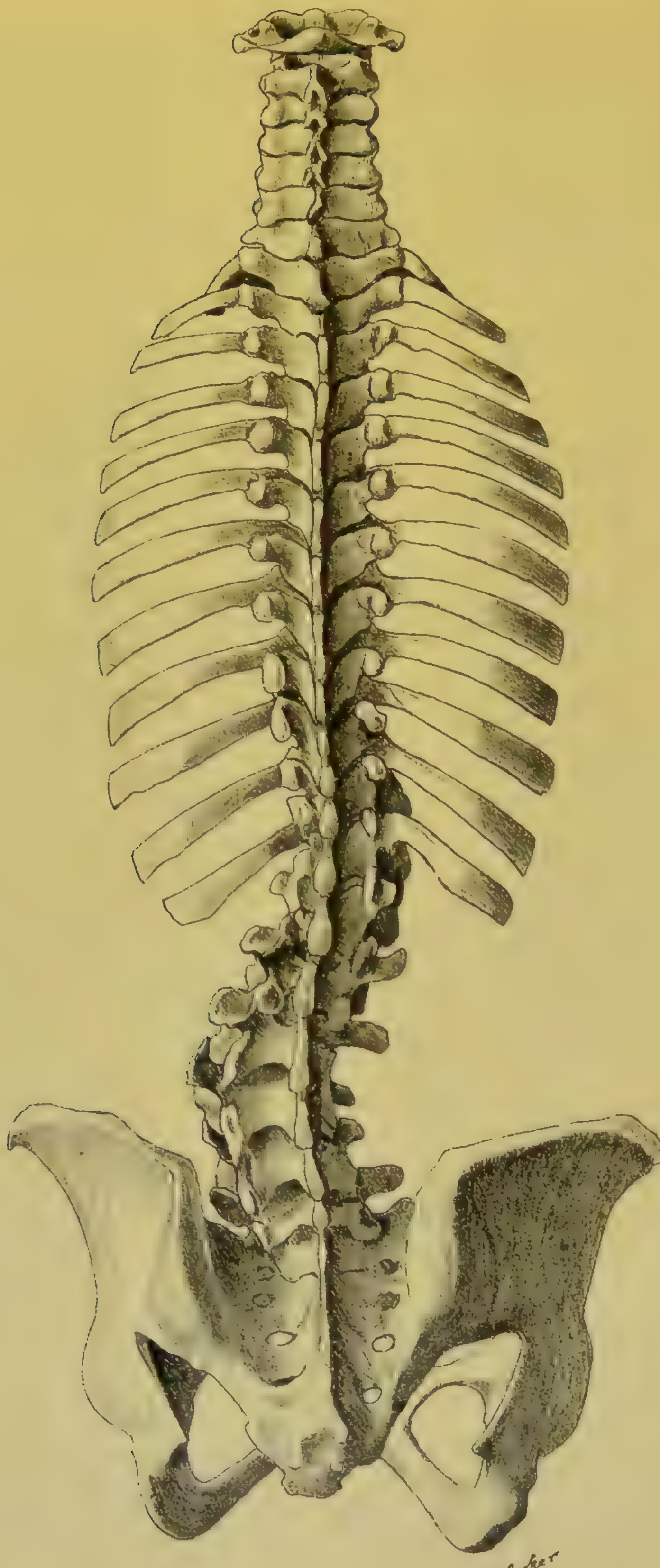

FIG. 1.

The back view of a scoliotic spinal column, in which the spinous processes are seen to be almost in a right line, despite the excessive rotation of the lumbar vertebræ. (Guy's Hospital Museum, 1006[90].)

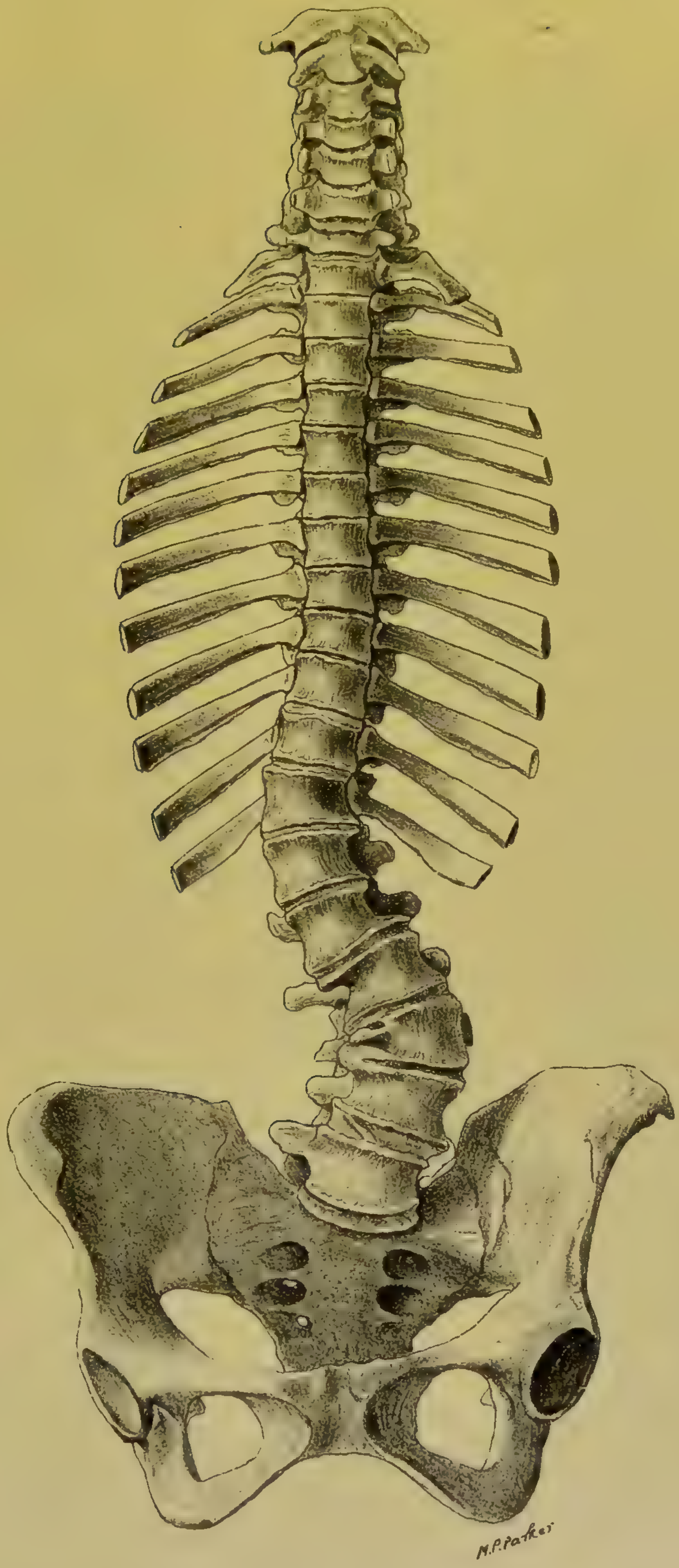

FIG. 2.

The front view of the same spinal column, in which the excessive rotation of the lumbar vertebræ and deformity of the vertebral bodies are well seen. (Guy's Hospital Museum, 1006[90].) These figures show that the deviation of the spinous processes is no measure of the deviation of the bodies.

the affected spinous processes are the distinguishing and diagnostic features of Pott's disease. By way of illustration, figures of Pott's disease and scoliosis with projection are given on pp. 37 and 118.

5. *Scoliosis with Obliteration or Reversion of the Natural Antero-Posterior Curves of the Spine.*—Cases of this description present either the less degree of flattening of the back, or the greater one of reversion of the natural kyphosis in the dorsal region, with flattening or some projection in the lumbar region (see Figs. 40 and 41, and compare the two views of a dried specimen, Plate II.). It is evident that such an appearance in the mid-region of the spine is due to two causes.

(*a*) Considerable rotation of the vertebral bodies around a horizontal axis situated near the apices of the spinous processes, and consequent sinking of the bodies of the vertebræ into the cavity of the chest, where they are deficient in support.

(*b*) It arises from the posterior projection of the ribs on the convex side.

The flattening in the lumbar region is owing to a compensatory backward pushing of those vertebræ ; and so much displacement may occur that two or three upper lumbar vertebræ near the intersection of the curves actually form a distinct " bow " in the outline of the spinous processes.

The clinical importance of recognising this group is considerable, inasmuch as the most troublesome factor of lateral curvature of the spine, excessive rotation, is here present, and the prognosis is dis-distinctly unfavourable. It may be laid down that in such instances the *external curvature of the spinous process is no measure of the extent of the internal displacement of the bodies* (Plate II. Figs. 1 and 2).

Varieties of Scoliosis.—From the causal point of view there are many varieties of scoliosis. A distinction is at once made if we place in the primary class those due to defective conditions in the spine itself, and those to general constitutional causes. While in the secondary group should be placed those forms which are distinctly traceable to local causes acting from a distance.

The varieties then are—

I. Primary—
- *a.* Scoliosis of Adolescents including Occupation-Scoliosis.
- *b.* Congenital Scoliosis.
- *c.* Rhachitic Scoliosis.
- *d.* Some forms of Scoliosis of Nerve Origin.

II. Secondary—
 a. Static Scoliosis.
 b. Scoliosis due to Cicatricial Contraction such as Empyema.
 c. Scoliosis in association with Nasal and Post-nasal Obstruction.

Scoliosis has also been described as flexible, fixed, and structural. This form of classification has a distinct advantage from a clinical point of view. A tabulation very useful for treatment is that made by Mr. Adams.

I. Cases essentially of Constitutional Origin, *e.g.* Hereditary Cases, General Weakness, Rickets.
II. Cases dependent upon Constitutional and Local Causes in about Equal Degrees, *e.g.* Bad Position, Certain Occupations, and associated with Debility.
III. Cases essentially depending upon Local Causes, *e.g.* Inequality in the Length of the Legs, Torticollis, Diseases of the Chest, etc.

But to return to the classification I propose to adopt.

Scoliosis of Adolescents, including "Occupation-Scoliosis."—The term "Scoliosis of Adolescents" is not quite satisfactory, as it conveys no definite idea of cause, but merely implies the date of onset. It is convenient, however, to group under this heading that large number of cases which, commencing in childhood and youth, and being associated often with muscular debility, are induced or aggravated by unsuitable occupations. If at the same time the opportunity is taken to discuss the pathogenesis of primary scoliosis together with the symptoms, morbid anatomy and diagnosis in general, much needless repetition will be saved.

Causes.—*Predisposing.*—The influence of sex and heredity have already been discussed. The others are general feebleness of health, anæmia, rapid growth, and in girls the onset of menstruation, with the cessation of those active habits characteristic equally of girls and boys in childhood. To these should be added the rapid and often excessive development of the breasts in girls, causing increased strain on the back, and the pernicious effects of corsets, together with the weight of long dresses. In the higher classes, girls at the age of puberty, or a little later, commence to imitate the habits of their elders, and exhaust their strength by late hours and sitting in hot "stuffy" rooms. In the lower classes too the willing girl is often the drudge of all work.

Feeble muscular development should be included as a predisposing cause, but a certain proportion of the cases are present in people exceedingly well developed,[1] and one finds that such instances may be classed in a subdivision as occupation-scoliosis. Injury is not a cause except indirectly and in this way. A weak and hysterical girl has a blow or fall on the back and is told to rest. She "indulges" the back in a faulty attitude and scoliosis begins.

Effective.—In illustration, I quote some cases from my notes:—

Edith W——, aged 14, dressmaker. Long curve, R. dorsal; short curve, L. lumbar.
Herbert R——, aged 18, clerk. Slight curve, R. dorsal.
George T——, aged 17, bricklayer. Posterior and lateral curve in dorsal region.
Ada A——, aged 22, nursemaid. Large curves to R. in dorsal and lumbar region (Figs. 27 and 28).
Elizabeth G——, aged 14, domestic work and nursing. Curve R. dorsal.
Lizzie W——, aged 18¾, domestic servant. Long curve, R. dorsal.
Alice S——, aged 22, nursery governess. Curves R. dorsal, and L. lumbar.
Minnie R——, aged 17, nursemaid. Chiefly R. dorsal.
May S——, aged 17, housemaid. Curves R. dorsal, L. lumbar.

These are illustrations of "occupation-curves." In all cases but one, that of the boy G. T., the muscular development was less than normal. In his case it was above the average. He had carried a hod of bricks on his shoulders up a ladder for three years, and he was particularly muscular. Other occupations in girls are associated with rotary lateral curvature, viz. needlework, book-folding, etc.

In various papers[2] Arbuthnot Lane has conclusively proved by direct observation on both the living and dead body the predominant influence of occupation in many cases of scoliosis. He gives drawings of the spine of a brewer's drayman, who carried casks on the right shoulder and front of the right chest. There was a marked scoliosis with the convexity to the right at the seventh dorsal vertebra, together with other changes in the skeleton. Mr. Lane insists that the deformity arising from the habitual performance of heavy labour is "first the fixation and then later the exaggeration of what is a normal physiological attitude, assumed in this particular form of labour," and in other varieties of scoliosis the curvatures are simply "the fixation and subsequent exaggeration of a movement

[1] Cf. case quoted by Sayre, *op. cit.* p. 395.

[2] *Med. Chir. Trans.* vol. lxvii.; *Path. Soc. Trans.* 1884 and 1886; *Clin. Soc. Trans.* 1886; *Guy's. Hosp. Rep.* 1885-87.

which is a normal one when the subject occupies a position of rest." He claims that "the double curves of the spine are a normal physiological attitude and a position of rest; and that they only become a deformity when they remain as permanent curves and cease to be

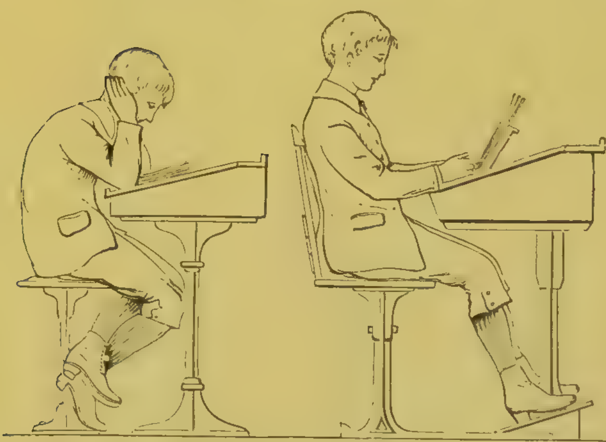

FIG. 42.—Side views of faulty and correct positions at the school desk.

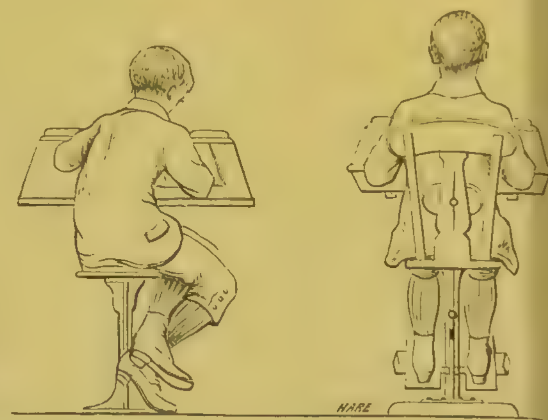

FIG. 43.—Back views of faulty and correct positions at the school desk. The effects of the twisting of the legs on the shape of the back are seen.

recoverable, in exactly the same way that the flexion of the dorsal spine is also an attitude of rest, and only becomes a deformity when it persists as dorsal excurvation." These papers are very thoughtful, and repay careful reading.

FIG. 44.—Piano-practice in a bad position.

FIG. 45.—Piano-practice in a correct position.

Certain attitudes are very likely to be followed by scoliosis, *e.g.* standing on one leg and sitting cross-legged. These cause twisting of the pelvis and rotation of the lumbar spine; so does excessive horse-exercise by girls without a reversible saddle. The exceedingly faulty arrangement of music-stools and school-desks are responsible for many cases of scoliosis (see Figs. 42-45 [1]). The attitude assumed by school-children when writing is not always the same. Sometimes the right arm and forearm are on the table guiding the pen, while only the fingers of the left hand touch the table. The result is depression of the left shoulder, and a rotary curve to the right (Fig. 46). At other times it is the left arm and forearm which bear the weight of the head, neck, and shoulder, and are therefore placed firmly on the table, while the right arm resting lightly, merely guides the pen. The right shoulder is consequently depressed, and there follows a long curve in the dorsal and lumbar region with its convexity to the

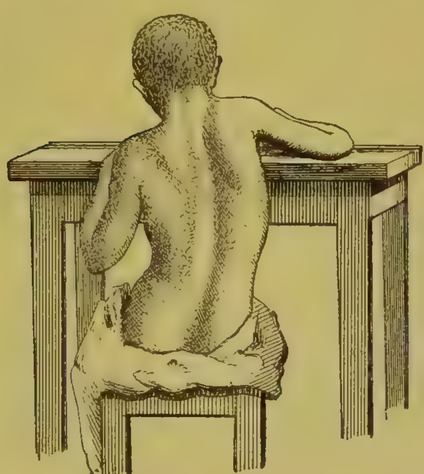

Fig. 46.—Dorsal scoliosis to the right, from an incorrect position while writing (after Rédard).

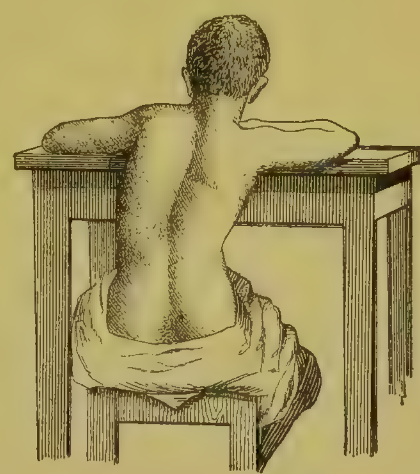

Fig. 47.—Dorsal scoliosis to the left, also from incorrect position while writing (after Rédard).

left (Fig. 47). Very often the fault is not in the child but in the desk. It is disproportionate to the height of the child, and the seat is placed at such a distance from the desk that the head and shoulders must be inclined forwards, with the trunk placed obliquely, in order that the pen may reach the paper. Preventive measures are described on p. 162. The influence of defective accommodation of the eye and errors of refraction in inducing faulty attitudes has already been referred to.

A Method of Examination for Scoliosis.—The more severe forms can be diagnosed almost at a glance, but in slight cases it is very easy to overlook the condition. Nor is it the mere recognition that is necessary. We wish to know the amount of rotation and fixation

[1] For the use of these blocks I am indebted to the North of England School Furnishing Company, Darlington.

of the spine, the stage of the deformity, and whether it is progressing favourably under treatment, is stationary, or becoming worse.

The patient's back should be bared, and it is as well to remove clothes hanging from the waist. To this end it is convenient to have at hand a loose flannel skirt which can be put on by the patient after removal of her ordinary garments, and kept in place around the hips by an elastic band. For the upper part of the body a loose flannel jacket may be put on, with the opening and buttons behind, or a small shawl is sufficient. Then:

A. To determine the existence of scoliosis in a suspected case the following points should be noted:—

1. The natural attitude when standing at ease and the angles made by the arms with the body, and the undue prominence of one or other hip.

2. An effort should now be made by the patient to stand in as straight a position as possible, and its effect on the deformity noted.

3. When the patient is at ease, mark out the tips of the spinous processes and the angles of the scapulæ with a crayon or aniline pencil, and note the deviation from the normal by taking a string lightly weighted at one extremity and fixed at the other extremity to the tip of the seventh cervical vertebra by a piece of adhesive plaster. The string should reach to the gluteal cleft.

Then direct the patient to cross her arms in front of the chest, and measure the distances of the angles of the scapulæ from the plumb line, and of the tips of the spinous processes from it at the points of greatest curvature.

4. The relative heights of the shoulders, the asymmetry of the sides of the trunk, and the general contour of the back are then observed. Particular attention in slight cases is necessary to two points—slight alteration in the outlines of the flanks, and flattening or prominence of the erectores spinæ. These signs are of great value.

The observations are taken when the patient is in two positions, viz. the position of ease in standing, and when she is flexing the back with the arms across the chest and the hands resting on the opposite shoulders. It is remarkable how much greater the deformity appears in the latter position. It "brings it out," as it were, the deformity of the ribs especially becoming evident now that the scapulæ are drawn outwards and upwards, and the ribs are uncovered.

5. In cases of doubt the front of the patient's chest may be examined, and any asymmetry of the breasts or deviation of the umbilicus from the middle line noted.

B. To test the flexibility, amount of rotation, and fixation of the spinal column.

1. The flexibility of the spine is tested by causing the patient to bend to one side or the other, keeping the legs straight, while the surgeon fixes the pelvis with his hands above the crests of the ilia; or, by placing a series of blocks beneath one foot until the patient is no longer able to keep the raised limb straight. The flexibility of the spine may also be tested by direct pressure of the surgeon's hands. If the usual right dorsal and left lumbar curves are present, the right hand is placed over the most convex part of the right ribs, and the left hand with the palm on the left flank. *The amount of flexibility is the gauge of the improvement that may be expected under treatment.*[1] B. Roth's[2] "best possible position" as secured by the patient's efforts aided by the surgeon is said by him to be the "keynote" of the exercises necessary for correction. This "best possible position" is obtained in various ways; sometimes by the patient taking hold with one hand (that on the concave side of the curve) of a horizontal bar placed two or three inches above and parallel with a second bar, which is grasped with the other hand; when the patient is suspended in this way the weight of the body assists in straightening the curve (Fig. 76). At other times it is sufficient to raise the arms vertically above the head, or to elevate the arm on the concave side of the curve above the head, while that on the convex side is placed at right angles to the body.

2. The amount of abnormal rotation of the vertebræ is estimated not by the deviation of the spinous processes, but by the alteration in the shape of the thorax.

3. The fixation of the spinal column. This is due to osseous changes, and is of serious import. If there be no marked alteration in the curves on placing the patient in the prone position, or on suspension, or in the "best possible position," then fixation changes in the spinal column are present. On the converse, considerable alteration is of good import. An important sign of fixation, and not generally recognised, is this—if, when the patient is suspended, the transverse axis of the pelvis does not become parallel with the

[1] *Clin. Soc. Trans.* vol. xxi. p. 301.

[2] *Treatment of Lat. Curv. of Spine*, p. 13.

transverse line joining the shoulders, but makes with it an angle of some degrees, then very considerable osseous change is present.

C. To record the progress of the case under treatment. This is best accomplished by photographs, taking care each time to mark out the tips of the spinous processes and the crests of the ilia and angles of the scapulæ.

An inexpensive and efficient scoliosometer is yet to be invented. The apparatus of Schenk and Schulthess are too complicated. B. Roth[1] uses a method which is simple and efficient. "The trunk should be flexed as far as possible, the knees being kept extended and the arms allowed to hang loosely, so that the scapular muscles are relaxed." By these means the ribs are bared of the scapulæ, which glide outwards, partly owing to the relaxation of the muscles and partly to the weight of the arms. "The metal tape is made of pure tin, and is 20 inches long, $\frac{5}{8}$ inch wide, and about $\frac{1}{25}$ inch thick, and can be obtained from Messrs. Mayer and Meltzer. I now take a tracing of the ribs posteriorly as follows: I feel for the lower angle of the left shoulder-blade, and fixing one end of the pliable metal tape with my left hand at that point, I carefully mould the tape close to the ribs across the spine to the lower angle of the right shoulder-blade. With a copying pencil I mark the metal opposite the dorsal spine, and then carefully remove the tape, upper edge downwards, on to a sheet of quarto-size paper and draw a tracing inside the tape, marking on the paper the point where the tape crossed the spine. The pencil line is afterwards inked, and the tracing cut out and folded down the middle, opposite the point marking the spine, and we have now an accurate record of the ribs posteriorly. Similarly a record is taken of the loins midway on each side between the last ribs and the iliac crests—that is, opposite the third lumbar vertebra—marking the tape as before where it crosses the spine." To obtain a more complete idea of the deformity, I would suggest that the distance between the points of intersection of the tape with the spine should be ascertained, and the curves laid out on full-sized sheets of paper with the proper vertical distance[2] between them, and the deviation of the spinous processes marked out on either side of the folded line. It can be quickly estimated by the eye. The method of using a strip of lead

[1] *Op. sup. cit.* pp. 8-10.

[2] This is the more important since it has been shown that scoliosis diminishes the height of the spinal column.

to record the deviation of the spinous processes is after all not so accurate as a drawing made to scale from fixed points.

Symptoms and Course.—In addition to the curvature and the general effect on the outline and structure of the trunk, such as elevation of one shoulder, prominence and flattening of the ribs, protrusion of one hip, alteration in the shape of the flanks, and lateral obliquity of the pelvis, there are certain subjective symptoms complained of by the patient, viz. pain, disturbances of circulation, respiration, and digestion, which require to be more fully entered into; and it will be convenient to discuss these under four headings, viz. the incipient period, the stage of development, the stage of arrest, and the stage of improvement.

I. *The Incipient Period.*—The particular variety of the deformity we are now discussing, "Scoliosis of Adolescents," is generally supposed to begin at the age of puberty, but there can be no doubt its first onset occurs in very many cases earlier than at that time. Pain is as a rule absent, although a feeling of weariness in the back extending to the legs may be complained of. A careful examination of the figure reveals slight elevation of one shoulder, alteration in the symmetry of the flanks, projection of one hip, or faulty habit of standing or sitting. Indeed the child "lolls" about, and is unable to bear any prolonged exertion.

II. *The Stage of Development.*—In cases where the general health is good, and often in children, there is little or no pain. But in weakly girls, with a scoliosis developing at the time of puberty, the amount of pain varies considerably. It may be slight aching pain in the lumbar region, or in some instances may be such as to incapacitate the patient altogether. But it is important to remember that a distinct class of cases exists, viz. the hysterical girl, whose existence is dominated by the idea that she has spinal disease; an idea which has arisen from an opinion expressed perhaps incautiously, and in her hearing, to the effect that there is some distortion in the back. In such instances localised patches of hyper- and anæsthesia will be felt, together with neuralgic pains in the sides of the chest. Sometimes distinct tenderness on pressure over the spinous processes is found, but it is merely, when coexisting with pure scoliosis, an evidence of nervous depression. Cases of this nature are distinguished by the fact that the deformity is not sufficient by pressure and stretching effects to cause such severe pain as is complained of, and it will often happen that the lumbar pain is aggravated by dysmenorrhœa and menorrhagia.

Hysterical paraplegia may even be present. When the deformity is severe, both local and diffused pain exist. The local pain is, as a rule, on the side of the convexity, and in the dorsal region will be found a little below the angle of the scapula on the convex side of the curve, and in the lumbar region, on the opposite side of the middle line near the transverse processes. The diffused pain arises from the altered shape of the thorax and the consequent pressure on viscera. The possible causes of local and diffused pain are :—

1. The increased tension of muscles and ligaments on the convex side of the curve.

2. Discomfort and pain arising from the altered position of viscera, and in those cases in which very severe deformity with osseous ankylosis is present, from constant tension of the nerves.

3. From a general hyperæsthetic condition due to low vitality.

Patients with large single C-curves are very liable to pain, probably owing to the rapid increase in the curve and inability of the affected structures to adapt themselves sufficiently quickly to the altered position. When the pain in such instances is chiefly lumbar and the deformity considerable, it may be due to the contact of the depressed ribs with the iliac crest, and the consequent irritation of the lateral branch of the last dorsal and first three lumbar nerves. Mr. Adams states that " the worst cases of local pain which have come under his observation have been in the most rigid and least flexible forms of spinal curvature, generally of many years' duration, but slowly and progressively increasing." The alteration from pressure in the shape of the individual vertebræ, their bodies and processes, is an indication of the extreme tension on the bony parts of the column, and is in itself sufficient to account for much of the local pain experienced. That direct pressure of bone on nerves occurs has not hitherto been demonstrated; and it is improbable, inasmuch as the pain is usually on the convex side of the curve rather than on the concave, while the foramina are normally much larger than the nerves which they transmit. The other symptoms complained of during the stage of development are referable to alterations in the positions of the viscera, and may be tabulated under the heading of—

Displacement Symptoms.—These are in evidence during this stage, but are more marked in that later period when fixation has occurred from bony ankylosis. In illustration of the effects upon the viscera, and the symptoms arising therefrom, I will quote two cases.

Case 27. *Intractable Scoliosis: Considerable Displacement of the Heart.*—William H———, aged 14, has suffered from curvature of the spine for twelve years. He is thin and the muscular development is feeble. As

FIG. 48.—Back view of a case of intractable scoliosis (Case 27, William H——, aged 14 years).

FIG. 49.—Front view of William H——, Case 27. Considerable displacement of the viscera existed in this case (see text).

a child he suffered from rickets, and there is a strong family history of tubercle. He now complains of pain in the back, shortness of breath, and of indigestion and constipation.

On examination, there is an extensive curvature to the right in the dorsal region, extending from the first to the tenth vertebra, with a second compensatory curve in the lumbar region; the curves are not lessened by extension; the legs are equal in length; the right lower ribs overlap the iliac crest; the right chest scarcely moves at all in respiration, and its resonance is partially lost; the heart's apex is 2½ inches below the nipple, and is displaced somewhat outwards; there is much pulsation at the inner end of the second and third left spaces; the right subclavian and common carotid are more prominent than normal, and are seen beating beneath the skin; the innominate artery

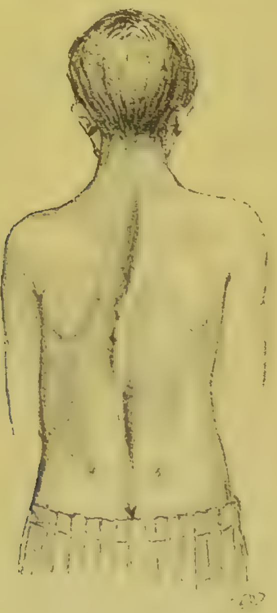

FIG. 50.

FIG. 51.

Two views of a case of scoliosis after measles and pleurisy (Case 28, Daisy C——, aged 12).

rises half an inch into the neck; the point of origin of the carotid and subclavian can be seen and felt; the tip of the ensiform cartilage points to the right side, and the umbilicus is displaced to that side; the lower edge of the liver is 2 inches below the margins of the ribs, and the belly is prominent and tympanitic (Figs. 48 and 49).

CASE 28.—Daisy C——, aged 12, had measles six months before seeing me, and it appears from the mother's description that pleurisy had followed the measles. The patient is weakly and ill, with a long curve to the right from the first to the ninth dorsal vertebra and a compensatory lumbar curve. The right chest is dull, and the heart's apex is just internal to and on a level with the nipple. The abdomen is prominent and tympanitic. On suspension the pelvis twists forwards to the right and upwards[1] (Figs. 50 and 51).

[1] This tilting may give rise to limping.

These cases are examples of the effect of advancing scoliosis upon the position of the thoracic and abdominal viscera. To sum up:—

The Lungs.—On the convex side the chest is less resonant, and the vesicular murmur is decreased. On the concave side the note is more resonant, and the respiratory murmur is increased. The total decrease in the respiratory capacity is the cause of the shortness of breath, the frequent and severe attacks of bronchitis, and the increased liability of these patients to tubercular mischief after a pronounced curve has existed for some years. It is possible, too, that deficient aeration and circulation of blood may explain the absence of subcutaneous fat so often seen in these patients.

The Heart.—If the concavity is to the left and in the dorsal region, the heart's apex is generally above its normal position and displaced outwards. I have seen the apex beat in an extreme case in the third intercostal space. If the concavity is to the right the heart is pushed well to the right. It is said that the right side of the heart becomes dilated. But from whatever cause it may be, some of these patients are cyanotic ; and many suffer from palpitation, although this may be ascribed to other causes, such as the concurrent dyspepsia.

Abdominal Viscera.—The liver, from its large size, is particularly liable to compression and displacement. So, too, the spleen is out of place, while the stomach and intestines are pushed forwards to compensate for the lowered position of the diaphragm. The intestines are distended with gas, an evidence of the general disturbance of the digestive functions.

Such is the picture presented by cases in which the spinal distortion has developed rapidly and is becoming extreme.[1] But it should not be inferred that all cases present so much functional disturbance as has been described. Many patients are fairly robust and hearty, and suffer in a slight degree, if at all, from general ill-health. In others their life is rendered miserable by impaired circulation, feeble digestion,[2] and limited powers of respiration. Following these symptoms, in girls there is general disturbance of the uterine functions. I have already adverted to Benjamin Lee's idea (p. 108) that primary lumbar curves have their

[1] The above remarks on displacement symptoms should be read in conjunction with those on the clinical aspect of scoliosis.

[2] Adams, *op. sup. cit.* p. 171, mentions a case of a lady, aged 23, with severe scoliosis, who suffered from severe and periodical attacks of vomiting, but was much relieved by efficient support.

origin in uterine disturbances, but I do not share his opinion, and fail to see any direct connection between uterine disorders and scoliosis.

The Ages at which Increase in the Scoliosis occurs.—Briefly it may be said, at three periods, viz. up to the age of 25, from 25 to 40, and in old age.

If a slight case commencing at the age of puberty is left untreated it may become steadily worse until growth has ceased, and severe cases may grow worse in spite of treatment. The majority of cases, however, may be regarded as having attained the maximum deformity at 25. In a small proportion of cases, as the result of debility, especially that which occurs from frequent child-bearing, a recrudescence takes place, and the curvatures become more pronounced between the ages of 25 and 40. The influence of rapidly-succeeding parturitions in this connection should not be forgotten. In a still smaller number of cases, owing to failure of the general health, a scoliosis which has been quiescent for thirty or more years will commence to increase, and cases have been recorded in which such an increase took place as late as the sixtieth year.

III. *The Stage of Arrest.*—This stage may be reached spontaneously, or as the result of treatment. Spontaneous arrest occurs in two varieties of cases: in the slight and in the well marked. There are many people of middle age going about without any apparent external deformity, an examination of whose backs shows them to have suffered from a small amount of distortion of the spine; and in forming an opinion as to the probable result of a case, this possibility of natural arrest should be borne in mind. By these cases evidence is also afforded that scoliosis is not always so serious a matter as it is sometimes said to be. The other class of cases in which natural arrest occurs present quite a different aspect. The scoliosis is extreme, and has ceased to increase simply because bony ankylosis has taken place, with ossification of the ligaments. These two varieties of natural arrest are at opposite poles.

When in the slighter Class of Cases may Natural Arrest be expected?—I have frequently insisted upon the great tendency of large single C-curves to become steadily worse. Conversely we find that the opposite condition of several small curves is particularly favourable to spontaneous arrest, on account of the more complete compensation; and an earlier arrest may be expected in a case with double curvature if the curves are equal than when they are unequal. Secondly, an important factor in inducing arrest is the attainment of a high level of general health, with increase of muscular power. Thirdly, the nearer the age of completion of growth the patient is when the scoliosis commences, the more likely is it to be arrested before it has become extreme. Fourthly, spontaneous arrest is frequently seen on the cessation of faulty habits of standing or sitting.

Evidence of spontaneous arrest is afforded by the loss of pain, fatigue, and discomfort, and by direct measurement.

IV.—*The Stage of Improvement.*—The recognition of this stage is made by observing the gradual diminution of all the signs of deformity enumerated, especially the projection of the ribs on the convex side and the acquisition of symmetry of the flanks. As the ribs return to their normal positions, the shoulders become level.

Morbid Anatomy of Scoliosis.—Scoliosis is not a disease, but an alteration in the position, shape, and texture of the spinal structures, dependent on long-continued pressure in an abnormal direction.

In the earlier stages of the deformity when it has lasted a year or two, some diminution in thickness of the bodies of the vertebræ and intervertebral discs in the concavity is found, and the ligaments accommodate themselves to their altered positions by shortening. In lateral deviation from spinal weakness it is possible that relaxation of the ligaments is present. The lesions hereafter mentioned exist only in advanced scoliosis.

It is essential to remember that scoliosis is not merely a deviation, but an actual twisting of the spine around a vertical axis. The bodies turn to the convex side, the spinous process to the concave side, and the transverse processes are rotated so that the "convex" process stands out, while its fellow is buried.

This is a convenient moment to revert to the distinction between the two parts of which the spinal column is composed, viz.:—

(*a*) The anterior, "body-column," or column of the vertebral bodies.

(*b*) The posterior, "process-column," or column of the laminæ, pedicles, and processes.

The function of the bodies is essentially supporting, and they suffer proportionately when the pressure to which they are exposed acts in a wrong direction. The processes are altered too, but less so, and the changes in them are secondary and due to the new position they must take.

Changes in the Vertebræ.—(*a*) The Anterior Column, the Bodies. Taking them as a whole, we find that at the middle of the curve they are displaced, being rotated even so far that the line joining their antero-posterior surfaces forms an angle of 90° with the vertical median plane of the body. They form the arc of the chord which is subtended by the line of the spinous processes. The greater movement of the bodies may be aided by their unsupported position in the visceral cavities, and in the lumbar region by the absence of attachment of the ribs. The alteration in the shape of the bodies is the result of two factors, viz. firstly, alterations dependent on lateral deviation; secondly, on torsion.

Fig. 52.—Anterior view of the lumbar vertebræ from a scoliotic spine. The bodies are seen to be wedge-shaped, and on them are the oblique and spiral striations, as if they had been twisted in their vertical axis (after Rédard).

Lateral deviation causes the bodies to assume a wedge shape, with the summit directed to the concavity and the base to the convexity (see Plate II. Fig. 2). In this change of shape the intervertebral discs partake. As to the structure of the bodies on the concave side, they become more dense and the cancellous tissue is replaced by compact. Osteophytes may be seen with lipping of the edges of the articulating surfaces. Torsion produces a change in the outline of the bodies. They become irregularly oval, with the larger part directed to the convexity. According to Lorenz, the fronts of the bodies show oblique and spiral striations or ridges directed from above towards the side of the convexity, as if the bone had been twisted by main force (Fig. 52). As the result of the irregular shape of the vertebræ, the spinal canal is altered in shape and is seen to be irregularly oval. The changes I have mentioned are best seen at the point of greatest curvature.

(*b*) The Posterior Column. The pedicles are shortened on the concave side and tend to assume a transverse instead of an antero-posterior direction, and are twisted on both sides. The laminæ on the concave side lose their thickness and depth even to the extent of one half, and may be atrophied, and their posterior aspect, instead of being plane, is convex. The articular processes of the concavity are shorter than their fellows, but the facets are deepened, *i.e.* a process of absorption is going on, by which the gradual removal of those processes results in rapid increase of the curves, since they naturally prevent lateral deviation of the spine and limit lateral movement. Occasionally osteophytes grow around the edges of the articulating surfaces. The transverse processes are altered, becoming irregular in shape, while those on the concave side assume an elongated or horn-like appearance; and the angle between the transverse and spinous processes is less than normal on the convex side, and correspondingly increased in the concavity. The prominent transverse process is on the convex side. The spinous processes move less than other parts, chiefly because the centre of rotation is situated in them. As a result of the crowding together of the parts in advanced scoliosis, the dorsal spines become less oblique and more horizontal, simulating the lumbar in appearance. When deviated the spines twist towards the concavity.

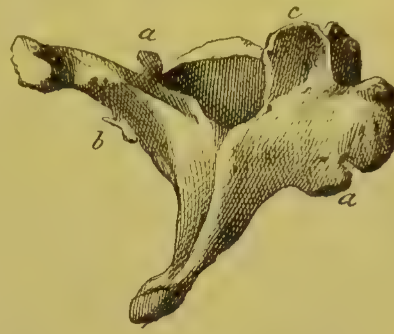

FIG. 53.—A dorsal vertebra from a case of scoliosis with the convexity to the right side, showing atrophy of the vertebra on the concave side. The articular processes *a* and *b* on that side are much atrophied, and the spinous process is seen deviated towards the concavity (after Lorenz).

FIG. 54.—A dorsal vertebra from a case of scoliosis, convex to the right side. Atrophy of the pedicle on the concave side. The vertebral body is irregularly oval (after Lorenz).

Spinal Ligaments.— The anterior common ligament does not precisely follow the displacement of the bodies. It is somewhat displaced, and appears to have slipped to the concave side of the curve. It is no longer centrally placed. On the concave side it presents a thickened border, and on the convex side the edge is indistinct, and conterminous with the periosteum without any line of demarcation. When it has once undergone this change of position and thickness, it acts as the chord of an arc in maintaining the bones in their abnormal position. Specimens of advanced scoliosis show that transformation of the fibrous tissue of the anterior common ligament into bone has taken place, a condition often synchronous with ossification of the intervertebral disc. This ossifying change is assigned to osteo-arthritis or osteitis deformans, but I feel sure that in advanced cases of lateral curvature there is a definite formation of bone, especially on the concave side of the curve. There is a specimen in Guy's Hospital Museum showing this. The change has probably been induced by the fixity of the vertebræ. The inter-transverse ligaments are stated to be shortened on the concave and elongated on the convex side.

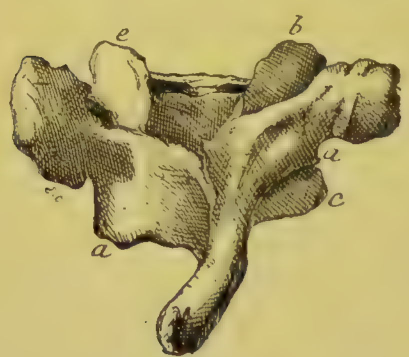

Fig. 55.—A scoliotic dorsal vertebra from a case in which the convexity was to the *left* side. Atrophy of the neural arch in the concavity is seen (after Lorenz).

The Spinal Muscles.—In long-standing cases alone are structural alterations found. Adams says, "In all the dissections I have had the opportunity of making at late periods, the muscles on both sides of the spine have been much wasted, reduced in several instances to very thin layers, pale in colour, and in more or less advanced stages of fatty degeneration, which probably commences in the muscle on the concavity of the curve, those on the convexity wasting later." Such alterations are due to inactivity of the spinal muscles. The prominence of the muscles on the convex side is explicable by the backward displacement of the transverse processes and increased curvature of the ribs. In early stages the muscles stand out for two additional reasons, viz. their position on the convexity of the curve, and the tension of their fibres resulting from the persistent effort to maintain the body equilibrium. The muscles of the concavity are seldom rigid or prominent. If rigid, it is on account of the shortening they undergo.

It is important to recognise that fatty and fibroid changes occur in old-standing cases with fixed curves only. In the early stages the muscles are merely wasted, and require suitable exercise to restore them to their normal size and strength. In still earlier cases, especially those of lateral deviation of the spine, the use of the dynamometer reveals considerable and often unequal loss of power on the two sides of the body.

Viscera.—The effects of the distortion on the heart and lungs

FIG. 56.—Front view of the bony framework of the chest from a case of scoliosis with the convexity to the right in the dorsal, and to the left in the lumbar region (Guy's Hospital Museum, 1006^{66}).

have been mentioned. The trachea, bronchi, and branches of the pulmonary artery are deviated and their diameters lessened. The arch of the aorta is shorter than normal. If the convexity is to the left and of great extent, the thoracic aorta has been observed to cross the line of the vertebral column, and to run down the right side.

The carotid arteries present sinuous curvatures, and the subclavian, if the curve is chiefly right-sided, is similarly affected. The latter effect is produced by the elevation and forward projection of the "convex" shoulder. Coincidently with this there is sometimes displacement of the inner end of the clavicle. The œsophagus

FIG. 57.—Posterior view of Fig. 56.

follows the curve of the spine if it be slight, but in pronounced cases it makes a right line for itself. The diaphragm loses its normal shape, and the relative positions of its apertures are considerably changed.

The *thorax* is profoundly affected in advanced scoliosis. On the convex side the capacity is markedly decreased, and the tip of the sternum is deflected slightly. On the convex side the

FIG. 58.—The scoliotic pelvis (Guy's Hospital Museum, 1006^{80}).

antero-posterior and transverse diameters are diminished; on the concave side the depth is lessened, but the diameters are increased. A horizontal section of the thorax shows it to be elliptic in shape, the longest axis being from the most prominent part of the ribs behind to the opposite nipple in front, instead of, as in the normal chest, between the mid-axillary lines, *i.e.* if the rotatory curve is to the right dorsally, the axis is behind its normal position on the right side, and in front of it on the left (see Fig. 33). The forces at work in the production of the remarkable alterations in the shape of the ribs are two; the vertebral bodies twisting to the convex side behind, and the fixed position of the sternum in front. Under the influence of these two forces, the ribs on the convex side are doubled up at points near the spine, viz. the angles, and on the concave side are unfolded at corresponding points.

The *pelvis* in severe cases is much deformed. In the ordinary deformity to the right in the dorsal and to the left in the lumbar region, the shape of the pelvic cavity is abnormal, the lumbo-sacral angle pointing to the left and encroaching to a marked degree on the left half of the cavity. With this there is also inward displacement of the left acetabulum. The wings of the sacrum and ilium on the left side are thickened, and the crest of the left ilium is lower (Fig. 58). This deformity should not be confused with the flattened pelvis of rickets.

CHAPTER VIII

SCOLIOSIS (*Continued*)

Pathogenesis of Scoliosis, Experiments of Judson and Others—Congenital Scoliosis—Rhachitic Scoliosis—Scoliosis of Nerve Origin—Static Scoliosis—Scoliosis of Cicatricial Origin—Scoliosis associated with Nasal and Naso-Pharyngeal Obstruction—Diagnosis of Scoliosis in General—Prognosis of Scoliosis.

The Pathogenesis of Scoliosis.—The space at my disposal will not permit me to review all the theories which have been advanced in explanation of the production of this condition. Indeed it would profit little to do so. They are set forth at length in most of the works on "Orthopædic Surgery." Suffice it to mention that the many theories may be arranged under three headings, the muscular, ligamentous, and osseous; and up to a recent date they all had two features in common, the lack of experimental proof and a discordance from clinical and pathological facts. Some of the discordant facts are the following[1]:—

1. Many delicate children with weak spinal muscles, of sedentary habits and a proneness to faulty attitudes, do not develop scoliosis.
2. Some vigorous children leading an active, open-air life, whose spinal muscles seem as strong or stronger than the average, develop lateral curvature.
3. Right-handed people sometimes develop scoliosis with the dorsal convexity to the left.
4. Some children with considerable difference in the length of the lower extremities do not suffer from scoliosis.
5. A patient with shortening of the right leg, and the pelvis sloping away to the right, may develop a curve with the convexity to the left in the lumbar region.
6. Lateral curvature with extreme rotation may develop with the spine in the horizontal position. A specimen of a mammalian

[1] H. L. Taylor, *Trans. Amer. Orth. Assoc.* vol. iii. p. 136.

spine with scoliosis is to be seen in the Museum of the College of Physicians and Surgeons of New York.

The lack of experimental evidence has been supplied by American observers. It will be advantageous to detail briefly these experiments, as they throw much light on the subject at issue.

Judson's Experiment.[1]—A flexible rod is passed through the central canal of a disarticulated vertebral column, and the relative positions of the vertebræ are maintained by spiral springs passing from the spinous process to uprights on either side. When pressure is made from above on the column, at first lateral deviation occurs, but as the pressure is increased, rotation follows. So that the result is a rotary-lateral curvature. If, while this pressure is still maintained, an attempt be made to bring the spinous process at the most prominent part of the curve into the middle line, a compensatory curve with its appropriate rotation makes its appearance.

Bradford and Lovett's Experiments.—Experiment I.—The spinal column of a fœtus at full term, with muscles and skin intact, but divested of its attached ribs, was first made the subject of observation. The column was found to be more flexible than in children, adolescents, or adults. Rotation, however, was not readily brought about by pressure applied to both ends, although considerable lateral deviation ensued, and a curve with the concavity forward was also produced.

Experiment II.—Pressure was applied to the whole spinal column of an adult male. The parts experimented on consisted of the spine, from which the larger muscles had been removed, the smaller muscles and ligaments being left, also a portion of the pelvis and the base of the cranium. A box with a rod fixed to its under surface and passing into the medullary canal of the cervical vertebræ, was secured firmly to the cranium, and so arranged that it could be moved upwards and downwards, but not laterally. Into the box weights were put.

Points observed: (*a*) The spinal column bore a considerable weight without yielding to any appreciable extent.

(*b*) As the weight was increased, a curvature with the concavity forwards was seen, and this became more marked as the weights were increased up to eighty-four pounds.

(*c*) No rotation was observed so long as the weight bore directly downwards, but rotation of the lower dorsal and lumbar vertebræ was seen when any lateral deviation was made in the

[1] *Trans. Amer. Orth. Assoc.* vol. iii. p. 96.

cervical region. The amount of rotation and deviation was much less than is possible in children.

Experiment III.—The body of an infant was similarly prepared, and by an ingenious arrangement downward pressure was applied to the top of the head and shoulders, the pelvis being firmly fixed. The results were, with increasing pressures: (*a*) increase of the normal curve backwards, succeeded by (*b*) lateral deviation of the column with increasing rotation, accompanied by the usual changes in the ribs, viz. flattening on the side of the concavity and projection on that of the convexity. This projection was most marked in the middle and upper dorsal region, but the amount of greatest rotation appeared to be in the lower dorsal region. If the angle of downward pressure were changed, or if the pelvis were so tipped as to cause a curve in the spinal column, the effect of downward pressure was more marked. Careful examination of the method employed showed that, although a well-marked scoliosis accompanied by the characteristic changes in the ribs was produced by downward pressure, yet it was caused by *downward pressure not exerted in a perfectly vertical direction, but obliquely.*[1] If the pressure were directly downwards, then merely increase in the antero-posterior curves ensued.

I have abridged the account of these experiments from that given in Bradford and Lovett's *Orthopædic Surgery.* The observations of Lorenz on the peculiar oblique striations of the vertebral bodies may be again alluded to in this connection (Fig. 52).

It remains to *recapitulate* some anatomical and physiological details before concluding.

1. The distinction that exists between the column formed by the bodies, which is supporting in function, and that formed by the arches, which is protective.

2. The bodies project into the thoracic and abdominal cavities. They are therefore free to move laterally; while the arches and processes are limited in mobility, being entangled in the ribs, dorsal muscles, and fasciæ.

3. Very little true lateral flexion of the spine is possible.

4. Lateral bending of the spine beyond a certain point is accompanied always by rotation. This can be readily shown by taking a disarticulated spine, piecing it together, and securing the vertebræ in their relative places by strands of stout catgut, or better, india-rubber, passing through all the bodies and parallel to

[1]. The italics are the writer's.

each other. If an attempt be made to approximate the axis and sacrum by lateral flexion, rotation comes early into play, and is especially noticeable in the dorsal region. This is better seen in a spinal column in which the intervertebral discs are retained. The explanation is this. The anterior column formed by the bodies is relatively little compressible, but is very extensile on account of the elastic intervertebral discs. The arches, on the contrary, are held by the processes, notably the articular, at a determinate distance. They are unable to separate, but can glide upon each other. It follows therefore that in lateral flexion of the spine the body column, being capable of extension, is carried to the convex side of the curve, where there is room for that movement to take place, while the arches are carried to that side, viz. the concavity, where they can glide upon each other.

5. When the spinal column is bent laterally, if an individual vertebra be observed, the body is seen to make a wider excursion than the spinous process. The body moves through three-quarters of an inch and the spinous process through one quarter, *i.e.* the rotation does not take place on the central axis of a vertebra.

6. Bony growth during the period of adolescence follows the path of least resistance; hence it is that in advanced cases of scoliosis the bodies are thicker on the convex than on the concave side. The same remark applies to the intervertebral discs.

7. According to Vogt there are three periods of rapid augmentation of growth in the skeleton, viz. from the first to the second year, from the seventh year to the approach of puberty, and at and after puberty. In weakly children these periods are associated with general debility and muscular and ligamentous relaxation. And it is just during these periods that the onset of scoliosis is most common.

8. In persons whose growth is finished, and who are generally well developed, the carrying of moderate weights poised on the head results in no deformity, but rather in a perfectly erect and normal spine.

To sum up the pathogenesis of scoliosis. We know that any cause which impairs muscular strength, such as rickets, over-fatigue, ill-health, and anæmia, is associated in the first instance with a general yielding of the spinal column in an antero-posterior direction. If any event now occurs to disturb the equilibrium, such as faulty attitudes, inequality of the length of the legs, persistent displacement of the head to one side, as in torticollis; or retraction of one side of the chest, as in empyema; or a strain is put upon the muscles of one side more than the other, as by excessive use of one arm,[1] lateral flexion follows. This is owing to the muscles of the weaker side yielding, and to the spine sagging over to that side, hence the convexity of the curve is on that side. Such lateral flexion is only possible within restricted limits, which are undoubtedly larger in weak than in normal spines. As soon as it has passed these limits rotation sets in, and a true scoliosis is developed, with the bodies to the convex, and the spinous process deviated in a less degree to the concave side. As the cause persists and the weight of the head, shoulders, and upper extremities press on the weakened spine, so will the scoliosis increase.

The order of events is—(*a*) Weakening of the spinal ligaments and muscles, followed by (*b*) antero-posterior flexion, lateral flexion, and rotation of the spinal column.

In the first place, weakening of the structures, and, in the second, loss of equilibrium.

That such is the course of events is incontestably proved by Bradford and Lovett's experiments. Given, as in their experiments on the flabby spine of a corpse, pressure evenly applied, the result is, firstly, increase of flexion; secondly, lateral deviation; thirdly, if obliquely applied, a rotation directly proportional to the superincumbent weight.

In dealing with the subject of scoliosis, it has been thought more convenient to group the appearances, symptoms, morbid anatomy, and pathogenesis of the subject in general under the heading of "Scoliosis of Adolescents," inasmuch as the more typical aspect of scoliosis is seen in this particular variety, and the delineation of its symptoms and morbid anatomy include those of the other varieties. A few special remarks, however, directed to the other varieties cannot be out of place.

Congenital Scoliosis.—Unfortunately the recorded cases are very few, and the literature of this class is correspondingly scanty. According to the statements of Fleischman and Philippeaux, it mainly exists in monstrosities, and in them it has been chiefly studied. These authors state that it is the consequence of the development in a wedge-shape of one or more of the vertebral bodies. Guérin believed it followed muscular spasm secondary to mal-developments of the

[1] The case is reported of twin sisters who sat at the same bench at school, and leaned, one on the right arm and the other on the left, in whom curvatures developed in opposite directions.

central nervous system. In other cases it is said to be due to fœtal rickets.

The recorded cases which have come to my knowledge are:—

1. A case described by Rokitansky, the specimen being in the Museum at Vienna.[1]

2. A child, aged 2 years, admitted into the Royal Orthopædic Hospital under the care of Mr. Adams.[2]

3. A cast from a similar case in the Museum of the last-mentioned Hospital.

4. A case of a woman aged 31 years, and described by Mr. Willett.[3]

Fig. 59.—From a photograph by Rédard showing the effect of the position in which a child is held by its nurse in producing scoliosis.

Rhachitic Scoliosis.—The first effect of rickets on the spine is to cause a general, not a local increase of the antero-posterior curve of the spine. If the arguments on the "Pathogenesis of Scoliosis" have been followed, it must necessarily result that unless the deformity be arrested or the superincumbent weight of the head and upper extremity be taken off, the antero-posterior curve must develop into a lateral deviation, and then into a true scoliosis. This sequence of events is assisted by the general mode of carrying children seated on the flexed forearm of the nursemaid. The forearm is frequently placed at an acute angle with the arm, and the child therefore rests on an inclined plane. Such a position cannot fail to be a powerful auxiliary to the development of scoliosis in rhachitic children. If the child is carried on the left forearm, for instance, he inclines his trunk towards the nurse's chest, and the deviation is thereby accentuated. The effect on the child's spine is well shown in Fig. 59. If the child be carried on the right forearm the effect is reversed. But inasmuch as rhachitic cases more often have the curvature to the left, the frequent use of the left forearm by nurses

[1] *Path. Anat. Syd. Soc.* vol. iii. p. 228, 1850. [2] *Op. sup. cit.* p. 228.
[3] Bradford and Lovett, *op. sup. cit.* p. 104.

in carrying children may have some influence on its production in this direction.

Of 69 consecutive cases seen by the writer at the National Orthopædic Hospital, 1890-94, 4 were marked examples of rhachitic scoliosis under the age of $2\frac{1}{2}$ years. Of 1070 surgical cases seen at the Evelina Hospital, 8 were examples of this affection at the same age. The affection, however, develops its full intensity between the ages of 2 and 6 years; but many writers admit the existence of that anomalous disease, "late rickets," a peculiar softening and rarefaction of bone occurring at the ages of 8 to 10 years.[1]

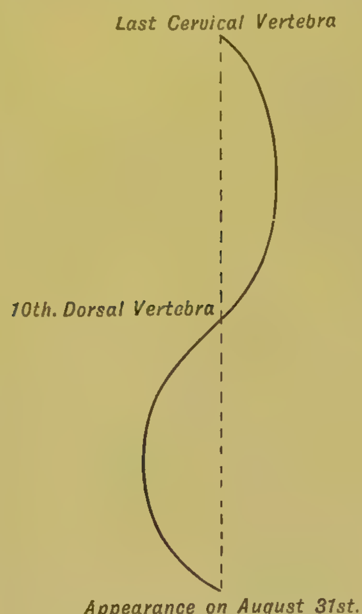

FIG. 60.—Outline of spinal curves at commencement of treatment of Lilian M. H—— (Case 29).

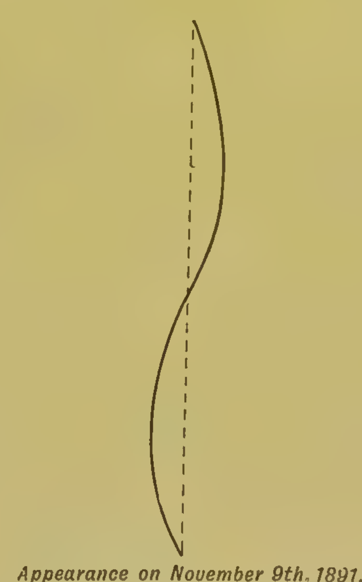

FIG. 61.—Outline of spinal curves in the same case after ten weeks' treatment.

The notes of the four cases under the age of $2\frac{1}{2}$ years mentioned above are appended.

CASE 29. *Case of Rhachitic Scoliosis.*—Lilian M. H——, aged 2 years, was a very ricketty child, with enlarged epiphyses, deformed chest, bent tibiæ, and considerable scoliosis. She was the fifth child; the others were healthy. She was weaned at the fourth month, and then fed for five months on condensed milk; now, "she has just the same as we do." On 31st August 1891, the date on which she was first seen, there was a large curve to the right occupying the dorsal region from the first to the tenth dorsal vertebra, together with rotation of the ribs and a compensatory curvature in the lumbar region (Fig.

[1] For a *résumé* of our knowledge on this subject consult Dr. Goodhart's *Diseases of Children.*

60). She was ordered one drachm of cod-liver oil twice a day, and to wear a poroplastic jacket. Finding, however, on 14th September that the poroplastic jacket was not sufficiently supporting, I had an occipital head-piece added. A marked improvement took place, and in ten weeks' time the spine had assumed the appearance seen in Fig. 61. Subsequently complete restoration of the form of the back occurred.

FIG. 62.—Back view of a child, aged 2 years, suffering from ricketty scoliosis.

CASE 30.—Clara H——, aged 18 months; very rhachitic. Both posterior and lateral curvature were present. There was much rotation of the bodies to the left, forming one large curve in the dorsal region. The curve disappeared on lifting the child up by the arms. The mother stated that the birth was a very difficult one.

The child was given one drachm of the extract of malt and cod-liver oil, and was ordered to be carried about on a wicker tray. Considerable improvement followed.

CASE 31.—Mabel B——, aged 2½ years, was also very ricketty; the active stage of the disease having subsided, the child was left in a very collapsible state. There was extreme general kyphosis, with much lateral deviation to the right. She was ordered a poroplastic jacket with an occipital head-piece, and soon improved.

CASE 32.—Winifred A——, aged 1½ year, presented many of the signs of active rickets. The curvature was to the right and chiefly dorsal. In this instance there was much exaggeration of the curve of the clavicle on the left side, without any evidence of previous fracture. The occurrence of increased clavicular curve on the side opposite to the spinal convexity was an unusual feature. Good results were obtained by the use of a poroplastic jacket with an occipital head-piece.

The appearances presented by cases of rhachitic curvature are well shown in Figs. 62 and 63, and may be enumerated.

(*a*) A general laxity of the spinal column is present, and, with the scoliosis, kyphosis or, less frequently, lordosis is associated.

(*b*) In young children at the ages of 2 and 3 years, according to Lorenz, the deviation is generally to the left. In older children the deformity appears equally on both sides.

(*c*) The primary curve is dorso-lumbar rather than, as in adults, dorsal or lumbar.

(*d*) The superior limit of the posteriorly-displaced ribs is below the corresponding scapula, *i.e.* the scapula is not much displaced (see Fig. 62).

(*e*) The alteration in the shape of the pelvis is subsequently very great, and causes considerable difficulty in labour.

This class of case has been treated of at some length, but it is not implied that all rhachitic cases are liable to develop true scoliosis. Far from it; in most instances it does not appear at all. Even when kyphosis is present, but a small proportion develop lateral curvature, as the deformity is averted at this stage by the cure of rickets either spontaneously or under treatment.

The morbid appearances of a spine deformed by rhachitic scoliosis is not different to those of the scoliosis of adolescents, except in the unequal growth of the epiphysial plates of the vertebræ.[1]

Scoliosis of Nerve Origin.—After infantile paralysis some deviation of the column, arising from unilateral atrophy of the extensor muscles, is occasionally seen. Scoliosis, however, rarely ensues from this cause alone. More often it is due to the weakening and shortening of one lower extremity.

[1] Cf. an article by C. B. Keetley on the "Causation of Scoliosis," *Trans. Brit. Orthop. Soc.* vol. i.

Distortion similar to that of infantile paralysis follows hemiplegia, progressive muscular atrophy, and pseudo-hypertrophic paralysis, the chief factor at work being unbalanced muscular action.

FIG. 63.—Back view of a child, aged 3½, suffering from marked scoliosis, dating from the onset of rickets. The posterior projection of the lumbar spines is worthy of notice. From a case seen at the Evelina Hospital.

In locomotor ataxy spinal curvature is very rare. Mr. J. H. Targett [1] says there are not more than six recorded cases. He

[1] *Guy's Hospital Gazette*, 6th Aug. 1895, pp. 133-135. On "Spinal Curvature in Nervous Disorders."

gives the notes of one case which he had been able to examine. In the dorso-lumbar region, and involving the first lumbar vertebra, was an angular curvature. On either side of the curvature there was much bony thickening. When the patient bent forwards a loud "crunch" could be heard, as "if the spine were broken at a certain level, and the lower end of the upper fragment played in a cavity, formed by the upper end of the lower fragment." In Friedreich's disease or congenital locomotor ataxy, scoliosis develops late in the disease, and is generally seen to be to the right in the dorsal region, with lordosis of the lumbar spine. Gradual weakness of the spinal muscles is the immediate cause, and then excessive use of the right arm determines the direction of the curve. In cases of spastic contraction of the lower extremities with marked adduction of the thigh, deviation is observed about the age of puberty. According to Mr. Targett, about half the total number of cases of syringo-myelia show curvature of the spine. It is generally a scoliotic curvature with a small amount of kyphosis, but pure kyphosis or lordosis seems to be very rare. Notes of three cases are given by Mr. Targett in the article mentioned in the footnote on p. 150.

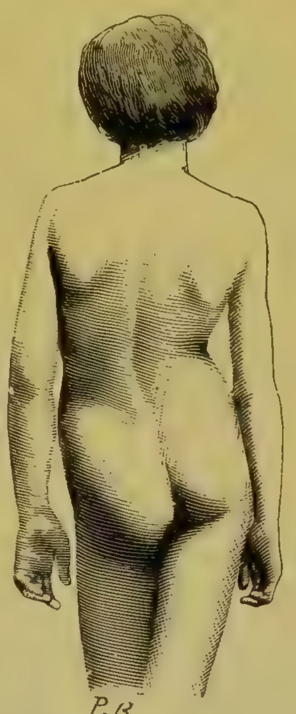

FIG. 64.—Hysterical scoliosis. A lumbar curve convex to the left is seen, due to hysterical contraction of the lower part of the right erector spinæ (after Rédard).

Hysterical contraction of groups of muscles in the lower extremities is met with. As a complication, hysterical contraction of the spinal muscles is seen (Fig. 64). It is noteworthy that Charcot states that this is present ordinarily in the dorso-lumbar region; the appearance of the contraction rapidly follows a slight blow or injury in that region; both the contraction and the spinal deviation sometimes disappear suddenly. They are always effaced under an anæsthetic.

Sciatica is stated by Charcot, Babinski, and Ballett to be complicated by two varieties of scoliosis, one in which the concavity of the spine is turned to the healthy side, and the other in which the concavity is turned to the affected side. The deviation is dorso-lumbar, and is due to the vicious attitude of the sufferer, arising from contraction and inability to bear the weight on the affected limb and resulting in twisting of the pelvis.[1]

Static Scoliosis.—The most obvious form is that arising from inequality in the length of the lower extremities. This is of two varieties—

(*a*) Due to a congenital asymmetry of the lower extremities.

(*b*) Arising from pathological conditions.

Congenital asymmetry is very common, and is, in my opinion, due to unequal growth of bone at the epiphysial line. Measurements of a few of the cases seen at my out-patient clinics are subjoined.

Name.	Age.	Measurements.		Curvature.	
		Right Leg.	Left Leg.		
1. Lily S—— .	14	32 inches,	$31\frac{1}{2}$ inches.	Left lumbar,	Right dorsal.
2. Ellen W——	19	$34\frac{1}{2}$,,	34 ,,	Right ,,	Left ,,
3. Sarah M——	26	$32\frac{1}{2}$,,	$33\frac{1}{2}$,,	Left ,,	Right ,,
4. Annie R——	11	$29\frac{1}{2}$,,	$29\frac{7}{8}$,,	,, ,,	,, ,,
5. Margt. G——	20	34 ,,	$34\frac{1}{4}$,,	Right ,,	Left ,,
6. Kate C—— .	13	$31\frac{1}{8}$,,	$31\frac{3}{4}$,,	,, ,,	,, ,,
7. Maud T—— .	12	29 ,,	$29\frac{1}{2}$,,	,, ,,	,, ,,
8. Ada S—— .	14	$31\frac{1}{2}$,,	$30\frac{5}{8}$,,	Left ,,	Right ,,
9. Jane T—— .	16	$33\frac{1}{2}$,,	33 ,,	,, ,,	,, ,,
10. Rose J—— .	21	34 ,,	$34\frac{1}{2}$,,	Right ,,	Left ,,

Cases 2 and 3 are examples of the curious fact that patients may have the lumbar convexity on the side of the longer leg.[2] *The general rule is that the convexity of the lumbar curve is on the side of the shorter leg.*

Measurements of a large number of persons show that inequality of the length of the legs is a constant occurrence. Yet very few such persons suffer from scoliosis, so that asymmetry of the legs cannot be a very important factor. We must infer the existence of persistent weakness of the spinal muscles when a mere lateral deviation, the result of tilting of the pelvis from unequal length of support, passes into scoliosis. The faulty attitude assumed must become a fixed position before scoliosis can be said to be present.

It is stated by some authorities that the left lower extremity is generally the longer, but Garson states the reverse. The difference

[1] For further information on this subject consult Rédard, *op. cit.* pp. 364-367, and Langenbeck's *Archiv*, 1889, Article, "Ischias Scoliotica."

[2] Cf. H. L. Taylor, *Trans. Amer. Orth. Assoc.* vol. iii. p. 136.

is not proportionately distributed between the tibiæ and femora. The shortening is present either in the femur, the tibiæ being equal; or the tibia is shortened, the femora being equal; or the tibia on the shortened side is actually longer than its fellow, while the femur is so much shortened as to more than neutralise the lengthening of the tibia. The difference between the limbs varies from $\frac{1}{4}$ to $\frac{3}{4}$ inch generally.

Asymmetry arising from pathological conditions of the lower extremities is associated, but not necessarily, with scoliosis. Among these conditions are the following:—Coxitis, congenital displacement of the hip on one side, osteo-myelitis and periostitis of the femur and tibia, injuries of and operative interference with the epiphysial lines,[1] genu valgum and varum, ankylosis of the knee, flat feet, the various forms of talipes, especially those paralytic in nature.[2]

The other conditions giving rise to static scoliosis are to be sought for in the upper extremities and head and neck. In the upper extremity the chief cause is loss of balance, which ensues from infantile paralysis affecting one arm, or in rare instances from amputation of a portion or the whole of the limb.

Torticollis is followed by scoliosis, the primary curve being in the cervical region. I have already mentioned a case of hypermetropia and scoliosis.

The relationship of vicious positions to scoliosis, which is an undoubted clinical fact, fits in with the experiments quoted on pp. 142, 143. Before pointing out more particularly the relationship, I would emphasise this statement: a short leg, a tilted pelvis, a paralysed arm are not necessarily followed by scoliosis. The explanation is that the spinal muscles have sufficient tone and equilibrium to maintain the column erect. If the muscles become toneless and weak, then lateral deviation follows, and a temporarily vicious attitude becoming fixed, scoliosis ensues; the condition of

[1] Cf. article by the author on "Shortening following Injuries and Diseases of the Epiphysial Line," *Lancet*, May 1890.

[2] In measuring the length of the limbs special care should be taken that the knees are kept fully extended and the limbs parallel. This is a small matter, but if not rigorously attended to, readily makes a difference of $\frac{1}{2}$ inch, or even more. Measurements are usually made from the anterior superior spine of the ilium to the internal malleolus. It is preferable to take the tape to the external malleolus. The convexity of the muscles of the sound thigh causes an increased measurement when the tape crosses obliquely over it, and the difference in the length of the limbs appears greater than it really is. Especially is this the case in paralytic limbs. By taking the tape to the external malleolus much of the source of error is avoided.

the spine is due to the subsidence of the body into positions of rest. The two factors are a toneless spine and loss of equilibrium.[1]

Scoliosis of Cicatricial Origin.—The cause in this variety is empyema, or repeated attacks of pleurisy. Figs. 65, 66, and 67 give the appearances in such a case, and the following are the notes of one case.

FIG. 65.—Scoliosis of cicatricial origin, and secondary to empyema (Case 33).

FIG. 66.—Front view of Case 33 showing the position of the discharging sinus after empyema, also the flattening of the chest on that side, and the elevation of the right shoulder.

CASE 33. *Scoliosis secondary to Empyema.*—Henry B——, aged 9 years, came to me at the Evelina Hospital in November 1893. Eighteen months previously he had been an in-patient on account of pleuritic effusion and empyema on the right side. The pus was evacuated at the sixth right space and there is still a sinus left. Through this a little curdy pus escapes from time to time. The right side of the chest is flattened, and there is seen a well-marked spinal curvature in the dorsal region, with its convexity to the left (Figs. 65 and 66).

[1] As showing the effects of position, there is in the Mütter Museum a cast of the Siamese Twins. In both there is lateral curvature, and the curvatures are in opposite directions, the shoulders towards each other being raised. The curvatures are due to the fact that in order to give each other more room, the twins stood leaning away from one another (Judson, *Trans. Amer. Orth. Assoc.* vol. iii. p. 96).

The aspect of the spine is one of deviation more than of scoliosis. The course of events is flattening and obliquity of the ribs on the affected side, and bending of the spine to the sound side. The ribs become flattened owing to the partial collapse of the lung and the cicatricial contraction of pleural bands. Removal of portions of ribs in the *late* stage of a discharging empyema, while securing the closure of the cavity, is likely, in my opinion, to increase the deviation, a matter *then* of secondary importance. "To prevent deviation of the spine and deformity of the chest, the great object is to cure the empyema early, and the comparative frequency with which one sees this deformed chest appeals very strongly to a more radical means of *primary* treatment of this disease (resection of a rib)."[1] In certain cases the deviation passes into scoliosis. Repeated attacks of pleurisy, by binding down the lung and obliterating the pleural cavity and causing muscular atrophy of the affected side, are factors in the production of scoliosis.

FIG. 67.—Scoliosis following pleuritic effusion (Frederick T——, aged 13½ years, seen at the National Orthopædic Hospital).

Scoliosis in Association with Nasal Obstruction and Adenoids in the Naso-Pharynx.—At first sight it might be asked, What is the connection between these affections? I shall endeavour to show that the connection is a close one. If a series of cases of adenoids be watched, these facts may be observed. During infancy and early childhood the subject of nasal obstruction shows deformity of the chest alone; in other subjects, and especially between the ages of 6 and 10 years, kyphosis makes its appearance. Later, from 10 to 16 years of age, scoliosis supervenes on the kyphosis, the abnormal shape of the chest still being very apparent. We have, therefore, this order of events: adenoids, contracted chest, kyphosis, scoliosis.

The proof that the deviation of the spine is dependent on the

[1] W. Arbuthnot Lane, *Guy's Hosp. Rep.* vol. xliii. p. 372.

post-nasal obstruction, and is not a mere coincidence, is furnished by the results of treatment. The cure of the thoracic deformity, kyphosis, and scoliosis follows rapidly on the removal of the obstruction in the nasal fossæ and post-nasal space. I have had several cases at the Evelina Hospital for Sick Children which verify this statement, — cases in which clearing of the naso-pharynx and

Fig. 68.—Scoliosis associated with adenoids, and relieved after their removal.

Fig. 69.—Scoliosis of old-standing and associated with adenoids (Olive B——, aged 9 years, seen at the Evelina Hospital for Sick Children).

removal of the tonsils have been succeeded by great amelioration of the deformity and immediate improvement in the general health. The feeble nutrition and the general want of muscular development, owing to insufficient entrance of air into the thorax, serve to explain the incidence of kyphosis and scoliosis, the onset of the latter being coincident with the period of rapid growth.

The characters of scoliosis from post-nasal obstruction are the following:—

(*a*) The curves are but little pronounced, and often dorsal.

(*b*) They are generally to the right.

(*c*) They are often "single" in character.

(*d*) Deformity of the thorax is always present.

(*e*) Girls are more often affected than boys. Of seven patients who have come under my notice during the past year, five were girls.

(*f*) They appear or become increased at the time of rapid general growth.

(*g*) Rarely are they "fixed"; they can be removed on suspension.

Diagnosis of Scoliosis in General.—If the distortion be at all marked the diagnosis can be made at a glance, the only possible source of error being the lateral deviation met with in the early stages of rapidly-progressing Pott's disease. The points of distinction have been pointed out on p. 36.

Difficulty, however, may arise in the early stages. The onset is often so gradual that care is required not to overlook symptoms, which, slight in themselves, must not be disregarded, nor treated with the remark that "the child will grow out of them." She may or may not, most probably will not. Special note must be taken of any slight alteration in the outlines of the flanks. Any flattening or prominence of the erector spinæ should be looked for, and regarded as a valuable and distinctive sign. The suspicion of the onset of scoliosis is further strengthened by a slight prominence of one hip or scapula, with elevation of one shoulder. If these departures from the normal are present when the patient is in the position of ease and comfort, and if they are aggravated in the stooping position, with the arms across the chest, then scoliosis is present.

Simple lateral deviation must not be confounded with scoliosis. The distinguishing signs are given on p. 107. Nor should hysterical deviation be too seriously treated.

For purposes of prognosis and treatment, it is essential to know what stage of the deformity is present.

In the *first* stage, that of vicious position and slight symptoms with little or no curve, the deformity disappears entirely on suspension, decubitus, or slight pressure with the hand.

In the *second* stage the deformity is more accentuated, the torsion is evident, and the curvatures of compensation have made their appearance. The spine possesses, however, a certain degree of flexibility, and suspension and decubitus produce a varying amount of recession of the deformity.

In the *third* stage the curvatures are very pronounced, the inclination and displacement of the trunk from the vertical line are marked. Deformities of the chest and displacement of viscera exist as complications. The spine is rigid and ankylosed, and suspension does not modify the curves. Very notable, too, is the obliquity of the transverse axis of the pelvis.

Prognosis of Scoliosis in General.—The question most frequently put to the surgeon when he sees cases of scoliosis is, "Will she grow out of it?" If the case be one of definite scoliosis, an unreserved answer in the negative may at once be given. Should only lateral deviation exist, the answer may be that "with due care and attention to treatment, great improvement will be effected, and the deformity will probably disappear." But in no instance can it be said that the patient has, untreated, grown out of either lateral deviation or scoliosis. In some cases the deformity is arrested without treatment after a longer or shorter interval, but some distortion persists through life.

Bradford and Lovett remark: "Two errors in prognosis are common. First, that the disease is of the most serious nature; second, that it is a trivial affection, and will be outgrown by the patient." Both statements contain just such a measure of partial truth as to render them misleading, and must have arisen from a want of careful appreciation of the factors at work in individual cases. In the succeeding remarks it is my endeavour to reiterate such points as may be useful in forming an approximately correct opinion; I say "approximately," as two kinds of cases defy calculation. That class which, in spite of careful treatment, is perverse from the first, and stubbornly refusing to yield, pursues a steadily downhill course. Fortunately this kind is exceptional. The other class of cases is that in which the disease becomes arrested spontaneously.

The elements of prognosis may be discussed conveniently under several headings.

The Cause.—Rhachitic deformities present many difficulties in treatment. A scoliosis beginning so early in life is liable to be influenced for the worse by other factors which come into play when growth commences, and the disturbed bodily equilibrium persists with increasing force through all the years of growth. Additional difficulties arise from the tender age and small frame of the patient rendering it troublesome to fit apparatus. Scoliosis from perverted muscular action, especially in girls and at the age of puberty, requires much caution in the expression of an opinion. Cases in which heredity is observed do not respond to treatment so well as those which are free from any such suspicion. Curvatures following empyema and pleurisy are always unfavourable for treatment, while those arising in connection with nasal obstruction and post-nasal growths are equally favourable, unless their removal is delayed too long.

The Age of Onset.—The later it is the more favourable may be the opinion as to the ultimate condition of the parts. Thus cases arising during the second dentition are likely to present less deformity in later life than those which begin in the first. Similarly those which commence between the ages of 17 and 20 rarely assume so severe a form as those which begin at puberty; more especially so if the former are due to preventable causes, such as bad attitude in sitting or static causes. Then, too, the later it appears the nearer is the approach of the period when spontaneous arrest takes place, viz. at the cessation of growth. The influence of repeated pregnancies on cases which have been quiescent for some years has been already alluded to (p. 132).

The Sex.—Taken as a whole, in girls the deformity assumes a more severe and rapid form than in boys, owing to their want of muscular development, and the feeble health often entailed by disorders of menstruation. But some of the severest cases I have seen have been present in boys, probably due to unsuitable occupations (Fig. 48).

The Condition of the Bodily Health.—This is undoubtedly one of the most important factors. Persistent anæmia and chlorosis may neutralise all efforts to obtain successful results. Similarly dysmenorrhœa and menorrhagia, from which so many female scoliotics suffer, by their exhausting effects prevent that steady attention to the improvement of muscular action and more perfect maintenance of equilibrium so essential to effect improvement. Girls in whom ill-health is tinged with hysteria are the worst subjects of all.

Many curvatures in town-bred people improve comparatively rapidly when the patient is sent into the country, and when the appetite and general tone are thereby bettered. If the health remain good all through, there is considerable hope of dealing successfully with a curvature of moderate severity, provided that no fixation is present.

The probable Rate of Growth of the Patient.—Patients with long, narrow, yielding spines, which may be moulded into almost any shape, are bad subjects when scoliosis sets in. The probable rate of growth may be estimated by noting the patient's height, and comparing it with the average for that age: the height of the parents should also be observed, and Galton's conclusions be remembered. These may be summed up in the following statement: "The deviation in height of the child from the average will probably be two-thirds of the total deviation of the parents from the normal." This must hold good, otherwise the race would become all giants or all dwarfs.

The Occupation.—Obviously, during the period of adolescence persistence in the occupation which has induced the scoliosis can have but one effect. Unfortunately, in the case of the hard-worked eldest daughter of a large family amongst the poorer classes, it is one thing to advise rest, and another thing for the patient to be able to obtain it. It was mentioned above that some of the worst cases of scoliosis are seen in boys. This arises from the nature of their occupation, such as the case of a boy who carried a hod of bricks up a ladder from the age of 14 to 16 years; or that of a grocer's boy, who at the same time of life was employed in lifting heavy weights. When growth is completed, occupations are far less likely to increase the curvature, unless they are too fatiguing, or there is a failure of the general health and strength.

The Site of Curvature.—Lumbar curves are less favourable for treatment than are dorso-lumbar or dorsal. Curvatures high up, cervical and cervico-dorsal, are particularly troublesome, owing to the difficulty of making any efficient pressure upon the vertebræ; while the natural kyphosis in the upper dorsal region facilitates increase of the scoliosis. Primary curvatures to the left in the dorsal region, unless the patient be left-handed, are more lasting, and more liable to increase than are right-sided curves. In the latter case the greater use of the right hand is a considerable factor in the production, and much improvement may be hoped for if this habit be discontinued.

The Form of the Curve.—It has been pointed out that the long C-curve, mainly a single one, is that particular form of early scoliosis which is likely to assume a very severe aspect later. The flexibility of the spine in these cases, which allows it to be so readily moulded, is an element which gives great opportunities to the surgeon, but which at the same time, if the case go untreated, allows the spine to settle down into very marked deformity, and that not slowly. I have known such a C-curve to develop into marked scoliosis, with right-sided dorsal and left lumbar curves, in less than ten weeks.

While large single curves are more easily straightened under favourable treatment, multiple curvatures of equal length are likely to be spontaneously arrested, especially if growth be nearly completed.

The Amount of Existing Curvature.—Attention should be paid not so much to the amount of displacement of the vertebral spines, but rather to rotation, as evidenced by the altered shape of the ribs and chest. Cases of scoliosis associated with "flat-back" are more grave than those with kyphosis. In the former much more rotation exists than in the latter. Still graver are those cases in which the normal antero-posterior curves are reversed (Fig. 41).

The Stage of the Curvature.—So long as there is a decrease of the deformity on suspension, some improvement will be attained. If the spine is rigid and fixed, the most that can be promised is that treatment will prevent the condition becoming worse, but no amelioration can be looked for.

The Treatment.—The essential point is that it must be begun early. Treatment well directed gives good, almost brilliant results, in cases which may be termed of the first degree. Complete cure is exceptional, and rapidity of improvement must not be expected, despite the opinion of some authorities.

A few words may be expressed on the time taken for a scoliosis of marked degree to be developed. Fisher,[1] in writing on the subject, says that "from the first stage . . . in a few weeks one or other of the conditions, which have been described as illustrating the three types of lateral curvature, is developed." Undoubtedly the cases which develop so rapidly are those with a long upper C-shaped curve. In one case, as I remarked previously, the change had occurred in ten weeks. In rickets I have seen kyphosis converted into very marked scoliosis in less than three months. When the curves are short and in the dorso-lumbar region, the development is slower than when they are entirely dorsal and of considerable length.

[1] Ashurst's *Internat. Encycl. of Surg.* vol. vi. p. 1066.

CHAPTER IX

THE PREVENTION AND TREATMENT OF SCOLIOSIS

Preventive Measures—General Treatment of Scoliosis—Local Measures—Recumbency—Postural Methods—Exercises—Methodical Correction—Supports—Indications for the Various Methods of Treatment at different Ages and Conditions of the Spinal Column.

The Prevention of Scoliosis.—The essentials of treatment are these:—

(*a*) To prevent the deformity, if threatened.

(*b*) To correct it when present.

(*c*) To maintain the correction.

We have now to speak of the prevention of the threatened deformity.

With regard to *general* measures. If a child is suffering from rickets, treatment directed to that disease, including appropriate diet, is naturally called for. Weakly boys and girls, especially those "town-bred," may be sent away into the country with much advantage.

The onset of puberty in both sexes is accompanied by a considerable strain on the physical powers. The more so is this the case in girls. Painful, deficient, or excessive menstruation should receive careful attention. All causes of impaired tone, such as late hours, must be avoided. General limpness and weakness of muscles call for the use of the tepid bath in the morning, with vigorous rubbing till the skin glows, moderate walking exercise, simple and sufficient diet, and, when occasion demands, a tonic. Women with scoliosis which has been stationary for some years should be told, on marrying, the possible effect of rapidly successive pregnancies in increasing the curvature. Children suffering from adenoids must be placed early under treatment.

There are certain special predisposing causes, attention to which may obviate much distress and deformity later. Many of these are so simple in their nature that unless particular mention is made of them to those who are responsible for the welfare of children, little or no notice is taken of them. These special causes may be treated of under the heading of *faulty attitudes*, of which the following are the chief.

Faulty Position in Carrying a Child.—I allude to the habit which some nursemaids have of carrying young and often weakly or rhachitic children on one arm and in the upright position. The effects are seen in Fig. 59, and have been mentioned above. Weakly children are best carried in the horizontal position. In the case of children under eighteen months, I follow Mr. Adams' plan, and recommend that they be moved about on a wicker tray lined with a thin firm mattress.

Position during Sleep.—Some children sleep in the supine position. This is undoubtedly the best. By the majority either the right or left lateral position is preferred. In most cases it is the right, probably because it is the more comfortable, as the weight of the liver does not then affect the thoracic and abdominal viscera, and this habitual assumption of the right lateral decubitus may explain in a partial degree the greater frequency of right-sided dorsal scoliosis. If the bed be soft and yielding, or the head be unduly raised by too many pillows, lateral flexion of the spine occurs. To prevent this, children and young adults should be taught to sleep alternately on either side, and care be taken that the head is low. The mattress must be firm and resistant, and feather pillows avoided altogether. From the production of lateral flexion in this way, a hint as to one method of alleviating it is obtained. If the deformity be right-sided, then the patient should be encouraged to lie on the left side, so that the latter becomes the more convex in the recumbent position. If scoliosis in a slight degree is present, the bed frame (Fig. 14) suggested by Mr. Fisher will be found useful if the patient persists in lying on the side of the convexity. In more marked cases it may be necessary to insist on the wearing of a support at night. The simplest and best is the poroplastic jacket.

Faulty Position in Standing.—This is very common in children and young girls. In the latter it arises sometimes from relaxation of the ligaments, and to obtain ease one leg is advanced and slightly flexed, and the body weight thrown upon it, the pelvis at the same time being tilted. In other cases it is nothing but a faulty habit. In a third class it is due to inequality in the length of the limbs. In the first class tonics and moderate muscular exercise by walking are advisable, together with douching and rubbing the weak limb. The second class need constant supervision from their parents and those in charge of them. The third class should have a cork sole fitted to the boot on the shorter leg.

Corsets.—They are unfortunately considered by the laity, or the majority at least, to be essential to the "development of the figure," and it appears impossible to impress upon people that corsets stiffened with whalebone and steel are injurious, preventing as they do the proper development of the back muscles. If a compromise must be made, it is well to advise that the corsets should be capacious and the waist merely stiffened with whalebone.

Excessive Use of the Right Arm.—This requires care in supervision and perseverance in training the left arm to work as well as the right. As an exercise sculling is most to be recommended.

Faulty Position in Writing.—The attitudes usually adopted are mentioned on p. 123. In French works on Orthopædics the faulty method of writing is called "English"; we, however, call it "Italian." Wherever the fault may lie, the chief point is to cultivate an upright "hand." The position must be such that one shoulder is not in advance, and the transverse diameters of the head and pelvis are parallel with the edge of the table and the margin of the copy-book. The feet should rest upon a comfortable stool.

Bad Position in Sitting.—Unfortunately the time when rapid growth commences is that at which it is deemed necessary to subject a child or adolescent to the process of mental stuffing, often with disastrous results. It is necessary, in order that evil consequences may not follow, so to regulate school work that the hours devoted to study may not be too long, and are arranged that equal periods of work and rest alternate. Especially should this be so in children of feeble development and with weak backs. In their case it is advisable to be assured that their sitting posture is not defective both at home and in school.

The following defects are noticeable in chairs and seats :—

The back of the chair is too straight and not sufficiently high. The result is that the back muscles, being unsupported, especially in the lumbar region, readily become tired; and the child leans to one side or the other. The head and shoulders readily droop and an habitual stoop is acquired. The height of the seat is too great, and in order to reach the ground the pelvis is twisted so as to bring one foot down (Fig. 43), or the tubera ischii rest on the edge of the seat, and the back is still less supported than before. The writing-table is too high or too low, and faulty attitudes become the easiest to adopt.

The chief points in determining the suitability of chairs and desks may be thus enumerated :—

1. The back of the seat should be at an angle of 120°, with the seat shaped so that it fits the lumbar and dorsal curves and supports the whole spine.

2. For children who are round-shouldered the chair-back should be carried up sufficiently high so as to support the head and cervical curve, but in normal children the chair-back should not be higher than the shoulders.

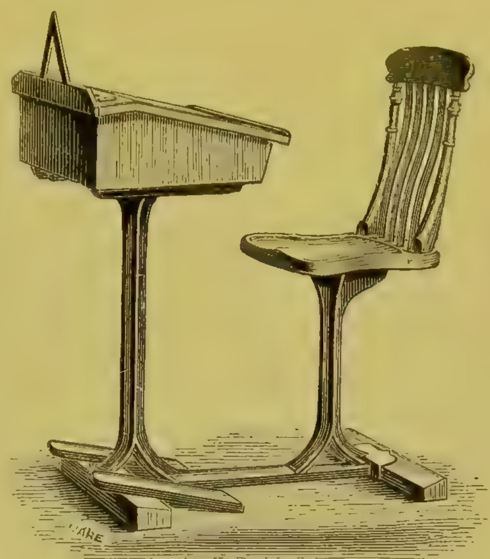

FIG 70.—A suitable desk and chair for schools.

3. The seat should be of the same depth as the child's thighs, or a little less, and about the length of his legs from the ground, and slope slightly backward at an angle of 10°.

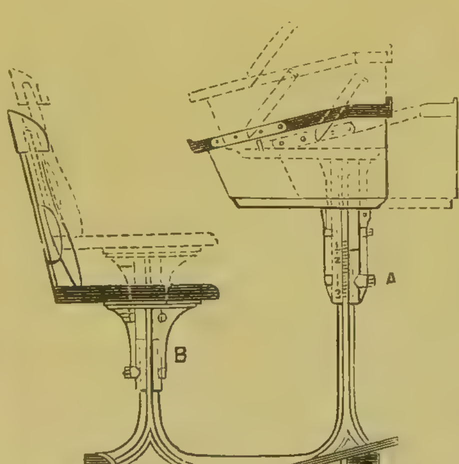

FIG. 71.—An adjustable desk and chair for schools.

FIG. 72.—The same desk and chair as in Fig 71, ready for use.

4. The writing-table "should be at a height proportionate to

For Figs. 70, 71, and 72 I am indebted to the North of England School Furnishing Company.

the height of the person sitting. The distance from the top of the seat to the top of the table should be one-eighth of the height of a girl, and one-seventh that of a boy. The height can also be determined in the following way:—The distance from the olecranon of the bent arm to the seat, with 2 inches added, should be the distance from the seat to the top of the desk. The edge of the table should be just over the edge of the chair. The inclination of the top of the desk should be a slope of 2 inches in a breadth of 12" (Bradford and Lovett).

5. To all school-desks a comfortable foot-rest, inclined at an angle of 20°, should be added. Many patterns of school-desks exist which fulfil these requirements. Among them are the desk and seat of Lickroth, Liebreich, Lorenz, and those made by the North of England School Furnishing Company.

One of the most prolific causes of scoliosis in girls is prolonged piano-practice on the ordinary pattern of music-stool. The effects are seen in Fig. 44, and their prevention in Fig. 45.

The Treatment of Scoliosis.—Many forms and so-called systems of treatment have been advocated, but some without discrimination. Scoliosis is a deformity of complex origin and far-reaching results. No one line of treatment can be applicable to all varieties. Each case must be judged on its own merits, and the factors at work in a particular case clearly recognised before attempts at alleviation or cure are made. It is therefore necessary to indicate the limits and application of the various forms of treatment at our disposal.

It has been shown in the section on "The Pathogenesis of Scoliosis" that the factors concerned in its production are—(1) the assumption of abnormal positions of the spinal column from various causes; (2) the fixation of such vicious positions from the constant influence of such causes; (3) the perpetuation and increase of vicious positions by the superincumbent weight of the upper part of the trunk, shoulders, head, and neck. Or, shortly, deviation and deformity of the spinal column, and accentuation of such deformity by weight pressing from above. The three factors mentioned above are, in a number of cases, acting synchronously, and the means of treatment at our disposal must therefore be so employed as to render these factors simultaneously ineffective. The means of treatment for the correction of the deformity, and the maintenance of that correction, are as follows:—

1. Treatment of a general nature, and directed to the restoration of the general health.

2. Recumbency, to remove the weight of the head and neck from the distorted spine, and give the weak muscles rest.

3. Postural methods, which teach the patient the assumption of correct attitudes.

4. Exercises so planned as to increase the strength of the weaker muscles, and at the same time to bring into action to a less degree the normal ones. Exercises assume two forms, active and passive.

5. Methodical correction of the curves, either by manipulation with the surgeon's hand, by the combined efforts of patient and surgeon, or by mechanical means, such as spring plates, etc.

6. Supports, or artificial aids to the maintenance of the erect position.

I repeat that those cases are in the minority to which any one of the above means of treatment is alone applicable. In the majority it is only by a judicious application of some of the above means that a satisfactory result can be effected.

We will then presume that the surgeon has made himself thoroughly conversant with the special points of each case—namely, the cause, the general health, the stage of deformity, the mobility of the spine, the amount of rotation, and the possibility of its partial or immediate reduction — and has eliminated so far as possible preventable causes on the lines laid down in the section on "The Prevention of Scoliosis"; and that he has given due attention to such constitutional conditions as may be within his domain, or sought further advice from physicians on such as are not, thereby placing the patient in the best position for local measures to ensure recovery, or, at least, to secure alleviation of the spinal distortion. Due attention must be paid to constitutional means, according to the period of life; in infants, the removal of the rhachitic taint; in children, good food, fresh air, avoidance of physical and mental fatigue, and the exhibition of preparations of iron, notably the syr. ferri phosphatis co., in doses of one-half to one drachm until the appetite is good and all signs of anæmia lost. In girls, especially at and after puberty: sufficient rest at the menstrual period, avoidance of late hours, fresh air and moderate exercise, such as walking, which is conducive to a good appetite and the rapid elimination of the waste products of metabolism, and the administration of pil. ferri carbonatis, or the same preparation of iron in capsules or jelloids. In growing lads, avoidance of all occupations which induce fatigue by reason of their excessive nature; and in all classes of cases, the relief of that general tiredness and pain in the back which in time reduces the level of general health. Dyspepsia and constipation will call for specific remedies, if, indeed, such are to be found.

It will then remain for the surgeon to do his part. Before indicating the application and the limitation of various local measures of treatment, it is convenient to speak of them now as briefly as possible.

Recumbency.—Of all means this is the one most calculated to neutralise the effect of the weight of the head, neck, and upper extremities. But as the treatment of scoliosis extends over months and years, it cannot be the only form employed without serious detriment to the general health and weakening of the spinal muscles. It is, however, more efficient than suspending the head by means of a jury-mast in accomplishing the desired object.

The patient may be placed recumbent for a limited number of hours, at the most from four to six daily, either in the supine, prone, or lateral position. Many cases will not require more than one to three hours daily. The prone position affords a welcome change from the usual dorsal decubitus. A useful combination of couch and exercising apparatus has been designed by Mr. Adams.[1] "The exercise essentially consists in the patient drawing herself up the inclined plane whilst the body is resting on the sliding board or movable stage, which is softly cushioned. The exercises should be taken while the patient is lying alternately on the back and stomach, so that both the spinal and chest muscles are exercised and developed. One arm can also be exercised more than the other, if required, by altering the length of the cord to which one of the handles is attached." The patient should draw herself up and allow herself to descend by her body weight five to ten times to begin with, allowing short intervals of rest, and the total duration of exercise should at first be fifteen minutes; this may be increased afterwards. The advantage of exercises in the horizontal position are great, as the weight of the head and upper extremities is removed.

In lateral decubitus Wolff's suspensory cradle is useful; this is figured in Mr. Reeves' book.[2] In slighter cases partial recumbency for two to four hours daily is sufficient. Ward's reclining chair, adaptable to any angle, is of value. During sleep a firm pillow may be placed beneath the ribs on the convex side and the head kept

[1] *Proceedings of the Med. Soc. of London*, vol. 1.
[2] *Bodily Deformities*, Fig. 29.

low. Infants with scoliosis are best carried about on a wicker tray (Fig. 25).

Postural Methods.—When scoliosis is associated with faulty standing and carriage, it is needful to teach the patient the proper manner of walking, standing, and sitting. To this end regular drilling for about half an hour daily may be resorted to, this period being divided into three parts, with intervals of rest of five minutes in the recumbent position. After a time the duration of the drill may be increased to one hour, with the same precautions and intervals of rest. During the remainder of the day recumbency for two or three hours, walking, and outdoor games should be enjoined.

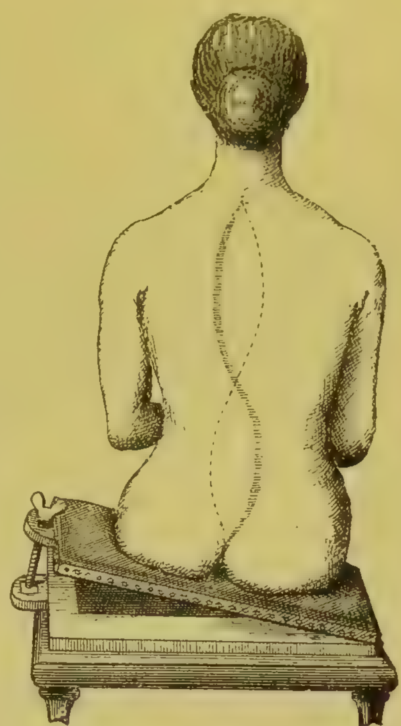

FIG. 73.—Volkmann's oblique seat for primary lumbar curvature.

Patients who habitually "stand at ease" should have any shortening of one leg attended to and remedied by a cork sole, and then be exercised by raising and lowering the body on that leg which has hitherto not been sufficiently used. In cases of primary lumbar curvature Volkmann's oblique seat is useful (Fig. 73). Partial recumbency in patients who suffer from weakness of the

FIG. 74.—Semi-reclining couch (Roth).

back muscles is most comfortably carried out by a semi-reclining couch, which can be placed at any angle (Fig. 74).

Exercises.—The kinds of exercises described are so very numerous that it is impossible to notice them all. The particular type of exercise adopted will depend on the individual preference of the surgeon. Personally I should give the preference to those forms which can be easily learnt by the patient after one lesson from the surgeon, and those which require no special apparatus.

The following exercises will be found efficient. They are arranged in two sets, the first set for the earlier stages of treatment and when the muscles are toneless; the second set when the muscles have acquired strength, and for those cases in which much deformity exists with considerable muscular development. In either case care should be taken that the patient takes full inspirations and expirations. If any doubt exists as to these taking place, then counting aloud should be enforced. It is advisable at any rate to begin with exercises in the horizontal position. In all cases the patient is loosely clad.

I. *Exercises adapted for earlier stages of scoliosis in which muscular weakness is present.*

1. The patient lies supine, with the arms by the side, and slowly raises them until they are fully extended above the head with the palms upwards. They are kept there for a few seconds and then slowly replaced.

2. The same manœuvres, except that the patient is in the prone position and the palms are downwards.

3. The patient in the supine position imitates with the arms and legs the movements of swimming on the back.

4. The patient prone, a small pillow being placed beneath the thorax, the head is extended and the movements of the upper limbs as in the breast stroke are performed.

5. The patient supine, the arm on the side of the dorsal convexity being extended and applied closely to the side, its fellow is slowly brought away from the side, at first in full extension, until the hand is beyond the head, and then the forearm is flexed and pronated so that the hand is enabled to touch the opposite ear.

6. The patient supine, the arm on the convex side being still applied closely to the body, its fellow, in full extension, is slowly circumducted several times.

7. If there is much habitual bending of the head, a strap or band is fitted around the head, passing well below the occiput and

retained in position by a chin-strap. The patient then sits with the attendant opposite him, and keeping the spine straight, bends backwards and forwards, the attendant resisting the backward movement of the head and spine.

II. *Exercises adapted for cases of scoliosis in which fair muscular power is present.*

1. The patient being seated, and if it is a case of right dorsal scoliosis, the right arm is held close to the side, while the left arm is placed behind the back, and movements of inspiration and expiration are carried out several times.

2. The patient being seated near the edge of a firm and high seat, bends the trunk slowly forwards, with the arm on the concave side and the thigh and leg on the convex side, extended as much as possible in a case of right dorsal curvature. The pelvis is held firmly by the assistant, the arm and leg are kept extended for a few seconds, then the patient gradually brings the limbs back into the original position, at the same time straightening the trunk. If the scoliosis be left lumbar, then the left arm and right leg are extended.

3. Sitting on a chair with the feet curled round the legs of the chair, the patient should, in the case of a single curvature, slowly bend over to the convex side of the curve, the assistant standing on the concave side, and resisting the return to the upright position with his hand pressing against the shoulder and hip of the concavity.

4. The feet being firmly planted, the patient, with the heels approximated and the toes turned well forwards, practises this manœuvre, with the pelvis resting against a bar. In the case of right-sided dorsal and left-sided lumbar scoliosis, the patient's left hand is placed behind the head and the right hand behind the hip. The trunk is then inclined forwards, while the assistant, standing behind, resists the movement of restitution with his left hand placed firmly against the patient's left loin, and his right hand against the most prominent part of the dorsal convexity.

The above exercises, though in no sense original, have the advantage over the simpler ones of flexion and extension of the spine against resistance in that they are designed to bring into play more especially muscles which are shortened.

When the deformity decreases, additional exercises may be tried, viz.—

5. The patient lying prone, with the arms first at the side, raises the head and shoulders from the couch. The hands are then placed

behind the head, and the same manœuvre repeated two or three times. The feet are fixed during these movements.

6. Still in the prone position, with the arm on the convex side under the chest, and that on the concave side over the head, the body is swayed over to the convex side.

Exercises which consist in bending the trunk and head over the edge of the couch and then extending them again are, as a rule, too fatiguing for scoliotic patients.

7. Other exercises are: the patient standing and the knees being fully extended, the trunk is flexed on the thighs, and then extension is made against the resistance of the attendant's hand placed on the upper dorsal vertebræ, care being taken that the pelvis is not twisted; or the patient standing against an open door with the heels, spine, and occiput as close to it as possible, moves the flexed elbow on the concave side as far back as possible several times. Special attention should be paid to flat feet if they are present, and the muscles of the thighs and legs exercised by the patient rising on tip-toes and keeping the back as straight as possible, then flexing the knees and hips and gradually resuming the erect position.

With all these measures local friction of the muscles is very useful. After exercising it is necessary to enforce one to two hours' recumbency. At first the exercises may be carried out once a day, and later, twice.

Amongst other forms of exercise, that of employing to the full the muscles of the chest by singing is very useful. It appears to me that the great value of singing in restoring the chest and back muscles has not been properly estimated. The erect attitude, the fully-extended head, and the necessity for deep inspirations are all of value in improving the tone of weak muscles. Of course particular attention should be paid to the position of the patient, and he or she must assume an upright and not a lounging attitude.

Dumb-bells and Indian club exercises are spoken highly of by some writers. It seems to me that as a rule they are too heavy, and fatigue the patient. Dumb-bells must not be used alone, but in conjunction with other exercises and recumbency. The former are best avoided if pain is present. When first employed they should, for the use of children from 7 to 10 years, not weigh more than half a pound each, and be of wood. From 10 to 15 years of age they may be three-quarters to one pound in weight; from 15 to 20 not more than two pounds. The great mistake is to have them too heavy; by fatiguing the muscles they defeat the very object for which they are used. At first they may be used for five minutes with a short interval of rest, but later for ten minutes, and afterwards for twenty minutes.

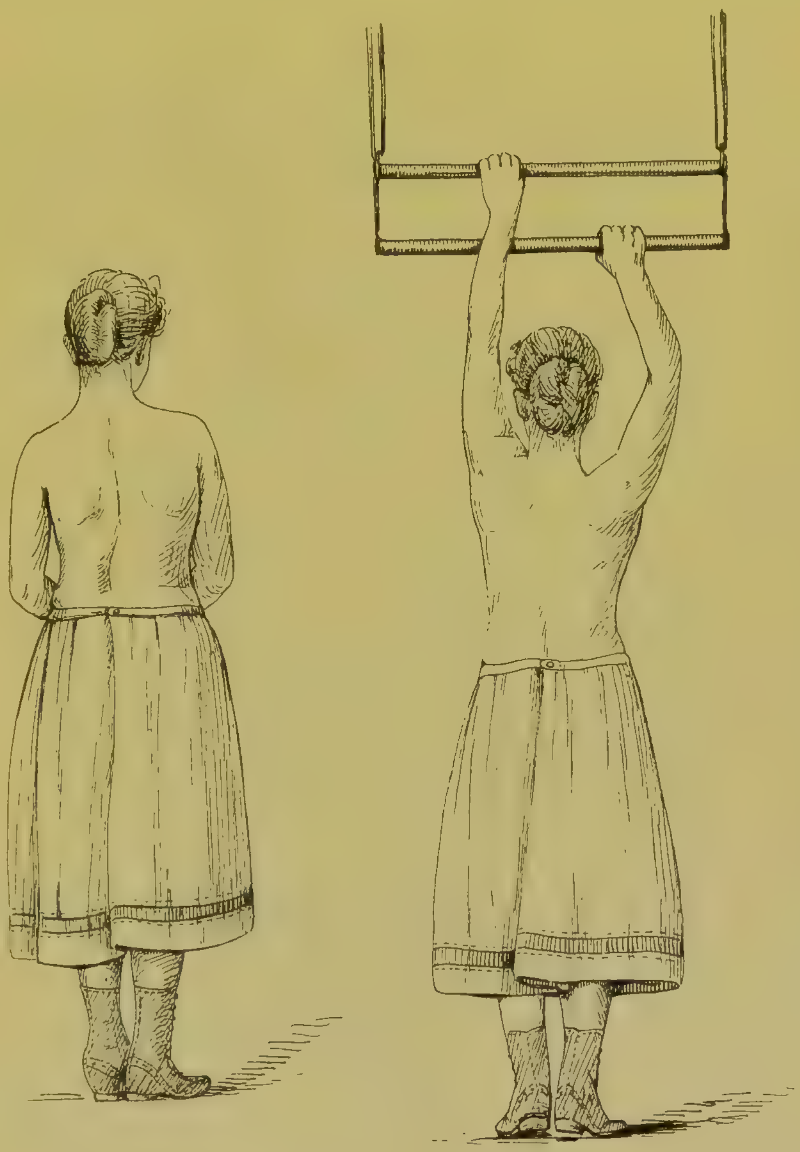

FIG. 75. FIG. 76.

Two figures showing the effect on the spinal curvature of suspension from two parallel and horizontal bars. The curve to the right is effaced by the left hand grasping the upper bar. The same result may be attained by placing a single bar obliquely, so that the highest portion of it is grasped by the hand on the concave aspect of the dorsal curve.

The treatment by suspension has already been spoken of, and is to be deprecated if used for every case. In relaxed spines suspension will probably make them worse. A modification of the usual suspensory bar has been introduced by Mr. Adams. It consists in having a second bar above and parallel with the original one. The second bar can be fixed at a varying distance from the first. The patient grasps the lower bar with the hand on the convex side of the dorsal curve, and the upper with the hand on the concave side. That the

FIG. 77.—Suspension of a scoliotic patient from a bar which is placed obliquely. The curvature to the right is effaced by the left hand being placed higher than the right. The bar from which the patient is suspended is not seen in the figure, but it will be noted that nothing of the left hand is seen, while part of the right is in the picture.

arrangement is efficient in temporarily diminishing the extent of the curve is seen by Figs. 75 and 76, but the improvement is difficult to maintain. In cervical and high dorsal curves Sayre uses a suspensory apparatus, fixing the head and shoulders. The use of elastic accumulators sold as chest-expanders finds favour with some. They may be conveniently attached to Mr. Adams' exercising plane, being fixed to the movable plane and pulling it downwards against the upward efforts of the patient; or they may be secured at one end to the ground, and the patient pulling upon the other, imitates the movements of the "top sawyer at the saw-pit." The accumulators can be employed in numerous other ways. A good method for both dorsal and cervical curves is to attach one end of a very light and easily extensible accumulator to the patient's head by means of a strap passing around the occiput, and prevented from slipping by a second strap beneath the chin, the other end being held by an assistant or fixed to the wall. The patient then bends backwards and forwards, keeping the spine straight. The exact amount of resistance can be better regulated by a weight and pulley instead of an accumulator.

Methodical Correction either by Manipulation or Instruments.—Correction by manipulation is exceedingly useful. At the commencement of treatment the patient lies prone with the arms fully extended, grasping a rod. The couch is tilted slightly at its head so that some extension is present, and the pelvis is fixed by a belt to rings in the couch. The attendant then manipulates the convex side of the curves with both hands simultaneously in such a way that the successive vertebræ are pressed on from below upwards. Thereby the prominent transverse processes and ribs are gradually brought into place, and much improvement is effected. The exercise should be continued for fifteen to thirty minutes. When considerable improvement has occurred, and the muscles are sufficiently strong for exercise in the upright position without fatigue, the following method may be employed. The patient sitting, the pelvis is fixed; the surgeon, seated behind the patient, presses with one hand against the summit of the curve, while his other hand grasps the upper arm. By simultaneous movements of pushing on the convexity with one hand and drawing upwards and backwards the shoulder of the concavity with the other, redressment is obtained.

Lorenz has designed a method of active and forcible correction. It consists in laterally flexing the patient daily over a stout padded bar, which forms part of a special apparatus. The same end is gained if to the head of a sloping couch a bar carefully padded is fixed, and the patient practises lateral flexion over this with the arms extended above the head, taking deep inspirations while in the laterally flexed position. Of Lorenz' method and Barwell's, by means of exercises with bands or straps and designated rachilysis,[1] I have had no experience.

Methodical correction and support can be efficiently obtained by steel instruments. The number of them is great, but I will only mention two forms, namely, the laced shield support (Fig. 78), and a combination of the spring plate apparatus of Adams and the laced shield apparatus made by Ernst. I do not wish these to be considered as the only forms suitable. There are others, but the latter (Fig. 79) has given good results in my hands, and it has been used to a considerable extent by others. It fulfils the requirements of a spinal apparatus in nearly all particulars, namely, it is light, weighing about one and a half pounds; it has a firm base on the pelvis; it fits accurately, thereby giving good support to the whole frame; constant pressure is exercised on the convexity of the curve by the spring plate; the apparatus is self-adjusting by the action of the springs, and, as improvement in the curves takes place by intercurrent exercises and gymnastics, the lacing can be let out; there is no hindrance to breathing, as the whole of the anterior part of the instrument is soft. That it is efficient is shown by the fact that when a scoliotic patient did not present herself for examination for some months, the curves were found to be over-corrected. The only drawback is the expense, but as the instrument lasts with care for some time, this cannot always be considered a serious matter. This instrument is particularly adapted for orthopædic practice as being self-adjusting, and visits to the surgeon at long intervals only are required.

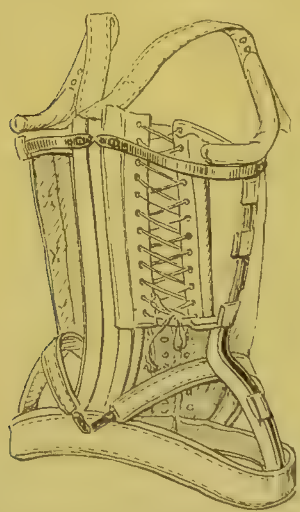

FIG. 78.—Laced shield spinal apparatus.

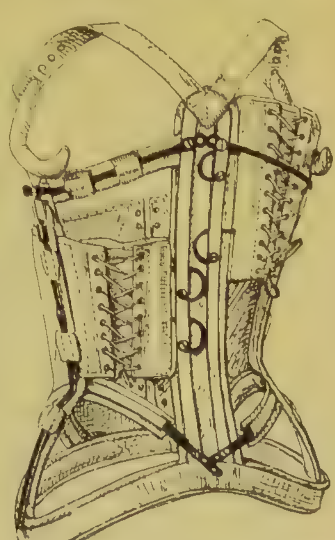

FIG. 79.—Spring plate and laced shield spinal apparatus.

A heavier form of instrument, and one requiring care and supervision in its use, is the spinal support with levers and plate. This, however, is somewhat complex and can be seldom necessary.

[1] For a description of this method, vide *B.M.J.* 28th Feb. 1891, pp. 461, 462.

Neither of these patterns of instruments should be employed if the case present fixed osseous curves.

Supports are indicated in two classes of cases:—

(*a*) Those in which there is much weakness of the spinal muscles, with commencing curvature. In these instances the use of the spinal stays designed by Mr. Adams (Fig. 80), combined with exercises, is valuable. The former are also useful in receding cases when the spinal apparatus alluded to above can be dispensed with, and before the return to simple, light stays.

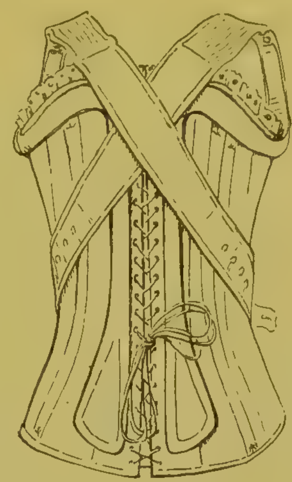

FIG. 80.—Mr. Adams' spinal stays for cases of commencing curvature, and to be used as a support when the patient is not exercising.

(*b*) In advanced stages of scoliosis, with fixed deformity arising from bony ankylosis at some portion of the column, when curvatures in other parts are increasing and the patient is suffering from pain and symptoms of visceral displacement and pressure, some form of support is necessary. Two kinds are in general use, the poroplastic jacket and the plaster of Paris jacket. The merits and demerits of these have been described on pp. 56-58. In my opinion, the poroplastic jacket is preferable, particularly if it be strengthened by vertical steel bands moulded to the outline of the figure (Fig. 81).

FIG. 81.—Poroplastic jacket and steel supports moulded to the figure, for inveterate cases of lateral curvature with bony ankylosis.

When the scoliosis is cervico-dorsal or high dorsal, *i.e.* above the seventh dorsal vertebra, it is necessary to add an occipital head-piece to the jacket, so as to remove the weight of the head and neck from the spine.

Indications for the various Methods of Treatment.—There is no panacea for scoliosis. Each case must be treated on definite lines, and a discriminating use made of the means at our command. To recapitulate the means: they are recumbency, postural methods, exercises, methodical correction, and support. With these must be combined constitutional treatment.

For practical purposes it is convenient to consider the indications from the point of view of the age, causation, shape, position, number, and condition of the curves, as to fixation or not. But there can be no hard and fast lines of treatment.

1. *In Children under Three Years of Age.*—Dependent as scoliosis is at this age largely upon rickets, every effort should be made to remove the rhachitic condition. Prophylaxis consists in the avoidance of the sitting position of the child either on the nurse's arm or lap. It must, if kyphosis or scoliosis threatens, be always carried on a pillow or in a wicker tray. When it is old enough to walk, firm support should be given to the back by a back-board, poroplastic or leather jacket during the day. The jacket should be removed twice a day to allow the muscles of the back to be douched with tepid water and to be well rubbed to increase their tone, also to permit methodical correction with the hands (p. 175). Particular attention is to be given to the decubitus at night. If mere spinal weakness, the supine is the best: if a curvature be commencing, the child should be taught to lie on the prominent side, with the head low and a pillow placed beneath the convexity. It is too often the case that slight rhachitic curves are disregarded; but from rickets alone some of the most inveterate curves of late adolescence ensue.

2. *During the first Period of rapid Growth, from Six to Twelve Years of Age.*—Prophylaxis consists in careful observation of the child so that she does not fall into faulty positions in sleeping, standing, sitting, or writing (pp. 163, 164); that all such conditions as myopia, adenoids (p. 155), and unequal length of the legs are corrected; and that too great a strain is not put upon her, either mentally or physically. The treatment is to curtail to a great degree the time spent in study, to enforce outdoor exercise, such as walking, or those games which necessitate the use equally of both arms for about one hour or less; to drill the child for half an hour in the second part of the day, so that she acquires a correct carriage, both forms of exercise being followed by recumbency for one to two hours, preferably on the prone couch (p. 168). Or exercises in the horizontal position on the couch may be enforced, at first for fifteen minutes, and then followed by rest for one hour, twice a day. If the height be out of proportion to the weight, the duration of recumbency should be greater, at least two hours twice a day, and the amount of exercise not more than half an hour twice a day. The ordinary gymnastic curriculum is to be avoided, as it is too long and too fatiguing. In place of drilling, when the curve has become pronounced the less exacting forms of exercises (Set I. p. 170) may be used, the whole time during which they are carried out not being more than half an hour;

or the use of very light dumb-bells, under one pound, for about ten minutes may be combined with the exercises. As the patient improves in strength, and the curvatures in flexibility, the more advanced exercises (Set II. p. 171) may be proceeded with, again not for more than half an hour, and to be followed by recumbency. During the remainder of the day, if there is weariness or fatigue, or the child lapses into a faulty position, a light spinal apparatus with spring plate and laced shield may be employed. Passive manipulation (p. 175) is also valuable. Too much attention cannot be paid to commencing scoliosis at this age. The spine is very flexible, and can be moulded in the early stage almost at will by the means described. This element of flexibility is also one of danger; if the condition be disregarded the deformity progresses rapidly, and the result is lamentable in later years. The duration of treatment cannot be definitely stated, but it will be necessary in most cases for supervision to be exercised for one to three years.

3. *During the second Period of rapid Growth, from Twelve to Twenty-one Years of Age.*—The signs and treatment of the preceding stage of lateral deviation have been discussed on p. 107. The prophylaxis consists in attention to the general health. Muscular weakness being a predisposing cause, the muscles of the back should be strengthened by tepid bathing, douching, friction, and the use of the constant current. The surgeon satisfies himself that all conditions of occupation, faulty positions, bad habits of standing, and causes of fatigue are removed, and sees that the general tone of the body is raised by fresh air, good and easily-digested food, and the administration of iron. He also inquires particularly into the pattern of chairs, desks, and music-stools, and the duration of music and drawing lessons.

The indications for treatment are best arranged according to the stage of the curvature, viz. commencing, established, and fixed.

A. Commencing cases, *i.e.* those in which there are some deviation to one side of the vertebra, prominence of the scapula, ribs, and crest of the ilium, with asymmetry of the flanks; or slight cases, where the curves can be made entirely or almost to disappear either by placing the patient in the improved position or by suspension or recumbency.

The first question that will be put is, Is it necessary that all the lessons be given up? In reply it may be stated, it is not essential. Rather they should be curtailed to a quarter or half the usual time, and carried on in the morning, when the patient is in greater vigour than in the afternoon, and followed by adequate rest.

If there be no muscular debility, and the scoliosis arises from faulty positions, or defective habits of standing, then the postural method (p. 169) is to be enjoined, and supports are unnecessary. Again, outdoor exercises are to be encouraged, with drilling and athletics, such as swimming, which bring into play all the muscles of the body. The patient should also be frequently exhorted by the parents when any lapse into a vicious position is noticed.

If with the scoliosis there is much muscular weakness, then a combination of recumbency, exercises, and support is called for. Recumbency is specially necessary in primary lumbar curves, and in neurasthenic or overgrown girls.

The daily routine should be somewhat as follows:—A tepid bath in the morning, with friction of the back and the exercises of Set I. (p. 170), and after breakfast methodical correction by manipulation for half an hour, followed by recumbency, then lessons and outdoor exercise. In the afternoon recumbency for one to two hours. In more advanced cases the exercises should be carried out in the afternoon as well. In the intervals of exercises and recumbency a spinal apparatus which combines support with methodical correction, such as the spring plate and laced shield, is useful,[1] or Mr. Adams' spinal stays, if it appear that the muscles are too weak to sustain the body. But it is better, if possible, to dispense with supports. It is also useful to encourage singing and other methods of distending the chest. As the muscular power increases, the exercises in Set II. (p. 171) may replace those of Set I. But manipulative correction (p. 175) must still be persevered with, and care be given to the position during sleep. With this treatment cure may be looked for in six months to two years.

B. Established or pronounced cases, *i.e.* those in which the curves may still be greatly improved or modified by the "best position," recumbency and suspension. Here postural methods are useful. The combination of rest, exercises, and support is more urgently called for, and methodical correction should be diligently persevered in. The exercises should be the more advanced, those in Set II., and should be gone through twice a day, and followed by recumbency for two hours. The daily routine is much the same as in the slighter cases; and mechanical supports with corrective apparatus

[1] Mechanical correction is chiefly of service in the dorsal region, where the plates can act by pressing on the displaced ribs. It is not of much avail in lumbar curvature.

and sufficient rest are necessary. In cases of multiple but still flexible curvatures the general effect of exercises should not be to remove them, but to give strength to the muscles of the back as a whole. If there be slight osseous fixation, Adams' method of suspension from the two horizontal bars (p. 174) may be employed; and it is stated that Lorenz' method of forcible correction is useful in these slighter cases of fixation,[1] but it is obviously inapplicable in advanced osseous ankylosis. Of this method I have had no experience, and I merely quote the opinion of writers on the subject. It is well to add that if the curvature be high up, viz. cervical or cervico-dorsal, the head and neck must be supported by an occipital head-piece or jury-mast.

C. Fixed or severe cases, where no change in the curves is produced by any alteration of position. All that can be done is to relieve the symptoms—viz. pain, and those arising from displacement and pressure on viscera—and, if possible, to prevent the deformity becoming worse. Poroplastic jackets strengthened by steel bands and perforated by a few air apertures, or plaster of Paris jackets, both with or without occipital head-pieces as may be necessary, are the means at our disposal. As the plaster of Paris jacket cannot be so tightly put on as to accurately fit the patient, any straightening of the lesser curves obtained by suspension during its application is rapidly lost. It can merely act as a general support. In Class B some improvement may be looked for, in Class C none. Indeed Walsham[2] states that "even with the use of supports it may, under some circumstances, get worse."[3] Curvatures arising from empyema are hopeless to attempt to rectify, and so are those associated with destructive nerve lesions, such as acute anterior polio-myelitis, or myopathies, or pseudo-hypertrophic muscular paralysis.

In no case is myotomy permissible. Although I have mentioned above the period during which it is necessary for treatment to be continued, I feel bound to state that in most cases of scoliosis inspection by the surgeon at intervals of one to two months is all that is called for, provided that he can ensure his directions being understood and intelligently carried out.

[1] Bradford and Lovett, *op. cit.* p. 177.

[2] *St. Bart's. Hosp. Rep.* vol. xx. 1884, pp. 195-211, "Notes from the Orthop. Dep. in Treatment of Lat. Curv. of Spine."

[3] For a general expression of opinion on the methods of treatment of scoliosis consult the Report of the Clin. Soc. Committee on "The Treatment of Lateral Curvature of Spine," *Clin. Soc. Trans.* vol. xxi. pp. 301-303.

SECTION II

DEFORMITIES OF NECK, CHEST, AND UPPER EXTREMITIES

CHAPTER I

TORTICOLLIS OR WRY-NECK

Varieties of Torticollis—Etiology and Causation—Cases illustrating various Points—Pathological Anatomy—Symptoms—Prognosis—Diagnosis—Treatment of Congenital Torticollis—Methods of operating—After-Treatment—Treatment of Spasmodic Torticollis, General and Operative—Section of Spinal Accessory Nerve, and of Posterior Nerve-Roots.

Synonyms—Latin, *Caput obstipum, Collum distortum* ; French, *Torticolis, Cou tortu* ; German, *Schiefhals.*

Definition.—A congenital or acquired deformity, characterised by lateral inclination of the head to the shoulder, with torsion of the neck and face.

Varieties.—False and True.

False torticollis is not immediately due to muscular or nerve causes, but is a symptom of disease in other structures. For instance, in cervical caries a displacement of the head occurs, and one sterno-mastoid becomes shortened. An error of diagnosis is readily avoided by noting that in spinal caries the muscles are tense and shortened on that side *towards* which the face is turned, while in the true form the tension is on that side *from* which the face is turned. The false variety may sometimes be due to cicatrices of skin and fasciæ following a burn.

True torticollis may be spoken of as acute and chronic.

The Acute Form arises from exposure to cold and from rheumatism, in fact is the ordinary stiff-neck, and is scarcely worthy of being called torticollis. In children it is apt to be more lasting than in adults, and may give rise to a faulty position of the head more or less permanent. With the deformity there is some tenderness of the muscles.

Chronic Torticollis in its true form may be arranged under the following headings :—

1. Congenital or "fixed wry-neck."
2. Acquired.

(*a*) Traumatic and cicatricial, following injuries to the muscles of the neck.[1]

(*b*) Compensatory. In scoliosis the head is frequently inclined to the right or left in the effort to maintain the equilibrium.

(*c*) Spasmodic. This may be tonic or clonic in character.

The classification, however, of the varieties I have adopted is as follows:—

Torticollis.—I. False, arising from spinal caries or cicatrices of skin and fasciæ.

II. True. 1. Acute—Rheumatic.
2. Chronic. *A.* Congenital.
B. Acquired.
Compensatory.
Spasmodic.

I have omitted the paralytic form on the authority of Gowers, *Dis. of Nervous System,* 2nd ed. vol. ii. p. 662.

From a pathological point of view, torticollis is spoken of as anterior when the sterno-mastoid is mainly affected, and posterior or retrocollic when the posterior cervical muscles are largely implicated; in the former the deviation is lateral, in the latter there may be backward movement of the head.

Etiology and Causation.—The male sex is more liable to congenital torticollis than the female, and it is more frequently found on the right side than on the left. The deformity is a comparatively rare one. Of 2000 patients seen by me at the Evelina Hospital, I have met with it but eight times. Gowers says: "The spasmodic form is more common in women than men. Of thirty-two cases of which I have notes (all those of hysterical nature being excluded), ten were in males and twenty-two in females. It commonly begins in the middle period of life, between 30 and 50 years of age. . . . Cases in females under 30 are often of a hysterical nature, and this is also probably true of the rare cases, in which similar spasm is met with in boys."[2]

The congenital form is said to arise from injury to the sterno-mastoid at birth from traction on the neck. Another cause is shortening of the muscle, following inclination of the fœtal head in

[1] Reeves, *op. cit.* p. 85. [2] *Op. cit.* p. 664.

the pelvis. This is supported by two facts: congenital torticollis is usually on the right side, and in 75 per cent the fœtal head is in the first position, which is associated with flexion of the head to the right shoulder. The shortened muscle may, on account of its inability to stretch, rupture during birth.

As to the precise connection of the so-called hæmatoma of the sterno-mastoid and induration of that muscle with torticollis, the literature is considerable and the evidence conflicting.[1] It would appear: (1) that in a certain proportion of cases of congenital torticollis no history of swelling in the sterno-mastoid after birth is obtainable; (2) in other cases there is a distinct history of such a lesion, these form but a small proportion; (3) in the majority of cases of hæmatoma, torticollis is not developed subsequently; (4) how far syphilis is a cause of congenital torticollis is not known. Cases undoubtedly occur in which induration of the sterno-mastoid and wry-neck are associated with signs of congenital syphilis.

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[1] Petersen, *Zeitschrift f. Chir. Orthop.* Bd. I. Heft 1. (1) No case of wry-neck has been proved to be due to rupture during birth of a normal sterno-mastoid. (2) Clinical and experimental evidence is against it. (3) The occurrence of intra-uterine shortening is known.

D'Arcy Power, "The Relationship between Wry-neck and Congenital Hæmatoma of Sterno-mastoid," *Roy. Med. Chir. Soc. Trans.* 1893. His conclusion was that sterno-mastoid hæmatoma is often followed by torticollis; see also discussion thereon.

Rushton Parker, *B. Med. Journ.* 1891, vol. ii. p. 1333.

Quisling, *Centralblatt f. Gynäk.* 3rd Jan. 1891.

Royal Whitman, *Trans. Amer. Orthop. Assoc.* vol. iv. p. 292—"Observations on Torticollis, with particular Reference to the Significance of the so-called Hæmatoma of the Sterno-mastoid Muscle." Whitman quotes the opinions of Busch, Volkmann, Stromeyer, Volbert. He then gives the probable history of congenital torticollis, which consists in torsion of the head and neck, effusion of blood, "encapsulatory inflammation" at site of injury, then the hard painless tension of muscle, followed by induration. The induration slowly disappears, and is replaced by fibrous tissue, which contracts and gives rise to permanent torticollis. Seven cases are given in which swelling was found after birth in the sterno-mastoid muscle. Nineteen months afterwards, the longest period to which the observations were carried, there was no torticollis. Of thirteen cases, nine were breech presentations and delivered by version, two by forceps, and in two there was no history of interference. Among the fallacies as to hæmatoma, Whitman adds that the muscle is shortened *in utero*, thus presenting a deformity with which induration is a coincidence and not a cause, and refers to such a case reported by Bruns at the Congress of German Surgeons 1891.

H. H. Clutton, *St. Thomas's Hosp. Rep.* vol. xvii. 1888, on "Congenital Sterno-mastoid Tumour or Induration." Eighteen cases are given. In none was there a history of syphilis. Eight cases were breech presentations, two were cases of turning, eight were vertex, and forceps were used in three. In two cases of the eighteen, wry-neck occurred.

Cf. also Taylor, *Path. Soc. Trans.* vol. xxvi. 1875. H. Arnott, *St. Thomas's Hosp. Rep.* 1874, vol. v. p. 276. Parker, *Brit. Med. Journ.* 1881, vol. i. p. 515. Golding-Bird, *Guy's Hosp. Rep.* vol. xlvii. pp. 253-273.

In illustration of my remarks, the following notes of cases which have come under my observation are given :—

CASE 34. *Congenital Torticollis without History of Swelling in Muscle after Birth.* —Ida H——, aged 5 years, was brought to me at the National Orthopædic Hospital. For the last two years the mother had noticed that the head was drooping over to the right shoulder. The labour was a long and tedious one, and instruments were used, but no swelling was noticed after birth. There was no history of syphilis. The appearance presented by the child is seen in Fig. 82, which illustrates the deviation of the head and the contraction of the sternal part of the right sterno-mastoid. The child was operated on by the open method, and the result was successful (see Fig. 83).

FIG. 82.—Congenital torticollis. Case 34 before operation. Slight atrophy of right side of face.

FIG. 83.—Case 34 after operation.

CASE 35. *Torticollis with History of Swelling in Sterno-mastoid after Birth.* —Rhoda B——, aged 3 years, came to me at the Evelina Hospital in September 1894. The birth was said to be " crossed " and the labour lasted two days, and the child was finally born by the breech; no instruments were used. After birth one hour was spent in resuscitating the child. Fourteen days after birth the mother noticed a "band and a lump" in the left sterno-mastoid. The child was taken to a hospital, and the mother was told that it would get well. The lump disappeared in nine weeks. The head was noticed to turn over in the second year, and since then has got worse, till it shows the present condition of deformity. The head was drawn down to the left shoulder, and the face was rotated to the opposite side. There was no history of syphilis.

CASE 36. *Gumma of right Sterno-mastoid disappearing under Treatment.*—James W——, aged 5 weeks, was seen at the Evelina Hospital in April 1893. The mother has had one miscarriage before becoming pregnant with this child. The miscarriage occurred at the end of the third month. This child is the third. It was puny, ill-developed, of an earthy complexion, and had snuffles, and a papular and syphilitic rash. On the right side was a distinct localised thickening of the sterno-mastoid, about the size of a halfpenny. It was firm and apparently painful. The muscle was decidedly tense, but there was no deviation of the head. The swelling in the muscle and the tension disappeared under the administration of pulv. hydrargyri cum creta gr. $\frac{1}{3}$ bis die, and up to December 1894 there was no sign of torticollis.

FIG. 84.—Congenital torticollis to the left (Case 38).

CASE 37. *Congenital Syphilis, left Sterno-mastoid Induration, and Torticollis cured by Mercurial Inunction.*—Jane C——, aged 6 weeks, was brought to me at the Evelina Hospital in November 1894. The child was puny, but at the time of birth was a fine large child. The labour was not lingering, but the child was born "feet first." Since birth the child has wasted considerably, and there is now a deep red multiform rash about the nates and vulva, extending down the thighs as far as the knees. The left sterno-mastoid stood out in marked relief from the side of the neck, and was firm and tender. The head was drawn towards the left shoulder, the face was rotated to the right, and the chin raised. The left side of the face was less developed than the right. Under the administration of pulv. hydrargyri c. cret., and rubbing in of hydrargyri oleatis, $2\frac{1}{2}$ per cent, the induration of the muscle and torticollis disappeared in two months.

CASE 38. *Left Torticollis, Breech Presentation, Syphilitic Eruption.*—Emily A——, 5 weeks, was seen by me at the Evelina Hospital 1st December

1894. She was the third child; the others were quite healthy, and there have been no signs of syphilitic trouble in them. The mother had one miscarriage nine years ago, but she states that she herself has always been healthy. This child was born feet first after a difficult labour.

Present condition.—The left sterno-mastoid is firmer and more tense than its fellow, and stands out in relief. Both its heads are implicated. There is asymmetry of the face, and the left side is distinctly smaller than the right. The head is drawn down to the left shoulder, and the face is rotated to the opposite side (Fig. 84). In the clavicular head of the sterno-mastoid a distinct hard nodule is to be felt. There is a multiform rash on the gluteal region. The child was given grey powder, as the rash appeared to be syphilitic. On 5th January the rash was seen to be undoubtedly syphilitic. Unfortunately I lost sight of this case.

CASE 39. *Indurated Mass in the right Sterno-mastoid, with no Contraction of the Muscle.*—Joseph D——, aged 3 weeks, came to me on 13th July 1895. The head was born first. The nurse had to bring the head through by traction, but no forceps were used. It was quite clear to the mother that the child was not born with a lump in the muscle; she first noticed it when the child was a fortnight old. About the legs and thighs there were some maculæ and papules which were suggestive of syphilis, but no confirmation in the history or after-symptoms was forthcoming. The right sterno-mastoid was occupied in two-thirds of its extent by a hard olive-shaped mass, which was not tender, and the skin over it was of normal colour. The head could be moved freely in all directions. On 27th July it was noticed that the lump was smaller, and there was some redness. The case finally did perfectly well, no torticollis appearing subsequently.

CASE 40. *Indurated Mass in right Sterno-mastoid (? syphilitic), and no Contraction of the Muscle.*—Sidney T——, 7 weeks. The mother states that she has had two miscarriages, one at the fifth month and one at the sixth week. This child had snuffles at birth, and now has a few papules on the legs and arms and in the gluteal region. The child was born by the breech.

In the right sterno-mastoid about its centre there was a hard indurated mass, which was not tender. The child was given grey powder, and the lump became gradually smaller until it finally disappeared.

CASE 41. *Mass in right Sterno-mastoid, Torticollis, Facial Hemiatrophy.*—Lilian M——, 9 weeks. The patient was the second child. The mother had been married previously, and there was a child by another father. The mother states that she has always had good health and has had no miscarriages. The history of the child was as follows:—The birth was by breech presentation, and the labour was hard but short. The child had a rash on the face and in the mouth fourteen days after birth. It consisted of red spots, which went "right through her and appeared about the lower parts." The rash lasted for three days, and appears to have been "thrush." The right sterno-mastoid was occupied by a hard irregular mass in the upper two-thirds of its extent. The muscle was tense, the head was approximated to the shoulder, and the face was rotated to the opposite side. The right side of the face and head were distinctly smaller than the left. No treatment was ordered. The child was seen on 8th January 1896, and the swelling had then increased. It was more lobulated. Subsequently the patient was admitted to the Westminster Hospital, and I divided the sterno-mastoid by the open method, at the same time removing a small portion of the indurated mass for microscopical examination. This showed a great excess of fibrous tissue between the muscle fibres, many of which were broken off short and embedded in cicatricial tissue. There was no excess of small round cells present. The case ultimately did well.

To sum up, then, the etiology of wry-neck. In my belief, a shortening takes place in the muscle before birth, due either to

FIG. 85.—"Ocular" torticollis from astigmatism (after Rédard).

FIG. 86.—Posterior view of the same patient as in Fig. 85.

malposition or congenital syphilis. The labour is lingering and the presentation is often "breech," or vertex requiring forceps; one case of wry-neck of mine presented a cephalhæmatoma as well. Traction may rupture or cause hæmorrhage into the substance of the shortened muscle, and shortening follows.

Spasmodic torticollis arises from many causes. The spasm is either tonic or clonic, or both kinds may be present. Frequently the spasm is chiefly on one side; in some cases it is equal on both sides, and when affecting the deep cervical muscles posteriorly is called retrocollic spasm. The causes are reflex irritation from enlarged glands, carious teeth, otorrhœa; excessive use of the muscles, as in "ocular torticollis" arising from astigmatism[1] (Figs. 85 and 86); and frequently repeated movements of the head, as in the case reported by Annandale[2] of a girl, aged 24, a weaver, who was obliged to move her head rapidly first to one side and then to the other, but especially to the left, and in her the spasm developed on the left side. Neurotic parentage, epilepsy, or facial spasm is met with sometimes in the families of those suffering from spasmodic wry-neck. A fall or blow, "habit spasm" (Gowers), malarial poison, are all indicated as causes; and sometimes it occurs in hysterical subjects, at others in perfectly healthy people.

Pathological Anatomy.—In *congenital* wry-neck Volkmann and Volbert found that in some cases no change was apparent in the muscles; in others the muscular substance had disappeared, and was replaced by fibrous tissue; while in a third variety there was fatty degeneration in the muscles, running through them in distinct bands. It is said that similar changes are found in cases of acquired torticollis, but this is denied by the best authorities. In the discussion at the Royal Medical and Chirurgical Society,[3] which succeeded Mr. D'Arcy Power's paper, "Mr. Thomas Smith pointed out that in other parts of the body rupture of a muscle was followed by lengthening rather than shortening, and he confessed his inability to understand how the retraction and cicatricial changes about the ruptured ends of the muscle fibres in the neck could shorten the muscle to less than its original length. Mr. R. W. Parker stated that in one case of congenital tumour of the sterno-mastoid at the Shadwell Hospital, in an infant 5 weeks old, he cut into one of these swellings and found nothing resembling blood. Mr. W. G. Spencer also referred to a case he had seen operated on by Volkmann of Halle, in which a hard tumour was dissected from the sterno-mastoid of a girl of 20 years of age, the subject of severe wry-neck. The anterior and posterior layers of the muscle-sheath had been converted into hard masses $\frac{1}{2}$ inch thick, with muscular fibres in the centre, while the general structure of the tumour was ordinary scar-tissue; the muscle fibre was healthy, and the strain of the injury appeared to have fallen upon the sheath before and behind." But a review of those cases in which inspections have been made are not entirely favourable to the theory of rupture

[1] Cf. cases reported by Bradford, *Trans. Amer. Orth. Assoc.* vol. i. p. 46; Lovett, *ibid.* vol. ii. p. 230; G. T. Stevens, *Archiv f. Ophthalmol.* 1887.

[2] *Lancet*, 1879, vol. i. p. 555.

[3] 24th Jan. 1893.

of the muscle fibre.[1] It is stated that the sternal head of the sterno-mastoid is more often affected than the clavicular, but occasionally both are shortened, although the outer part of the muscle is less so than the inner.

FIG. 87.—Torticollis of medium severity (after Rédard).

With the deviation of the head, there are also contractions of the fasciæ and alterations in the cervical spine. The intervertebral discs in old-standing cases are wedge-shaped, the bodies are ankylosed, the anterior common ligament has almost disappeared, and osteophytes are thrown out.[2] These changes result in lateral curvature in the cervical, with secondary curves in the dorsal region.[3] Witzel has observed asymmetry in the length of the clavicles. In long-standing cases the platysma, splenius, and scaleni are secondarily shortened, owing to the malposition of the head.

FIG. 88.—Very severe congenital torticollis in a young child. The asymmetry of the face is well seen (after Rédard).

The asymmetry of the face (Fig. 88), due to delayed development on the affected side, is very noticeable in many cases. On the side of the contraction the line joining the external angular process of the frontal bone with the angle of the mouth is less than on the other side. It may be as much as $\frac{3}{4}$ inch. The nose is also deviated from the sound side, and the cheek is less developed. These changes are present more often on the right side.

[1] Lüning and Schulthess have published the details of a very interesting *post-mortem* examination. The case was an infant of 5 months, delivered by the forceps, which showed at the time of birth a swelling at the middle part of the right sterno-mastoid. This was then shortened to the extent of $\frac{3}{8}$ inch. The cleido-mastoid portion of the muscle was *entirely* fibrous, with a separate insertion to the mastoid process. On the opposite side the two bundles of the muscles were fused together and the insertion normal. It was impossible in this case to admit contraction of the muscle secondary to traumatism. *Zeitschr. f. Orth. Chir.* 1891, Bd. i. Heft 1.

[2] Lane, *Guy's Hosp. Rep.* vol. xliii. p. 370.

[3] *Deutsche Zeitschr. f. Chir.* Bd. xviii. Hefte 5 and 6, p. 335.

I have heard Mr. Adams say that he has not been able to satisfy himself as to the non-development of one side of the face. He thinks it is only apparent and due to the deviation of the line joining the eyebrows and the obliquity of the nose. By careful measurement with suitable calipers, it is easy to satisfy oneself that the measurement is distinctly less.

The causes of the non-development have been variously assigned. Bouvier found in one case an unequal development of the carotids, those on the affected side being the smaller. Dubrueil[1] affirms that there is also unequal development of the cerebral hemispheres, with asymmetry of the skull. It is possible that impeded blood supply may cause retarded development on one side, but the matter is still in the region of speculation. Mr. Golding Bird's opinion is that both the wry-neck and the asymmetry are due to central nerve-lesions. These, however, have not been demonstrated, and the diminution or disappearance of the asymmetry when the cases are operated on early is against this supposition.

The pathology of the *spasmodic* form is obscure. Gowers says: "In no case has a lesion been found that can be regarded as an indication of the morbid process to which the spasm is due. The facts that many muscles are involved, and that when the spasm commences in a single muscle it usually spreads to others, make it probable that the muscular contractions depend on the over-action of the nerve cells, and not on any irritation of nerve fibres." In one case of mine at the Westminster Hospital the torticollis was undoubtedly due to the entanglement of the spinal accessory nerve in the scar-tissue, arising from the healing of suppurating cervical glands. I removed the scar-tissue and a portion of the spinal accessory nerve, and the deformity disappeared.

Symptoms.—It will be convenient now to indicate the normal action of the muscles implicated in the various forms of torticollis.

The *sterno-mastoid* inclines the head to the shoulder, rotates the face to the opposite side, and draws the chin forward and slightly elevates it.

The *trapezius*, the highest part of it, rotates the head to the opposite side, draws it backward, and inclines it strongly to the shoulder.

The *splenius* inclines the head and slightly rotates the face to the opposite shoulder. The trapezii and splenii, acting together on both sides, carry the head backward.

[1] *Éléments d'Orthopédie*, 1882.

The *complexus* extends the head, and rotates it to the opposite side.

The *scaleni* flex the head antero-posteriorly and laterally.

The combinations met with are—

1. The sterno-mastoid and trapezius of one side, if implicated, cause great inclination of the head to the same shoulder, and some rotation to the opposite side.

2. The sterno-mastoid of one side and the trapezius of the opposite side, acting in concert, cause much rotation of the head.

3. One sterno-mastoid and the opposite splenius cause extreme rotation of the head. Inasmuch as in wry-neck the head is never rotated to the side of the contracted muscles, it is assumed that the sterno-mastoid and splenius of the same side are not involved.

4. Both splenii acting together cause strong retraction of the head (retrocollic spasm). In the case of an elderly lady, who consulted me, if the head were at all raised from the chest, such violent action of the splenii took place, and the head was jerked so forcibly backwards, that she felt in danger of suffocation.

5. The sterno-mastoid, trapezius, and complexus turn the head to the opposite side.

6. The scaleni, splenius, levator anguli scapulæ, and platysma, if acting together, draw the head to the shoulder.

Bearing these points in mind, and assisted by palpation, there will not be great difficulty in ascertaining in which muscles the affection is seated.

The *symptoms* of the so-called *acute wry-neck* or stiff neck are sufficiently definite. The history of cold, of previous rheumatic attacks, the great tenderness and pain in the muscles, the rapid onset and the limitation of the stiffness mainly to the posterior muscles are characteristic points.

Congenital Wry-Neck presents the following *symptoms* :—

In all stages the sterno-mastoid is primarily at fault. In slight conditions it is seen in relief, and felt to be somewhat hard and indurated. Some limitation of movement is present. In severer cases the rotation of the face and lateral flexion of the head are pronounced.

The symptoms may be arranged thus :—

1. *The Deformity.*—The head is laterally flexed and the face is rotated[1] to the opposite side. The chin is raised and carried

[1] Rotation is greater when the clavicular part of the sterno-mastoid is affected. Generally the sternal part is the more rigid.

forward, especially when an attempt is made to extend the head. The lobule of the ear is therefore inclined to the shoulder, and a vertical line drawn from the tip of the lobule falls just inside the middle of the clavicle, instead of well outside. The shoulder of the affected side is raised, owing to the retraction of the sterno-mastoid, and later of other muscles, viz. the trapezius and levator anguli scapulæ. The clavicle is more curved.

2. On palpation, the affected muscles are hard, but not painful, and stand in relief.

3. Limitation of movement in advanced cases is great, and pain is caused by attempts to rectify the malposition.

4. *Asymmetry of the Face.*—The eyes are not on a level, nor

FIG. 89.—Congenital torticollis, showing asymmetry of the face (Florence A——, aged 3 years and 10 months. National Orthopædic Hospital).

FIG. 90.—The same case as in Fig. 89 after treatment.

are the angles of the mouth; the cheek of the affected side is less prominent, the nose appears smaller than normal, and it is oblique in direction and deviates to the affected side. The measurement from the external angular process of the frontal bone to the angle of the mouth is less on the affected side (Figs. 88 and 89). When the asymmetry of the face is slight, it is more readily observable on looking at the image of the patient's face in a mirror (Golding Bird). The cranium is said, on the authority of Dubreuil,[1] to be asymmetrical, and I have seen it so.[2] It takes the form of an oblique oval. The parietal eminence is more prominent and the frontal eminence less prominent on the affected side.

5. Cervico-dorsal scoliosis is present in advanced cases, the

[1] *Gaz. Hebd. des Sci. Med. de Montpellier*, 1886.
[2] As in Case 41.

convexity of the curve being on the unaffected side. A compensatory curve is often present in the dorsal region.

6. In severe cases deglutition is interfered with.

7. Strabismus does not often result from the deformity, as compensation is effected in the cervico-dorsal spine. Astigmatism, however, is a cause of torticollis.

8. The surface temperature is lower on the affected side to the extent of two to six tenths of a degree centigrade. This observation was first made by Broca, and has been repeatedly confirmed by Rédard.[1]

Spasmodic Wry-Neck.—The *symptoms* appear in the following order: first spasm, secondly pain. Spasm is gradual in its onset and intermittent in character, at one time greater, at another less, but in many cases increasing. It may remit at times and even cease, but only to reappear with increased force weeks or months later. It is greater when the patient is walking or excited, and ceases during rest. The pain is dull and aching, and when the spasm is most marked it is shooting or cramp-like. The muscles which are affected never waste nor show signs of degeneration. In fact they are, if anything, hypertrophied.

The position varies according to the muscles affected, and a glance at the description of the physiological action of single muscles and of muscles in combination will serve, with palpation, to identify them. In the more superficial muscles a distinct hardening can be felt.

Sometimes one muscle only is affected. Then it is in nearly all cases the sterno-mastoid, and rotation is a prominent feature. If the muscles on both sides are involved, the head is over-extended (retrocollic spasm). The muscles usually associated after a time with the sterno-mastoid are the trapezius of the same side in its upper part, the platysma myoides, and more rarely the splenius of the opposite side, or the scaleni, levator anguli scapulæ, and complexus of the same side. When both splenii are affected the retrocollic spasm is extreme.

The points of diagnosis in spasmodic torticollis are:—

1. The affection more often begins on the right side.

2. The sterno-mastoid is the first muscle to take on a spastic contraction, and thence the contraction extends to the deeper and posterior muscles of the same side and later to the opposite side, and even to the muscles of the face and arm.

[1] *Op. sup. cit.* p. 182.

3. Pains of various kinds are present.

4. The spasm may be tonic or clonic in character, and generally gets worse.

5. No wasting of the muscles is present.

6. No asymmetry of the face is developed.

7. Division of the sterno-mastoid is futile as a mode of treatment.

8. It very rarely, if ever, affects children.

The *prognosis* may be thus summed up. Some cases of spasmodic wry-neck increase up to a certain point, and then remain stationary. Slight contraction may never go beyond this point. Rarely the spasmodic form disappears spontaneously. In the congenital form, cure can be effected in the early stage, and the facial asymmetry disappears; in later stages much improvement can be obtained.

The *diagnosis* is not difficult in any case. The only source of error is cervical caries. The fixation of the head in every direction, the impossibility of moving it at all without causing pain, the persistence of the pain, and the presence of thickening around the cervical vertebræ are reliable distinctions. There ought to be no difficulty in deciding whether the case is one of congenital or spasmodic wry-neck. The real difficulties lie in ascertaining the cause of the spasmodic form, and sometimes which muscles are at fault.

The Treatment.—In deciding the lines on which treatment is to be placed, it is of course necessary to be fully acquainted with the cause, *e.g.* the acute or rheumatic form, and wry-neck arising from irritation of enlarged glands, and abscesses, which soon subside when the cause is removed. Fortunately, too, in that form in which there is most induration and fibroid change in the muscles, namely, the congenital wry-neck, we have in tenotomy a simple and very effective mode of cure.

Acute or rheumatic torticollis readily yields to hot fomentations, sprinkled with tincture of opium to relieve the pain, or the application of linimentum iodi or emplastrum cantharidis, together with the internal administration of sodii salicylat. gr. xv. every four hours for a day or two, and of a brisk purge. Rest of the parts is ensured by the attendant pain.

The treatment of congenital wry-neck is either manipulative, mechanical, or operative. But before commencing it is advisable to ascertain if astigmatism exist; if so, it must be properly corrected. If in young children congenital syphilis is present, mercury should be given in the form of pulv. hydrarg. cum creta gr. $\frac{1}{3}$ to $\frac{1}{2}$ thrice daily, and a $2\frac{1}{2}$ per cent strength of hydrargyri oleatis rubbed

PLATE III.

From a photograph of a case of congenital torticollis under the care of Mr. R. W. Murray of Liverpool, who has kindly allowed me to reproduce this and Plate IV.

PLATE IV.

The same patient as in Plate III. after treatment by Mr. Murray.

over the tense muscle. The case of Jane C——, No. 37, quoted on p. 189, is a successful instance of the relief of sterno-mastoid induration and slight wry-neck by these means.

Manipulative.—In young infants with slight deformity, the mother should be told to flex the head to the opposite shoulder and turn the chin to the same side several times daily, at the same time rubbing the skin over the affected muscle with some simple ointment such as lanolin, which prevents excoriation. These means will often serve to arrest an incipient wry-neck. As the child grows, a leather or poroplastic collar (Fig. 91) may be worn, to prevent any return of the deformity.

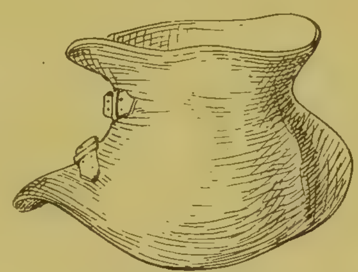


FIG. 91.—Cervical collar for use in the after-treatment of congenital torticollis. It is also of value in the treatment of cervical caries, when the occipital head-piece can be dispensed with.

Mechanical.—In view of the fact that in section of the sterno-mastoid there exists such a simple and efficient means of cure, the use of complicated apparatus alone is much to be deprecated. It very rarely, if ever, gives good results.

Operative.—The principles which should guide us in undertaking operative measures are:—

1. To completely divide the tendinous and fascial bands which prevent the restitution of the head. The method of "open section" has realised to a great extent the possibility of accomplishing these results.

2. After tenotomy to maintain the improved position by means of a simple apparatus, and such as does not interfere with daily manipulations.

3. The after-treatment must permit at the same time effective treatment of the deviations of the cervical vertebræ.

It must be admitted that tenotomy is not always followed by complete reduction of the deformity. This is especially apt to be so when the posterior cervical muscles are adaptively shortened and osseous, or fixed changes have taken place in the cervical vertebræ. It is stated that the best age to operate in torticollis is from 4 to 8 years of age. I should not, however, wait till so late, if the torticollis refused to yield to simple manipulation. Then the sooner tenotomy is done the better.

A short review of the anatomy of the parts will be of service in considering the merits of subcutaneous tenotomy of the sterno-mastoid and "open section." Division of the sterno-mastoid is usually done just above its insertion into the sternum and clavicle. Immediately behind the sternal head is the anterior jugular vein, arching outwards to join the external jugular vein. At the outer border of the clavicular head is the external jugular vein, which receives the suprascapular vein, transversalis colli vein, and a branch from the cephalic vein. The external jugular vein passes into the subclavian. In the triangular space between the two heads of insertion of the muscle there is a small branch of the suprascapular artery which is of no surgical importance. A knife introduced into the triangular interspace between the heads and slanting inwards, would wound the common carotid artery, and, slanting outwards, the internal jugular vein.[1] Behind the sterno-mastoid is externally a wall of deep cervical fascia, which separates the muscle from the great veins of the neck and marks off the site of operation from the deep cervical and mediastinal spaces; internally a layer of muscle, composed of the sterno-hyoid and omo-hyoid muscle and portions of the deep cervical fascia, limits the site of operation from the same dangerous regions in the neck and thorax.

Subcutaneous Section of the Sterno-mastoid.—Occasionally this has been done in the middle part of the muscle, but on account of the close proximity of the carotid sheath, it ought not to be attempted at this spot. The writer once did it in this place, but felt so impressed by his happy escape from trouble that he is not disposed to tempt fortune again. The muscle is divided generally at the lower end.

In some instances it appears necessary to divide the sternal head alone, as it is so very prominent, but experience teaches that when the sternal head has been divided the partial relaxation thereby produced merely serves to demonstrate that some of the malposition is due to the tension of the clavicular head. In most cases it is therefore necessary to divide both at one sitting to secure a good result.

The inferior attachment of the sterno-mastoid may be divided subcutaneously in the following manner:—The parts and instruments are duly asepticised, the operator stands on the right side in either case. If the right muscle be affected, he enters his knife from the outside, if on the left, from the inside, taking care in either case not to wound the external jugular vein. Some surgeons make

[1] A case is recorded of wounding of the internal jugular vein during the open incision. The vein was tied and the patient made a good recovery. Bradford and Lovett, *op. cit.* p. 707.

the incision through the skin with a sharp tenotome, and then pass a blunt tenotome inwards. The tendon may be divided by cutting on to it, or by passing the tenotome beneath the muscle and cutting towards the skin. The former plan is likely to lead one into difficulties by wounding the anterior jugular vein, and the latter, by transfixing the muscle, often leaves some fibres uncut, thereby necessitating a further operation. At the moment of section and when the edge of the tenotomy knife is turned towards the skin, the assistant, having previously relaxed the muscle, now makes it tense by carrying the head towards the opposite shoulder and rotating the face to the same side. The muscle is then carefully divided by saw-like movements of the tenotome. This is withdrawn and the puncture is closed by a piece of gauze soaked in collodion or strapped on with adhesive plaster.

The exact site of division should be $\frac{1}{2}$ to 1 inch above the clavicle. It is advised that the skin be drawn downwards over the clavicle, and transfixed there. The skin with the knife in it is then allowed to glide up over the clavicle, so that the site of section of the muscle is at the distance mentioned above the clavicle. The drawing downwards of the skin over the clavicle can only be necessary when section is made from the posterior margin, in order to avoid the external jugular vein. I have not, however, found it necessary, nor is it required in making the incision for ligation of the third part of the subclavian artery. It smacks of surgical "fetish." The old practice was to return the head to the position of deformity for four to five days, and then slowly commence the necessary extension. With this procedure, extended experience of the open method forces me to disagree.

The "Open" Method of Section of the Sterno-mastoid.—Careful antiseptic precautions are necessary in all particulars. The sterno-mastoid is placed on the stretch by the assistant; an incision is made across its lower attachment, the inner and outer borders of the muscle carefully defined, a director is passed beneath it, and the muscle divided from within outwards. It may equally well be divided by careful movements from without inwards. If any strong and tense bands of fascia are seen, they are severed at the same time. The hæmorrhage, which is generally slight, is then stopped, the wound dried, and the edges of the skin incision united by careful suturing. The head is then placed at once into the corrected position, and fixed either by a plaster of Paris arrangement or by strapping and bandages.

The advantages and disadvantages of the two methods are as follows:—

The advantages of the subcutaneous method are: (1) practically little or no scar is left; (2) there is less danger of suppuration.

Its disadvantages are: (1) it is often insufficient, as after section of the sternal head the clavicular head and bands of fascia come into prominence, and require more extensive and precise division. It can only be of value when the sternal head is small, well-defined, and can be isolated by the finger. (2) There is distinct danger of wounding the external jugular vein or its connections, with the possibility of entrance of air into veins. (3) On account of the fear of wounding the deeper structures the tendon may be transfixed, and the operation rendered useless. In the old septic days an open incision was, for obvious reasons, avoided.

The advantages of the open method are: (1) every step of the operation is seen and abnormal vessels are avoided; (2) complete division not only of the sterno-mastoid, but of tense fascial bands is possible, and the after-treatment is thereby shortened. Its only disadvantage is the resulting scar, but this will be very slight, and after the lapse of years quite unnoticeable if aseptic precautions are observed and the skin sutures carefully adjusted. For my part, I greatly prefer the open method for the patient's safety and my own comfort. To avoid scarring of the lower part of the neck in girls, it has been proposed to divide the muscle at its masto-occipital attachment.[1] The incision begins in the skin at the lobule of the ear, coasts close round behind the auricle, and follows the upper limit of the attachment of the sterno-mastoid beneath the hair.

Section of the sterno-mastoid by the open method is a very satisfactory operation, and gives good results, but it is necessarily limited in its application. It will not entirely reduce the deformity if many other muscles are secondarily shortened, or when fixation of the spine is present.

It has been proposed to remedy the shortening of the posterior cervical muscles, which are too deep and numerous to be tenotomised, by forcible manipulations of the head under an anæsthetic. Bradford and Lovett say: "In correcting this deformity the patient should be thoroughly anæsthetised, and an assistant should firmly hold the shoulders, while the patient should be drawn up so that the head projects beyond the end of the operating table. The head should

[1] Phelps, *N. Y. Med. Rec.* 4th Aug. 1894, p. 146.

be held by the hands and rotated in all directions, considerable force being used." On the authority of these writers, we read that "the danger of fracturing the spine is in such cases of course so slight as to be disregarded, and the deformity can be over-corrected."[1]

After-Treatment.—The plan of treatment I have adopted, after first seeing it employed by Mr. Longworth Wainwright at the Evelina Hospital, is as follows. The wound is dressed, and the head is put into the over-corrected position. It is then fixed by the following arrangement of plaster of Paris. A piece of house-flannel is cut of such a shape as to cover the back down to the crests of the ilia, the posterior aspect and sides of the neck, and the vertex and side of the head, and reaching over the forehead to just above the supraorbital ridges. This is placed in moist plaster of Paris and quickly adjusted to the back, neck, and head in the over-corrected position, a flannel bandage having been previously placed on the parts to be covered with the plaster. A strip of flannel of sufficient width, which has just been removed from the plaster of Paris, is then passed round the neck, thus ensuring a correct fit of the first piece here, and further acting as a collar for the support of the head in its new position. While this is being done an assistant passes an ordinary roller bandage round the chest and abdomen, to keep the large piece of flannel in position, and to adjust it accurately. The whole is left undisturbed for ten to fourteen days, and the patient is then sent out with a plaster of Paris collar. It is well to divide this anteriorly, and to lace it so that it may be taken off, and daily movements of active and passive manipulation practised. The collar should be worn for four to six months. A more comfortable form of collar is one made of leather or poroplastic material (Fig. 91), and taking its bearings from the thorax and shoulders. In place of plaster of Paris, silicate bandages are used.

FIG. 92.—Sayre's arrangement for elastic traction after operation for congenital torticollis.

[1] This is the method advocated also by Lorenz, *Wiener Med. Presse*, 19th Feb. 1893. He reports twelve cases treated in this way, and all have been completely cured.

Levrat[1] employs the following method after open section: "The head being enveloped in cotton wool, a silicated bandage is wound horizontally around it at the level of the forehead, and a similar bandage vertically over the crown and under the jaw. Where these bandages meet at the level of the mastoid process on the sound side, a small hook with the concavity looking upwards is inserted. Another silicated bandage is wound round the body below the axillæ, and through the thickness of the bandage a hook is inserted in the middle line in front, having its concavity looking downwards. When the bandages have dried, the two hooks are connected by a band of rubber, which assists the sterno-mastoid of the sound side to keep up a continuous traction, and so correct the deformity. The apparatus and dressing are left untouched for fifteen days." Patients who are old and intelligent enough to assist in their own cure, may be treated after Mr. Owen's plan on the following lines: "Open section is performed, and sand-bags afterwards placed on either side of the head to keep it in good position. As soon as the wound is healed, and the patient can get up, he is directed to walk about with a bag of shot in the hand of the contracted side, and told to carry his head to the opposite side many times a day, practising in front of a mirror. At night he is advised to sleep on the affected side, with the head raised on the pillow. In addition, passive manipulation is of great value, the movements always aiming at the widest possible separation between the mastoid process and the affected side." By these means both the sterno-mastoid and the other shortened structures are stretched in a way that appears to me safer than the forcible plan combined with the tenotomy, which is recommended by Lorenz, Bradford and Lovett. The less forcible measures suffice to restore the neck to its proper line, unless the operation has been delayed to an advanced age, *i.e.* twenty years and upwards, and even in these a great improvement may be effected.

As mentioned above, the asymmetry of the face cannot be remedied although it may disappear, and the later the operation is performed, the more marked is the facial deformity which persists.

Those who prefer the more gradual methods of instrumental correction will find Mr. Adams' wry-neck apparatus of service (Fig. 93). It is complicated and expensive, but it is exact, and can be so made that a spinal instrument with spring plate and laced shield may be fitted to correct any lateral curvature.

[1] *Lancet*, 24th Nov. 1888.

The Treatment of Spasmodic Wry-Neck. Non-operative.—In some instances complete mental and physical rest will be followed by subsidence of the spasm, and the pain may be relieved by hot applications or blisters. In other instances nerve tonics such as valerianate of zinc or asafœtida are useful. Sedatives, as succus conii, chloral hydrate, bromide of potassium, give relief. The best of all is subcutaneous injection of morphia, but the evident danger of contracting the morphia habit should militate strongly against its use. Occasionally with one or other of these means the spasms will subside. A weak constant current often relaxes the spasm, and if there is much pain from the distorted position of the head a rigid support may be ordered.

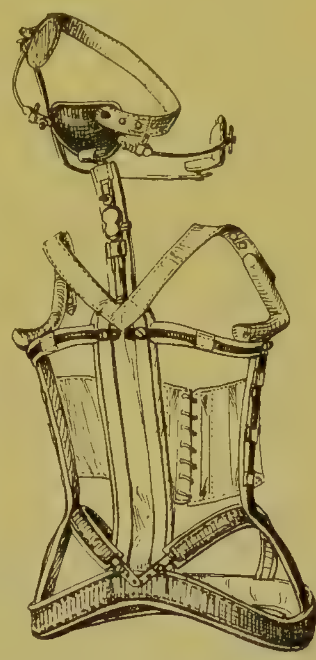


FIG. 93.—Mr. Adams' wry-neck apparatus.

Operative.—Myotomy of the affected muscles is found to be useless. There remain then stretching, division, resection or ligation of the spinal accessory nerve, with or without resection of the posterior divisions of the cervical nerves.

Operative interference is called for—

1. When treatment by drugs, galvanism, and supports has failed.

2. When the spasm is increasing.

3. When it is such as to prevent the patient from attending to his business.

4. If there is much difficulty in deglutition.

Resection of the posterior divisions of the cervical nerves is called for when retrocollic spasm is present and division of the spinal accessory fails to relieve it. Stretching of the spinal accessory nerve does not appear in the few cases in which it has been done to have been followed by successful results, and the same remark applies to division of the nerve. Mayo Collier claims to have obtained success by ligation of the nerve.[1]

Excision of a portion of the spinal accessory nerve is that operation which has given the best results. The nerve may be resected

[1] For a *résumé* of the literature of this subject up to 1891 a *brochure* by Noble Smith may be consulted—*Spasmodic Wry-neck:* Elder and Co. Since then the following papers have appeared :—

Petit, *Revue d'Orthopédie*, July 1891. An analysis of 26 cases operated on by the at the anterior or the posterior border of the sterno-mastoid. Although the operation is more difficult at the anterior border, yet it is preferable to do it there, since it is at that spot a single nerve-trunk, and has not broken up into its divisions, nor can it be confounded with other nerves. At the posterior border other nerves issue, viz. the small occipital, posterior auricular and superficial cervical. The steps of the operation are as follows:—The patient lying with the head turned to the opposite side and the parts having been shaved and rendered aseptic, an incision 3 inches in length, commencing at the tip of the mastoid process, is made along the anterior border of the sterno-mastoid. If the external jugular vein comes in the way, it should be divided and tied. The anterior border of the sterno-mastoid is defined and drawn backwards. With a little dissection the posterior belly of the digastric muscle and the occipital artery come into view. These, together with the prominent internal jugular vein, serve as guides to the nerve, which runs vertically and enters the muscle one inch below the tip of the mastoid process. From a quarter to half an inch of the nerve should be excised.

If the nerve is divided at the posterior border of the sterno-mastoid, it can be found almost at the middle point of that border. It is traced forward in the substance of the muscle until it is seen to divide into its branches for the sterno-mastoid and trapezius. About half an inch of the nerve is excised in front of that spot.

Immediately the nerve is resected the sterno-mastoid and trapezius are paralysed; but the head does not become straight at once, owing to the shortening which has taken place in other muscles. It is necessary to use an artificial muscle on the lines laid down on p. 204, and to resort to passive movements of the head daily for a period of three to four months. Although successful in some cases, especially in those in which the spasm is tonic in its nature

author. Excision of a portion of the nerve was followed by perfect success in 13, much improvement in 7, slight improvement in 2, temporary benefit in 3, and 1 died of phlegmonous erysipelas.

Appleyard, "Spasmodic Wry-neck," *Lancet*, 18th June 1892; also E. Owen on the same subject, *ibid.*

Pearce Gould, "A Case treated by Avulsion of the Spinal Accessory Nerve," *ibid.*; Noble Smith, *ibid.*

Keen, "A New Operation for Spasmodic Wry-neck. Division or Exsection of the Nerves supplying the posterior rotator Muscles of the Head," *Annals Surg.* vol. xiii. p. 44.

Gardner and Giles, "Neurectomy in Spasmodic Torticollis and Retrocollic Spasm or Torticolis Postèrieur," *Australian Med. Journal*, 1893.

and confined to the sterno-mastoid, yet resection fails to cure those cases in which retrocollic spasm is present.

It then becomes necessary to divide the posterior branches of the cervical nerves. This operation appears to have been devised and carried out for the first time in 1888 by my friend Dr. Gardner, then of Adelaide and now of Melbourne, and to have been closely followed independently by Dr. Keen of Philadelphia in 1889. Noble Smith has operated successfully on three occasions in this manner. Keen[1] gives full directions as to the mode of finding the nerves, but his description is characterised by Gardner[2] as unnecessarily complicated.

The resection of the spinal accessory nerve should precede by a considerable interval the difficult operation on the cervical nerves, because, firstly, the less operation has been known to be successful even in cases in which movements occurred in muscles not supplied by the spinal accessory nerve, and, secondly, the trapezius being completely paralysed after division of the spinal accessory, time is also given for a more complete study of the muscles involved in the spasm, and in this way unnecessary operations, with their risks and resulting scars, may be avoided.

The paralysis which follows section of the spinal accessory and cervical nerves is of no moment.

[1] *Loc. sup. cit.*

[2] This writer suggests the following points as of service :—

(*a*) The incision should be made at a level of half an inch below the lobule of the ear, commencing at the middle line, and carried transversely outwards for 3 inches, and a small vertical incision let downwards between the edge of the trapezius and posterior border of the sterno-mastoid.

(*b*) Define clearly the sub-occipital triangle.

(*c*) The first nerve will be found crossing it ; the second will be seen outside the triangle below the inferior oblique, and the third an inch lower down the neck than that muscle.

CHAPTER II

DEFORMITIES OF THE THORAX

Congenital Deformities of the Chest, affecting the Sternum, Ribs, and Cartilages—Acquired Deformities arising from Rhachitis, Adenoids, and Spinal Distortions.

THE deformities of the thorax are either congenital or acquired.

The Congenital Deformities are seldom seen. They consist of cleft sternum, absent sternum, or deficiency in the number of the ribs. A peculiar form of congenital deformity of the sternum is a funnel-shaped depression, situated not at the xiphoid cartilage, as in cobblers, but extending over nearly the whole sternum, and bounded by the ribs on either side, by the abdominal wall below, and the upper part of the sternum above (Fig. 94). This was described particularly by Ebstein and Zuckerkandl. The latter thought it to be due to the pressure of the inferior maxilla on the gladiolus during fœtal life. It is said to be not only congenital but hereditary.

FIG. 94.—Congenital funnel-shaped deformity of the chest (after Rédard).

Dr. I. S. Haynes [1] classifies the congenital deformities under the headings of deformities of the sternum, ribs, cartilages, and any one or all three parts may be involved. The deformity in the *sternum* consists of holes, varying in size from a pinhole to openings ½ inch in diameter. Less often the sternum is nearly or entirely cleft throughout its length. Examples of the latter condition are recorded by Dr. Thomas Sinclair [2] and Dr. E. H. Martin.[3]

[1] *Amer. Med. Surg. Bull.* 15th Nov. 1894, p. 1356.
[2] *Dublin Journ. Med. Science*, 1887, p. 557.   [3] *N. Y. Med. Rec.* 24th Sept. 1887.

Variation in the Ribs.—Abnormalities consist either of an additional cervical or lumbar rib, or of deficiencies of the ribs themselves, or there may be fusion of two ribs, usually the first and second, to form the so-called bicipital rib.

Variation in the Cartilages.—According to Otto,[1] "the attachment of the front end of the ribs is deficient, inasmuch as they are either not connected with their cartilages or they are not connected by them to the breast-bone, or the cartilages are entirely deficient."[2]

The treatment of these cases of cleft sternum or extensive deficiency of the ribs and cartilages should be to protect the important structures beneath, and at the same time to adjust an apparatus so that it serves to prevent the lateral curvature, which is apt to follow on in adult life.

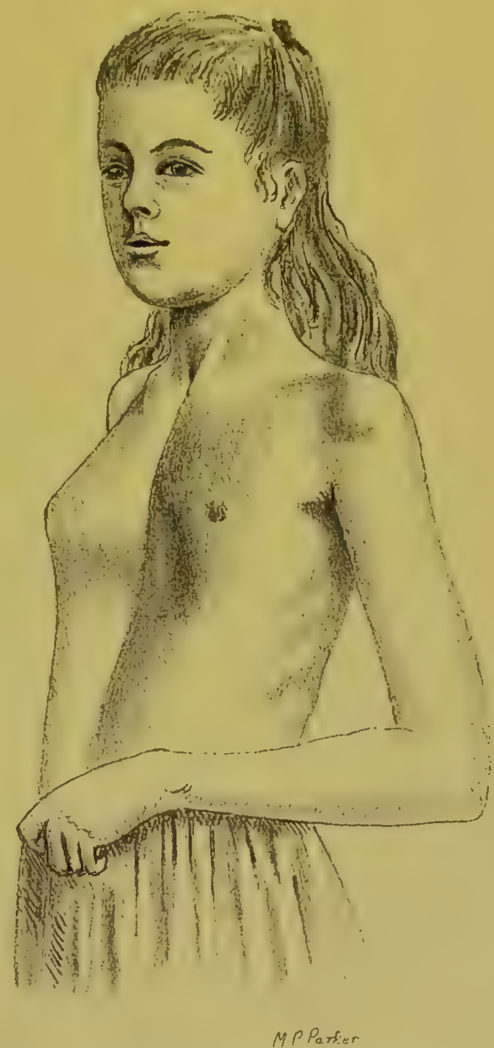


FIG. 95.—Congenital depression of the sternum, from a patient aged 12 years.

Acquired Deformities of the thorax follow two principal types: "pigeon-breast" and the excavated or depressed sternum, such as occurs in cobblers.

The most common form is "pigeon-breast" arising from rickets. In a severe case of rickets the sternum is unusually prominent, the ribs bend sharply at their angles, the costal ends of the ribs are beaded, the thorax is diminished in measurement from side to side and increased antero-posteriorly if the decubitus is lateral, but the reverse if it is constantly dorsal. There may be seen three distinct grooves, two vertical, one being at the junction of the ribs and costal

[1] Quoted by Bennett, *Trans. Acad. Med. of Ireland*, 1883, vol. i. p. 163.
[2] Cf. Osborne, *Archives of Pædiatrics*, vol. viii. p. 346.

cartilages, and the other in the mid-axillary line; the third groove is oblique about the level of the ensiform cartilage. The latter is probably produced by the pull of the diaphragm in inspiration on the weakened ribs; while the vertical grooves arise, the anterior from the sinking in of the ribs at that weak spot, the junction of the bone and cartilage, and the lateral from the pressure of the arms on the softened ribs. The alteration in the shape of the chest is due to the external pressure on the chest walls. Rhachitis is frequently associated with spasmodic croup, and the chest deformity is noticeably worse after each attack. Sir William Jenner has pointed out that in rickets the aperture of the glottis is not sufficiently large to permit air to enter the thorax so rapidly as it expands by the action of the inspiratory muscles. Barlow,[1] speaking of scurvy-rickets, states: "During the development of this disease the sternum, with the adjacent costal cartilage and a small portion of the contiguous ribs, seems to have sunk bodily back *en bloc*, as though it had been subjected to some violence which had fractured several ribs in front and driven them back. This curious appear-

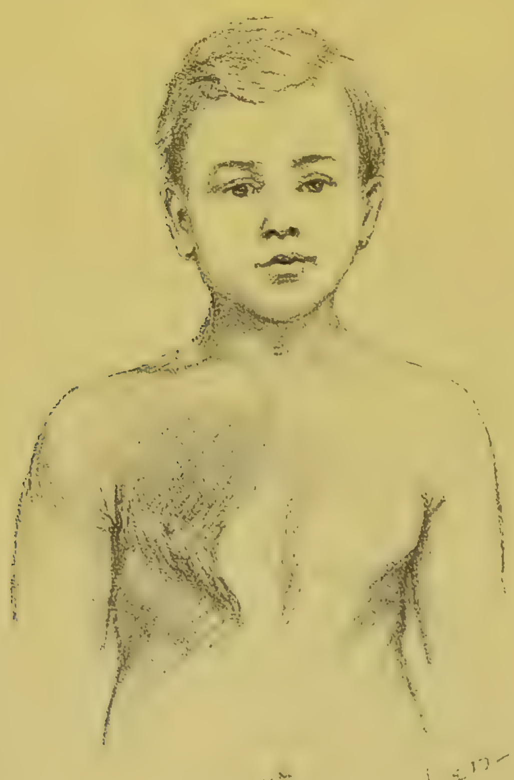


FIG. 96.
Front view of a ricketty chest.

FIG. 97.—Semi-lateral view of the same chest as in Fig. 96.

[1] Bradshaw Lecture, "Infantile Scurvy and Rickets," *Brit. Med. Journ.* 10th Nov. 1894.

ance, taken in conjunction with the sub-periosteal and other haemorrhages, is said to be diagnostic of the disease."

Another form of "pigeon-breast" is that produced by obstruction to the ready entrance of air. The obstruction arises from adenoids, enlarged tonsils, nasal polypi, and chronic rhinitis. The accompanying Figs. 98-101 are taken from cases of adenoids which have come under my notice at the Evelina Hospital. The characteristic deformity is well seen. The chest is bulging at its upper and middle

FIG. 98.—Front view of chest deformity due to adenoids of the naso-pharynx.

FIG. 99.—Side view of the same.

part, and retracted in its lower part and excavated. The sternum is not so keel-like as in rickets, and the lateral vertical grooves are absent. The antero-posterior diameter is increased, while the transverse is diminished. The origin of the deformity is, doubtless, the constant sucking in of the lower part of the chest. Unlike the pigeon-breast of rickets, this develops not in infancy, but in adolescents, and that slowly.

The sequence of events, nasal and post-nasal obstruction, deformed chest, kyphosis, and scoliosis, has been dwelt upon already. The proof of their interdependence is in the results of treatment; removal of the obstruction is followed by rapid improvement in the thoracic and spinal deformities.

Other causes of an abnormal shape of the thorax are empyema,

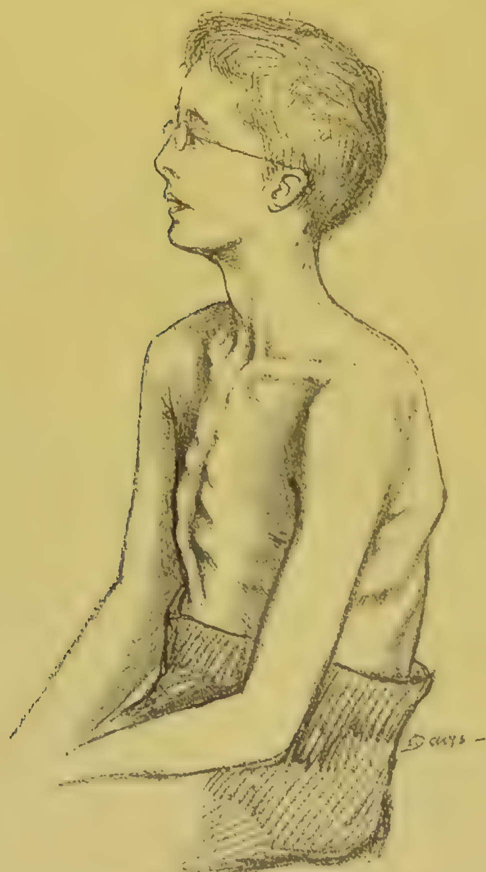


FIG. 100.—"Pigeon-breast" arising from adenoids (Sidney X——, aged 11 years, Evelina Hospital).

FIG. 101.—An extreme condition of "pigeon-breast" due to naso-pharyngeal obstruction.

Pott's disease and scoliosis (p. 138), and certain occupations such as cobbling.

The treatment of thoracic deformities consists in attacking the prime causes. Ricketty children require the special treatment for that disease, and later, if the chest remain ill developed, they should be encouraged to take full and deep inspirations many times a day, to exercise the arms, to run about freely in the open air, and the more they shout the better for their chests. To be taught to sing is perhaps the best indoor exercise.

Pigeon-breast deformity arising from adenoids is readily improved or cured by their removal. In all cases of malformed chest the wearing of corsets is to be avoided, and no apparatus for pressing the sternum into position should be used. Rhachitic cases usually right themselves as the child increases in health and strength, and adenoid cases soon improve if attended to. Scoliotic and kyphotic cases of chest deformity are best let alone.

CHAPTER III

CONGENITAL DEFORMITIES OF THE HAND AND FINGERS

Club-hand—Congenital Contraction of the Fingers—Supernumerary Fingers—Suppression of the Fingers—Webbed Fingers—Hypertrophy of the Fingers—Congenital Lateral Deviation of the Fingers—Congenital Furrowing of the Limbs.

CLUB-HAND

Synonyms—French, *Main bote*; German, *Klumphand.*

Definition.—A congenital deformity of the upper extremity in which the hand is unduly deflected from the forearm.

Frequency.—Reeves states that at the Royal Orthopædic Hospital about three cases of the deformity, generally associated with some other malformations, are seen annually. During the past five years, at the National Orthopædic Hospital, at my out-patient clinic, I have met with four cases, one of which is figured below. Several instances have, I believe, come under the notice of my colleagues, but I do not think as many as three in a year.

In his article on "Congenital Absence of the Radii," with which club-hand is usually associated, M'Curdy[1] quotes Kronig,[2] who remarks: "There are forty-five recorded cases of congenital absence of the radius, and in twenty-one the defect was bilateral. In only two were the thumb and metacarpal bones well developed. In the great majority of cases the child was both premature and still-born, and seldom lived many weeks. Nearly always other defects were present in other parts of the body." Dr. M'Curdy writes: "Dr. L. H. Sayre[3] reports one case, and Dr. A. E. Taylor has given me a report of one case by letter." Rufus A. Collins[4] records a case of club-hand and foot. Dr. Lewis Sayre describes the appearance and treatment of a

[1] *Annals of Surg.* Jan. 1896, pp. 44-47.

[2] *Brit. Med. Journ.* 10th March 1894.

[3] *Trans. Amer. Orth. Assoc.* vol. vi.; and *N. Y. Med. Journ.* vol. lviii. No. 19.

[4] *Chicago Clin. Review*, October 1894.

case in his work on *Orthopedic Surgery*. Malgaigne describes three specimens which exist in the Musée Dupuytren. Compared therefore with club-foot, club-hand may be looked upon as rare.

Forms of Club-Hand.—For so unusual a deformity the classification given is somewhat cumbrous. But as the forms of affection are many, some arrangement must be adopted. The hand may deviate either to the outer or inner border of the forearm, and be in a position of flexion or extension. Hence we have radial and ulnar club-hand, and palmar and dorsal club-hand. But it is not often that the deformity is so simple, and mixed deviations occur, so that radio-palmar, radio-dorsal, ulnar-palmar, and ulnar-dorsal are the forms met with.

FIG. 102.—Club-hand of the radio-palmar form, with partial absence of the radius and entire absence of the first metacarpal bone and thumb (after Rédard).

Morphologically the cases may be grouped thus :—

1. The skeleton is complete and well formed. Cases of the ulnar-palmar form belong to this class. The malformation consists in a modification of the relations of the articular surfaces, and in an abnormal inclination of them.

2. The skeleton is complete, but various deformities are found. The radius is often shortened and the carpal bones atrophied. This is the most usual variety.

3. The skeleton is incomplete and deformed. The radio-palmar varieties are generally of this group. There is frequently an absence of one or more bones of the carpus, metacarpus, or of one of the bones of the forearm. When the radius is absent the ulna is shortened, increased in size, much curved, and the lower epiphysis considerably altered. The carpal articulation is abnormal, and there exist in it numerous fibrous bands and tendons, which are not in any way related to the normal structures. Frequently other irregularities are present in the body, such as absence of certain groups of muscles, or vascular and nerve defects.

CASE 42. *Congenital Club-Hand of Radio-Palmar Variety.*—E. J., male, aged 1 month, was brought to me at the National Orthopædic Hospital in 1895. He was the second child, and, so far as can be ascertained, no deformities have occurred in his relatives on either side of the family. The right hand and forearm were deformed. The malformation was of the radial-palmar variety. The shaft of the radius was certainly absent, the upper epiphysis being felt, while some doubt existed as to presence of the lower, since the mass of bone felt in that situation might have been the enlarged lower end of the ulna. The first metacarpal bone was absent, and the thumb hung by a loose band of tissue. The ulna was much curved (Fig. 103). In other respects the child was quite normal.

By way of treatment, a malleable iron splint was placed on the ulnar border of the forearm, and the excessive curvature was gradually reduced. Later it is proposed to form a false joint between the base of the first phalanx of the thumb and the second metacarpal bone.

Fig. 103.—Radio-palmar variety of club-hand, with partial absence of radius and complete suppression of the first metacarpal bone, illustrating Case 42 before treatment.

Fig. 104.—Illustrating the condition in Case 42 after treatment (see text).

Etiology.—With reference to this point, less evidence is forthcoming than in the case of congenital club-foot. Speculation may be hazarded that the deformity is due to malposition *in utero*. It is not possible to understand how that, according to Guérin, a nerve lesion *in utero* can be a direct cause of absence of the radius.

Symptoms.—In the palmar cases the hand forms with the forearm a more or less acute angle, open anteriorly. The lower end of the radius is prominent posteriorly, and the carpus articulates with the anterior surface of the radius. There is generally some degree of mobility of the hand on the forearm. The electrical reactions of the muscles show them to be either partially paralysed or atrophied. The forearm is small and wasted, owing to the shrinkage of muscles and to the absence of the radius.

Treatment.—The means which are adopted to alleviate the deformity are passive movements, massage, the use of retentive apparatus, tenotomy, and operations on the bones.

Passive movements and massage are of service only when the patient is very young. But they are valuable in that they prevent aggravation of the deformity by contraction of the tendons on the concave aspect of the wrist. Various apparatus have been devised with the objects of arresting increase of the malformation and to render the hand useful. But they are not very satisfactory, and the patient can use his hand in many cases to better purpose unfettered by any contrivance.

Tenotomy is advocated by Mr. Reeves, and that writer is at considerable pains to indicate the tendons which should be cut in the various forms. Suffice it to say that those which interfere with the placing of the hand in a right line with the forearm should be divided. He gives hints as to the best means of avoiding important nerves and vessels in their altered relations. In any case, if tenotomy is performed, it should be carried out at the wrist and not at the fingers, for the reason that, if done in the latter position, loss of movement is likely to follow. That complete success can be attained in cases of *acquired* club-hand by division of the tendons of the wrist, has been shown elsewhere (p. 243).

Operative Measures on the Bones.—Bardenheuer,[1] in those cases in which the development is suppressed, replaces the defect, at least in its lower part, with bone, and claims to permanently correct the deformed position of the hand. The details of the operation are as follows: "By a longitudinal incision the distal end of the ulna and the carpus are exposed, and the former isolated from its attachments. The ulna is then split through its middle into a radial and ulnar section. These are separated by allowing the carpal bones to come up between them. By means of an ivory peg through each side, the ends are fixed to the carpus." A plaster bandage is put on and left for four weeks. This operation has been done by Bardenheuer

[1] Quoted by Rincheval in his paper on the "Treatment of Congenital Bone Defects in the Forearm and Leg." An abstract appears in the *Annals of Surgery*, February 1895.

twice for congenital absence of the radii, in an 18 months old child and in a baby of 7 months. The results in both cases were good. The deformity was permanently corrected and the mobility of the hand was about normal. In one of the cases there was a very pronounced growth of the deformed extremity a year after the operation. Dr. Leroy M'Curdy,[1] finding Bardenheuer's operation impossible, on account of the shortening of the soft structures, which rendered futile any attempt to shift the end of the ulna across to the centre of the carpus, except by a virtual amputation of the arm, performed the following operation in the case of a female infant aged 5 months: "The ulna was severed at a point where the free end of the upper fragment could be brought to the semilunar bone. The case was of the palmar variety. An incision was made obliquely across the forearm, beginning upon the dorsum and passing upward and around to the flexor aspect, the object being to allow the structures to slide upon each other, and then be sutured in the corrected position, thus avoiding the gap that would otherwise be left after a cross section. The tendons on the radial side were tenotomised, the ulna divided at the point mentioned above, the semilunar connected and drilled, and after drilling the ulna, these bones were adjusted with silkworm gut. Considerable hæmorrhage ensued, and several arteries required ligation. The arm was put up in plaster and the wound healed by first intention." Dr. M'Curdy gives figures illustrating his case before and after operation, and the result appears to have been most successful.

Congenital Contraction of Fingers

This deformity is quite distinct from contraction of the palmar fascia, Dupuytren's contraction, and should not be confounded with it.

In infants and children it occasionally happens that the little finger on both hands is found to be flexed. Generally the affection is limited to the fifth finger, but at times the ring finger, and even all the fingers, are contracted. Three figures are here given showing congenital contraction of the little, little and ring fingers, and all the fingers (Figs. 105 to 108). They are taken, one from a case seen at the National Orthopædic Hospital, one at the Evelina Hospital, and one from a private case. The affection in question is not only congenital, but is also hereditary. Still more, it is frequently

[1] *Annals of Surgery*, January 1896.

associated with congenital hammer-toe, and in that event the second toe is often affected in both feet. Some congenital contraction of the little finger is not at all uncommon, and it is only when it increases that it comes under the notice of the surgeon.

FIG. 105.—Congenital contraction of the little finger of the left hand in a girl aged 15 years.

FIG. 106.—A similar deformity in the right hand in the same patient as in Fig. 105.

According to Mr. Adams,[1] congenital contraction is observed chiefly in girls, and my own observations agree with this. But this writer states that "no deviation is observed in the little finger at the period of birth." On this point it is permissible to differ from Mr. Adams. In the case which is shown in Fig. 110 the infant was 2 months old.

Mr. Adams divides the affection into *three stages*. In the *first* stage there are observable some flexion of the second and third phalanges of the little finger, and some inclination of these phalanges outwards towards the median line of the hand. No

[1] *Contraction of the Fingers and Hammer-Toe*, 2nd ed. Churchill, London, p. 96.

contracted bands of fasciæ can be felt, nor is there any shortening of the skin on the palmar aspect of the fingers. The flexed phalanges can in many cases be restored by gentle manipulations, but they drop again as soon as the extending force is removed.

In the *second* stage the flexion of the second and third phalanges is increased and permanent, and the first phalanx is hyper-extended. Any attempt to straighten the finger is resisted by the contracted skin and fascia, and by the shortened lateral ligaments of the articulations.[1] This stage is reached about the seventh to the tenth year.

FIG. 107.—Congenital contraction of the ring and little fingers in a boy aged 5 years. The palm is seen to be entirely free from contraction.

In the *third* stage, not only is the deformity aggravated in the finger originally affected, but the remaining fingers begin to contract, although the palmar fascia is never involved as in Dupuytren's contraction. In the congenital form, according to Adams, a central longitudinal band of contracted fascia makes its appearance on the flexor aspect of the phalanges. This longitudinal band is not a thickening of the digital prolongations of the palmar fascia, which are situated more on the lateral aspect of the phalanges. Occasionally in the third stage the third phalanges are hyper-extended instead of flexed.

With reference to the etiology, but little is known beyond the facts that the affection is both congenital and hereditary. As to its pathology, the one account of a dissection which I have come across is that by Mr. C. B. Lockwood,[2] who states that "the band in question consisted of a thickening of the digital fascia opposite

[1] Mr. William Anderson, in his "Lectures on Contraction of the Fingers and Toes," *Lancet*, July 1891, expresses the opinion that the chief agent in causation is an insufficient growth of the lateral ligaments of the interphalangeal joints, their growth not being *pari passu* with that of the bones.

[2] *Path. Soc. Trans.* 1886.

the flexor aspect of the proximal interphalangeal joint. Except that it was thickened and shortened, the fascia was perfectly natural."

Diagnosis.—1. From Dupuytren's contraction. The following table gives the distinctive points :—

	Congenital Contraction.	Dupuytren's Contraction.
Age of onset . .	Infancy and childhood.	Adult life.
Sex	More often female.	More often male.
Point of origin . .	Fascia of fingers.	Fascia of palm.
Parts affected in fingers	Central portion of palmar prolongation.	Lateral portion of palmar prolongation.
Position of phalanges .	First is hyper-extended, second and third flexed.	First and second flexed, third generally extended.

2. From acquired contractions of the fingers other than Dupuytren's. This is generally made clear by a history of injury, or of suppuration, or of some nerve lesion. Occasionally scars will be found about the forearms, wrists, and fingers.

Treatment.—In the first stage it is sufficient to straighten the affected fingers by frequent passive movements, and to buckle a small malleable iron splint to the back of the hand and to the finger, so that the latter is retained in the extended position. The splint should be removed three times daily and the fingers passively exercised. As a rule, this treatment removes the slight deformity. But occasionally, even in infants, the contraction has advanced so far that passive movement fails to fully restore the position, and it is necessary then to divide the shortened bands of fascia. This was done by me in the following case :—

CASE 43. *Congenital Contraction of Fingers, Operation, Cure.*—Mrs. H—— consulted me in 1893 with reference to the condition of her child's hand. The abnormal condition of the fingers was noticed shortly after birth, and had increased since. The baby was 2 months old.

The fourth and fifth fingers of the right hand were flexed at the first and second interphalangeal joints, and a distinct thickening of the

FIG. 108.—Contraction of the hand said to have existed from birth.

FIG. 109.—Front view of the hand in Fig. 108 after section of all the flexor tendons at the wrist. Good movement of the fingers was obtained.

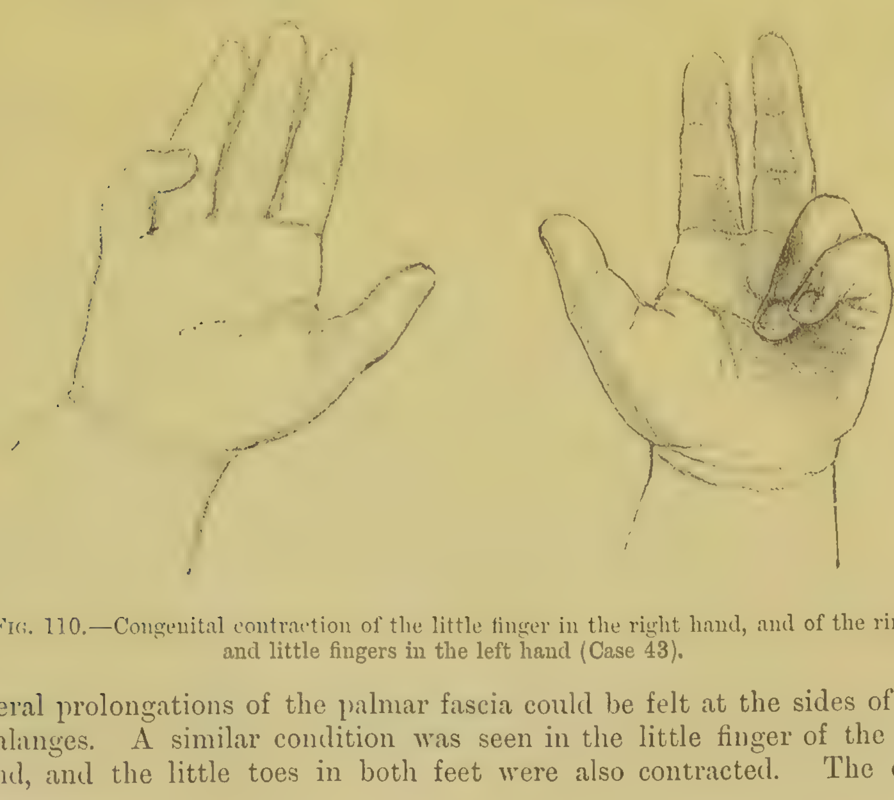


FIG. 110.—Congenital contraction of the little finger in the right hand, and of the ring and little fingers in the left hand (Case 43).

lateral prolongations of the palmar fascia could be felt at the sides of the phalanges. A similar condition was seen in the little finger of the left hand, and the little toes in both feet were also contracted. The contracted bands of fascia in the hands were divided, and a malleable iron splint was applied. This was removed every night and the fingers were manipulated. The contraction was thus completely overcome (Fig. 112).

In the second and third stages, the fascial bands which are seen and felt to be prominent should be divided and the finger put up in a small malleable iron splint in as full extension as possible. In performing this little operation, the fascia knife should be passed between the skin and the band; and the latter should be cut transversely. At the same time it is well to turn the knife on to the flat and pass it for a short distance up and down between the skin and fascia, thus severing the fine processes which pass into the skin. As a rule about three punctures are required to each phalanx.

Fig. 111.—A view of the left hand in Case 43 showing the hyper-extension of the first phalanges in congenital contraction of the fingers.

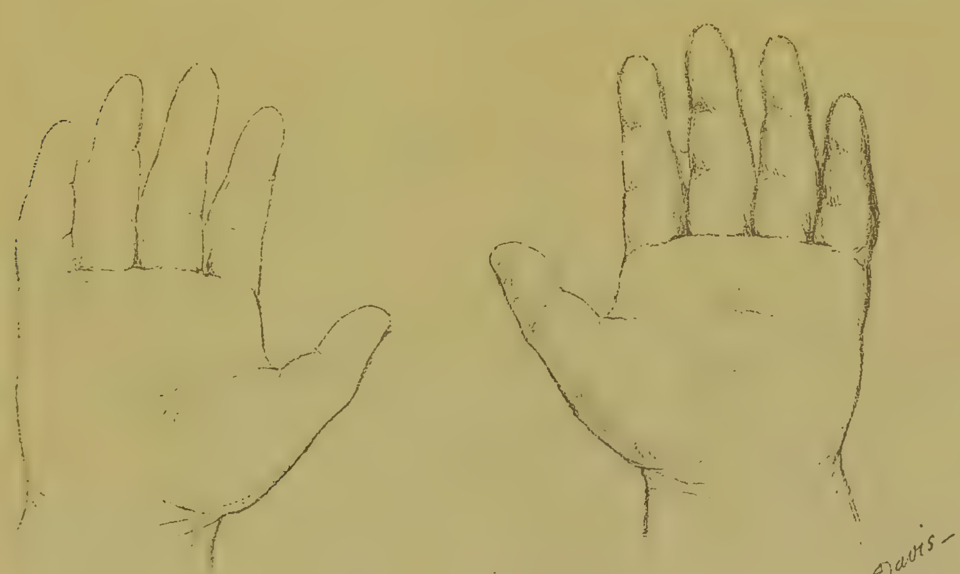


Fig. 112. —The condition of the hands in Fig. 110 after treatment by operation and manipulation.

Unfortunately these cases show a strong tendency to relapse, and it is well to warn the patient that after a finger has been straightened a long course of mechanical treatment will be necessary to maintain the improvement. For this purpose an apparatus similar to that used after operation for Dupuytren's contraction may be worn day and night for three months in cases in the second stage, and at night for a further period of three months in cases in the third stage. My colleague, Mr. Muirhead Little,[1] has tried forcible extension in a case, but the affected finger showed a marked tendency to re-contract, which he believed would be overcome by the use of a simple metal splint he had designed.

In inveterate cases, and in people who obtain their living by

FIG. 113.—The feet in Case 43, showing congenital contraction of the little toes, which existed with similar contractions of the fingers.

manual labour, the propriety of amputating the offending digit may be discussed with the patient.

Supernumerary Fingers.—Synonym—Polydactylism.

This condition is often hereditary, and may be traced through several generations, and frequently exists both in toes and fingers.

There are five varieties of polydactylism.

1. An additional finger is more or less developed, and is generally situated at the ulnar border of the hand, being attached to it by a narrow pedicle.[2]

[1] *Internat. Med. Mag.* May 1894, "Remarks on Congenital Contractions of the Fingers, and their Treatment by Forcible Extension."

[2] *Vide* "A Remarkable Case of Polydactylism with Marked Hereditary History," Surgeon-Captain H. E. Drake-Brockman, *Brit. Med. Journ.* 26th Nov. 1892, p. 1167.

2. An additional thumb is more or less developed. It is free at its extremity, and articulates either with the head or the shaft of the metacarpal bone, or with one of the phalanges. Its articulation sometimes communicates with the metacarpo-phalangeal joint.

3. The supernumerary digit, more or less perfect, is closely united throughout its whole length with another digit. This condition is also seen more often in the thumb.

4. A completely developed extra digit is found, and possesses its own separate functions and tendons. In such cases it is evident that the extra power conferred on the hand is a greater advantage than the unsightliness of the deformity is the reverse. So that often no surgical intervention is necessary.

FIG. 114.
Polydactylism (after Rédard).

5. The bifurcated hand, which has eight fingers and no thumbs. Two cases are reported, one by Murray[1] and the other by Giraldès.[2]

Treatment.—In the first variety, the additional digit should be removed early in life. In the second variety removal is indicated, but care must be taken in so doing to avoid sepsis, as the articulation of the extra digit frequently communicates with the metacarpo-phalangeal articulation. White[3] records a case where a supernumerary thumb of this variety was twice removed, and each time reappeared in its original form. Even the nail was reproduced. As to the third variety, the propriety of operation is doubtful. If the deformity be removed, a large scar will be left, inasmuch as the metacarpal bone must be taken away. In the fourth variety it is advisable not to interfere.

FIG. 115.
The bifurcated or double hand.

Suppression of the Fingers.—These are of interest rather to the teratologist than to the practical surgeon. The fingers may be deficient either in number or in length, owing to the absence of

[1] *Med.-Chir. Trans.* 1865.
[2] *Mal. Chir. des Enfants*, Paris, 1865.
[3] "On the Regeneration of Animal Substances."

their segments,[1] or both these conditions may be present. It is not unusual to see rudimentary fingers at the extremity of a mal-developed arm. The forearm, wrist, and metacarpus are totally suppressed, and the rudimentary fingers articulate with the end of the humerus. In these cases but little can be done from a surgical point of view. If the hand is very unsightly or useless, amputation of it is the best resource, and a good artificial hand is to be preferred.

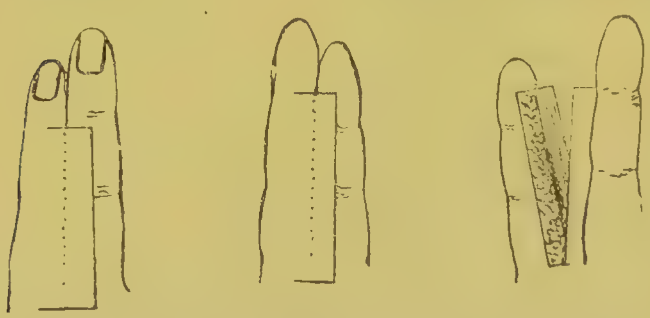


FIG. 116.—Diagram of the incision and flaps in Didot's operation. The dotted line shows the limits of the adjoining fingers.

Webbed Fingers.—Synonym—Syndactylism.

There are three varieties. (*a*) Two fingers, generally those on the inner side of the hand, are united by skin and fibrous tissue; (*b*) union is by muscular as well as fibrous tissue and skin; (*c*) the bones are fused throughout their entire length, or more often at the second and third phalanges only.[2]

Treatment.—In the third variety but little can be done, and the case is often best left alone. In the first and second varieties the chief difficulty after operating is to prevent some re-formation of the web, especially towards the base of the new cleft. This difficulty is overcome in various ways.

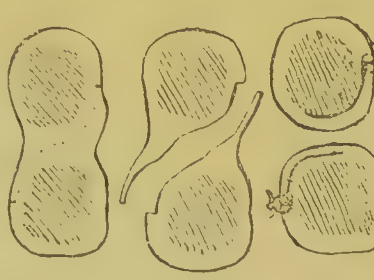


FIG. 117.—Transverse section showing the mode of adjusting the flaps in Didot's operation.

1 *Vide* a case of hereditary malformation of the hands and feet, by Ramsay Smith and Stewart Norwell, *Brit. Med. Journ.* 7th July 1894, p. 8.

2 Dr. E. Goldman of Freiberg has published a paper of interest on the subject of malformations of the hand in the *Beiträge für klin. Chirurgie*, April 1891. Dr. Goldman says syndactylism may be rightly regarded as an arrest of development, since in certain stages of fœtal existence the fingers are bound together by webs of varying extent. The thumb almost always remains free; and in most instances two fingers only, usually the third and fourth, are joined together. These facts can be at once explained by referring to what takes place in the development of the hand. As it is known that the thumb becomes detached from the fingers about the seventy-fifth day of fœtal life, whilst the four fingers remain bound together for a longer time, it will be seen that the disturbing element must occur at the time when the thumb has been separated. The subsequent separation of each finger does not take place simultaneously, but as follows, as is seen in the larvæ of the triton and proteus. The forefinger, whilst distinct from

1. The formation of a permanent opening at the bottom of the web by transfixing it with a silver pin, or a piece of rubber, or vulcanite, and then division of the web from top to bottom, taking care to keep the raw surfaces apart.

2. Didot's operation. An incision is made along the palmar surface of one finger, and is joined at each end by short transverse cuts so as to form a flap. On the dorsum of the other finger a similar proceeding is carried out, except that the flap is in the opposite direction. The remaining tissues of the web are then divided, and the dorsal flap of one finger covers the palmar surface of the other (Figs. 116 and 117).

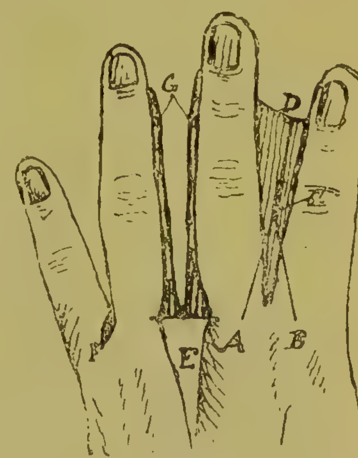


FIG. 118.—Diagram of the incisions and flaps in Zeller's operation.

Points to be observed during and after this operation:—

(*a*) The two fingers are not of the same size, and the flaps should be cut accordingly.

(*b*) The flaps must not be too broad, so as to leave no raw surfaces in apposition.

(*c*) The sutures must be accurately adjusted at the bottom of the new cleft, so as to leave no granulating surface.

(*d*) The cleft must be carefully watched to prevent formation of new adhesions.

Lastly, the operation is not easy to perform satisfactorily on a small hand, and it should therefore be deferred till the child is six years of age. It is likely to be unsuccessful if the fingers are very closely joined.

3. Zeller's operation. Two incisions A and B are made on the dorsal aspect of the web and fingers meeting at C. They should extend from the metacarpo-phalangeal to the first interphalangeal joints. This triangular flap is reflected towards its base, and the web is divided from C to D. The flap A B C is then carried forward and fixed to the palmar surface and between the clefts, and so prevents contraction (Fig. 118).

4. Norton's [1] operation. Small rounded anterior and posterior flaps are made at the cleft, with their bases at the heads of the metacarpal bones. The web is divided and the flaps joined at

the thumb, sends off as a main branch the middle finger, from which the ring and little fingers are sent off as secondary branches.

[1] *Brit. Med. Journ.* Aug. 1881.

their apices (Fig. 119). The following points should be attended to:—

(*a*) The flaps should be thick, so that their vascular supply is good.

(*b*) They should be rather narrow, to prevent bulging.

(*c*) The tissues between the heads of the metacarpal bones should be cut back or removed, so as to allow the flaps to meet well.

FIG. 119.—Diagram of incisions and flaps in Norton's operation.

(*d*) The flaps must be long enough to prevent tension.

(*e*) In joining the flaps, small needles and fine sutures must be used, so as to injure the tissues as little as possible.

Other points are, that care must be taken that the new web is in a line with the natural one, and that the fingers are kept apart during the healing process.

Choice of Operation.—1. If the web is small and thin, or if the union between the fingers is very close, the formation of a permanent opening at the base of the web is to be preferred. The web may be divided subsequently, and its edges trimmed and sutured.

2. If the web is extensive, complete and of good width, Didot's operation is the best.

3. If the web is incomplete and reaches but half-way, Zeller's or Norton's operation is indicated.

Hypertrophy of the Fingers.—This condition is sometimes seen at birth in a minor degree, and becomes exaggerated later.

FIG. 120.—Hypertrophy of the fingers, from a photograph by Dr. Hawkins Ambler (*Lancet*, 4th Feb. 1893).

The following forms are described: hypertrophy of all the tissues of the finger;[1] lymphatic enlargement of the subcutaneous tissue; a nævoid condition of all the soft structures (Billroth). In a specimen shown by Mr. Robert Jones of Liverpool at the meeting of the British Orthopædic Association in July 1894, the hypertrophy was mainly lipomatous. Pathologically, it is observed that the arteries

[1] A case, recorded by Dr. Hawkins Ambler, in a girl aged 12 years, of hypertrophy of both ring fingers, appears to have been of this variety. It was hereditary. *Lancet*, 4th Feb. 1893. Dr. Ambler has kindly sent me the photograph of this case for reproduction here (Fig. 120).

going to these fingers are larger than normal. The temperature of the part is generally raised.

Treatment.—Compression of the fingers and ligature of the arteries of the fingers have both been tried, but without success. When the finger becomes a source of annoyance it should be removed.

Congenital Lateral Deviation of the Fingers.—Mr. Reeves figures in his work on *Bodily Deformities* a remarkable case of congenital deviation of the finger in which the second and third

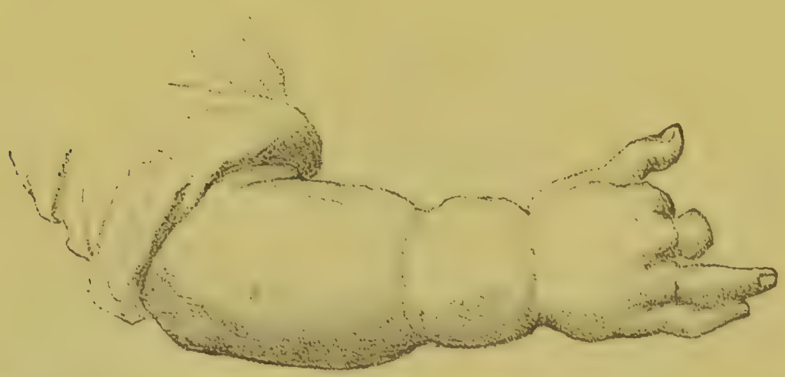


FIG. 121.—Congenital furrowing of the forearm and intra-uterine amputation of fingers (after Rédard).

phalanges are laterally bent on the first, so as to form nearly a right angle. The condition appears to have been improved by the use of a suitable instrument.

Congenital Furrowing of the Limbs.—These are found more frequently in the leg than the arm, and are associated with many other kinds of congenital deformity. They are undoubtedly due either to compression of the limbs by an abnormally long umbilical cord, or by amniotic adhesions. In some cases the pressure of the band causes intra-uterine amputation, and the part so separated is delivered before or after the fœtus.

CHAPTER IV

ACQUIRED DEFORMITIES OF THE HAND

Dupuytren's Contraction, Etiology, Causation, Symptoms, Diagnosis, and Treatment, Various Methods of Operating—Traumatic Contraction of the Forearm, Wrist, and Fingers—Jerk-, Snap- or Spring-Finger—Mallet-Finger.

Dupuytren's Contraction

Synonyms—English, *Contraction of the Palmar Fascia*; French, *La Maladie de Dupuytren, Retraction de l'Aponévrose Palmaire*; German, *Die Dupuytrensche Contractur der Finger.*

Definition.—A permanent flexion of one or more fingers arising from contraction of the palmar fascia, and its digital prolongations.

Occurrence and Etiology.—*Sex.*—The most extended and valuable statistical table has been compiled by Dr. W. W. Keen of Philadelphia.[1] It contains 253 cases, including 70 cases recorded by Mr. Noble Smith.[2] Dr. Keen says: "The sex is noted in 227 cases, of these 180 were men and 40 women." The comparatively large number of women here given is out of proportion with the general experience. But it should be remembered that Mr. Noble Smith's 70 cases included 15 women. Mr. Adams' experience is that the proportion of males to females is about 1 in 15 or 20 cases. He has operated on four or five ladies, and seen it in a few more; Dr. Keen has seen four, and operated on one. So that the affection must be more common in men.

Digits affected.—In 105 cases, in which the finger affected is stated, the analysis gives following result:—

[1] Quoted from Adams' pamphlet, *Further Observations on the Treatment of Dupuytren's Contraction*, London, J. and A. Churchill, 1890; also Adams' *Finger-Contraction and Hammer-Toe*, 2nd ed. p. 85.

[2] *Royal Med.-Chir. Trans.* 1884. Mr. Smith's cases were obtained by examining 700 elderly people in workhouses. Of 400 women, Mr. Smith found 15 cases in which either contraction existed or there was fascial induration with thickening.

The thumb was affected	9 times
The forefinger was affected	13 "
The middle finger was affected	45 "
The ring finger was affected	88 "
The little finger was affected	77 "
The ring and little fingers together . . .	65 "

The phalanges were very unevenly attacked. In 73 cases, the first phalanx was affected in 15, the first and second in 45, the second phalanx alone in 7, and the third phalanx was also involved in 6 cases.[1]

In many cases both hands are involved, but not simultaneously nor to an equal degree, but the right hand is not so much more frequently affected than the left, as the theory of the production of the contraction by traumatism would imply. Of 184 cases of Keen's, the right hand only was attacked 58 times, the left 23, and both hands 103 times.

Heredity.—Keen found this factor present in 50 of 198 cases; in 3 of them it occurred in three generations and once in four generations.[2]

Age.—The deformity is one which comes on in middle or late life, *i.e.* at the time when fibroid changes generally supervene. Cases are recorded in which Dupuytren's contraction and narrowing of the orifice of the prepuce have been seen in the same elderly person. Although it is generally an affection of late life, I have seen it once at the age of 16 in a girl, and once at 28 years.

Occupation.—The onset of the contraction has been supposed by some to be due to repeated traumatism of a slight character. In some cases this is undoubtedly so, and the following is an instance:—

CASE 44. *Dupuytren's Contraction in a Bookbinder: Operation: Cure.*—Bertha G——, aged 16 years, came to me at the National Orthopædic Hospital complaining of pain in the palm of the left hand, and inability to straighten the ring and little fingers. By occupation she was a bookbinder, and she stated that she was accustomed to steady the mass of sheets in the hollowed palm of the left hand while sewing and fastening them. On examination, the inner part of the palmar fascia was felt to be thickened, and formed two fibrous cords at the bases of the ring and little fingers. From each cord a lateral prolongation passed on each side into the ring and little fingers. These were contracted and flexed at the interphalangeal joints. The bands were divided by

[1] In congenital contraction of the fingers the first phalanx is always hyper-extended, and the third occasionally.

[2] And compare Bulley, *Med. Times and Gaz.* 1864, ii. 218; Madelung, *Berl. klin. Woch.* 1875, xii. 291; Adams, *Brit. Med. Journ.* 29th June 1878.

multiple subcutaneous punctures, the fingers extended as much as possible after the operation, and placed in a metal splint until the punctures were healed, when an Adams' apparatus was used. The ultimate result was satisfactory, complete power of voluntary extension being gained.

The contraction has been known to occur in those who use the palm of the hand much in their daily work, *e.g.* carpenters, drivers, engravers, gardeners.[1] But that repeated and slight traumatism is not the sole factor at work is shown by Dr. Keen's tables. In 72 cases where the occupation was recorded, 18 were manual labourers, and 54 obtained their living in ways which could not, without unduly stretching the imagination, be called manual. Mr. Adams has observed that the majority of his cases were drawn from the professional classes. Medical men, lawyers, writers, and engineers are instanced. The contraction is not unknown in the leisured classes. As far as professional men were concerned, there was one feature common to all, viz. an inheritance of gout.

Traumatism.—While statistics are against rather than in favour of repeated slight traumatism as the sole cause, and the point lies in the word "repeated," it is impossible to deny that a *single* injury is sometimes the precursor of contraction. Dr. Abbe[2] instances the following. A patient while climbing a ladder pierced his palm with a piece of frozen mortar, and dated the onset of the affection from that time. In another instance a civil engineer had a long series of stakes to put into the ground, and pressed them hard with his palm. Next day he had a sore palm, and traced the contraction directly back to this date. In 1888 Dr. Abbe operated on A. C., aged 53 years, for Dupuytren's contraction, which he attributed to a strain while turning on a stopcock some years previously, when he heard a snap as if something were breaking in the palm. This part became puffy, and then the swelling slowly disappeared, the palmar contraction following fifteen months afterwards. It is permissible for me to instance one case of my own.

CASE 45. *Dupuytren's Contraction immediately following an Injury.*—Mr. T. R. P., aged 56, two years previously caught the little finger of the right hand in a door. For a time it was very painful and

[1] A chemist consulted me for Dupuytren's contraction. In the transverse crease of the left palm and in a line with the ring finger there was a hard nodule, while a band passed down to the ring finger, which was slightly flexed. For many years the spot where the nodule was seen had been pressed on in using the pestle and mortar in pill-making. There was also a strong history of gout.

[2] *N. Y. Med. Journ.* 13th Jan. 1894.

considerably swollen, but when the swelling had passed off, he noticed "a 'leader' at the root of the little finger, where there had not been one previously." On examination, a typical Dupuytren's contraction in the early stage was seen, which was relieved by subcutaneous section.

As to the explanation of these cases coming after a single injury, it appears to me that Abbe's theory of reflex nerve irritation is the best which has yet been advanced.

Causation.—The theories are as follows:—

1. Traumatism, which has already been alluded to.
2. Gout and Rheumatism.
3. Syphilis.
4. Nervous origin (Abbe).
5. Bacterial origin (Anderson).

Gout and Rheumatism.—Mr. Adams stated that in his experience at the Royal Orthopædic Hospital the affection was found to be more common among butlers and indoor servants than in those who performed manual labour. With reference to the cases occurring in the professional classes, he says the only condition common to the whole series is a disposition to gout (Paget's minor manifestations of gout). In illustration of the possible influence of gout, I quote a case and give figure (No. 122).

CASE 46. *Traumatism in a Gouty Patient, followed by Dupuytren's Contraction.*—Emma C——, aged 25 years, came to me at the National Orthopædic Hospital in April 1893 with this history. Her father and mother had died of chalk gout, and she had "rheumatism" at the age of 15. She has one brother and one sister, but they have not suffered from any pains. For twelve years she had been engaged in a laundry as a "starch-pinner."

Two years ago she carried her baby for a distance of three miles, mainly on the right arm and hand, and directly afterwards the right hand swelled, especially over that part of the palm which corresponds to the head of the fourth metacarpal bone. Since then she has noticed difficulty in straightening the corresponding finger.

On examination, there is a fluid swelling around the fourth metacarpo-phalangeal joint, and the head of the matacarpal line is distinctly enlarged. There is no redness about the swelling, but it is painful on pressure. Anteriorly the swelling is not so marked. A well-defined fibrous band of palmar fascia runs from it to the lower margin of the anterior annular ligament, and the lateral prolongations to the ring finger are thickened. The ring finger cannot be extended at all, and the little finger by passive movement only. There are tophi in both ears. After the administration of citrate of potash and vinum colchici, and the local application of bicarbonate of soda, twenty grains to the ounce, the swelling diminished very much. From the history, the tophi, and the effect of the treatment, it seemed to me a typical example of traumatism in a gouty patient followed by contraction.

The theory of a gouty or rheumatic origin receives much support from Keen's tables. Of 48 cases, 42 had either a personal or family history of gout or rheumatism.[1]

Syphilis.—Ricard and Ricket record cases in syphilitic subjects in which the affection yielded to iodide of potassium.

Nervous Origin of the Affection.—Abbe says: "The theory of gout, so far as I can see, is purely an assumption." The sequence of events, according to this writer, is as follows: "First, a slight

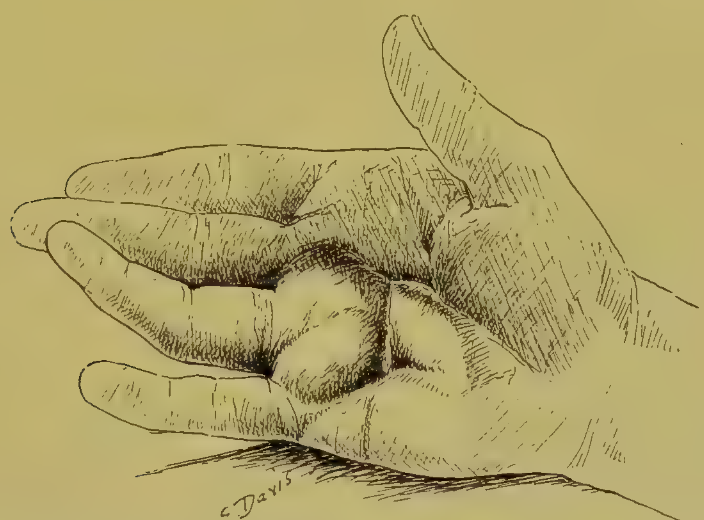


FIG. 122.—Commencing Dupuytren's contraction of the hand and gouty swelling about the metacarpo-phalangeal articulation of the ring finger (Case 46, Emma C——, aged 25).

traumatism occurs, often entirely forgotten; then a spinal impression, produced by this peripheral irritation, succeeded by reflex influence on the part originally hurt, producing in its turn pain, hyperæmia, hypertrophy, and contraction of the bands of the fascia; and occasional joint lesions simulating sub-acute rheumatism."

The points in favour of Dr. Abbe's theory are the frequent association of neuralgia with the affection, the occurrence of the affection more frequently in people highly sensitive, and the intimate connection of the skin of the palm, full of nerve-endings as it is, with the fascia. A case quoted here from the *Edinburgh Medical Journal* is of interest in this connection.

[1] Mr. Lockwood, in the discussion on Mr. Adams' paper at the Medical Society in May 1890, stated that he had made a necropsy in a case in which there was general gouty disease of the joints, and in which the fascial contractions were found to be incrusted with urate of soda.

CASE 47. *Dupuytren's Contraction: Epilepsy: Disappearance of Fits after Operation.*—Mr. A. G. Miller records the case of a patient, a joiner aged 32, who had become subject to fits ten months before he came under observation. He is said to have been "nervous" ever since; five years ago he was arrested in mistake for some one else, but there were no fits until a dispute took place with his parents, after which he left their house and worked very hard at his "bench." This, as already said, was about ten months ago, and it was after this spell of hard work that he noticed a contraction in the palm of his right hand, and almost simultaneously the fits began. These were epileptiform in character apparently, commencing with flexion of the fingers of the right hand. Consciousness, as a rule, was lost, but on one or two occasions the fits had been cut short by forcibly preventing the flexion of the fingers. There was found to be contraction of the palmar fascia of the ring and little fingers of the right hand. The prepuce was also contracted. After the fascia had been stretched and the prepuce slit up, only one fit occurred during the several months that the patient remained under observation. Mr. Miller regards the case as one of epilepsy, resulting from peripheral irritation; but it is only fair to state that after the operation the patient was under treatment with bromide for some time at least, and the rarity of such a condition arising from such a slight cause makes it very desirable to follow the subsequent history of the patient.

Bacterial Theory.—In his Hunterian Lectures, Mr. William Anderson speaks thus: "The situation of the initial lesions and the peculiar tendency of the new growth to feed like a parasite upon the tissues in which it spreads and which it replaces, have led me to believe strongly that the active agent of destruction is a specific micro-organism which gains access to the subcutaneous tissues through accidental lesions of the epidermis, mostly effected by the finger-nails. This would explain far better than any existing hypothesis the persistent causes of the disease, and its proneness to recur after the most skilfully-devised operations." Mr. Anderson's speculations are by no means so improbable as might at first sight appear. There are many observations bearing on the existence of micro-organisms in the skin. It is only necessary to speak of the parasitic origin and propagation of papillomata, the common wart; and elsewhere[1] I have hazarded the opinion that the causation of acute infective disorders of the deeper tissues, especially the bone, is to be found in the micrococci which are constantly present in the sweat and sebaceous glands.

But until Mr. Anderson's theory is substantiated by careful

[1] Tubby, *Guy's Hospital Reports*, 1890, "Acute Infective Periostitis."

observations we must fall back upon the following opinion as to the etiology and causation of the disease. In a patient whose neurotic condition arises from hereditary or acquired gout, slight causes are sufficient to start the fibroid process; and such causes are to be found in traumatisms either single or frequently repeated.

Morbid Anatomy.—The exact nature of the affection has been made very clear by numerous dissections, references to which are given below.[1]

The points to be borne in mind are: (1) The affection is primarily a contraction of the fascia, and secondly, of the skin. The tendons have nothing to do with it. (2) The palmar fascia is not a well-defined aponeurosis. It fades off gradually at its edges. (3) It gives off two sets of processes, the superficial to the skin, and the deep to the lateral aspect of the fingers, passing to the sides of the first and second phalanges, to the periosteum, and to the tendon sheaths. The nature of the change in the fascia is a fibroid hypertrophy. In some cases this appears to be local, and to affect the fascia in the form of small fibromata. In other cases, however, it is a general hyperplasia of one or more bands followed by contraction. On account of the intimate union of fascia and skin, the latter must accompany the former in any change in its length. The reason why the ring finger is more often affected is pointed out by Reeves. In flexion of the fingers, the deepest part of the palm corresponds to the ring finger, and it is this part of the palm which is most compressed in grasping or pushing a round or circular body.

FIG. 123.—A dissection illustrating the contraction of the palmar fascia and its prolongations in Dupuytren's contraction (after Druitt).

Variot found that the fat of the palm had disappeared in one case,

[1] Dupuytren, *Leçons Orales de Clinique Chirurg.* 1832, and *London Med. and Surg. Journ.* vol. i. p. 267; Goyrand, *Medicale de Paris*, 1835, p. 481, and *Mémoires de l'Academie Royale de Med.* tom. iii. and *Gaz. Méd.* 1834, p. 219; Partridge, *Path. Soc. Trans.* 1853-54, vol. v. p. 343; Druitt, *Surgeons' Vade Mecum*, 11th ed. p. 301; Sevestre, *Journ. d'Anat. et de Phys.* Paris, 1867, iv. p. 249; *St. Bartholomew's Hosp. Catalogue*, vol. i. p. 177, Churchill, 1882; Lockwood, *Path. Soc. Trans.* vol. xxxvii. p. 556; Ricket, *Prog. Méd.* 1877; Ménard and Variot, *Thèse de Paris*, 1881; W. Adams, *Finger-Contraction and Hammer-Toe*, 2nd ed. 1892, p. 12; Lancereaux, quoted by Reeves, *Bodily Deformities*, p. 358; Madelung, *The Causes and Treatment of Dupuytren's Contraction*, Trübner's Translation, 1876.

and that the palmar fascia and subcutaneous tissue, the latter being thickened, were continuous. He also described hypertrophic changes in the deeper layers of the skin and thickening of the walls of the sweat-glands. Madelung thinks that the disappearance of the fat of the palm is the first stage, and is occasioned by old age, traumatism, and inflammation. When the fat has atrophied, the palmar

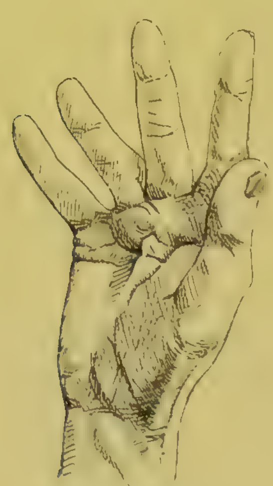


Fig. 124.

Fig. 125.

Fig. 126.

Three figures illustrating three stages in Dupuytren's contraction (Fig. 126 is after Rédard).

fascia is more subject to irritation from injury or repeated traumatism, especially over the heads of the metacarpal bones, hence the thickening. Bearing on the part taken by gout in the production, that dissection of Mr. Lockwood's in which he found the fascial contractions incrusted with urate of soda, is of great value.

Symptoms.—At first there is a feeling of tightness in the palm of the hand and in the ring or little finger, and the patient finds some difficulty in fully extending the fingers, and later there may be seen some nodular indurations in the palm opposite the heads of the metacarpal bones. There is often considerable neuralgic pain in the hand. The skin is at first quite movable on the indurations, but later it becomes adherent, dry, and thickened, and a puckered dimple appears in the transverse crease. The affected fingers then begin to retract in this order; the first phalanx on the metacarpal, and the second on the first. As a rule the third remains extended on the second, but in the last stage, when the finger is much pressed into the palm, the terminal phalanx is flexed (Figs. 124-126). With the adhesion of the skin in the palm, fibrous bands, like the string of a bow, make their appearance, and often stand well out, and can be traced on to the lateral aspects of the fingers. In some cases the fibrous bands first appear in the fingers. The affection may progress rapidly or slowly. Mr. Adams states that he has known the tip of the finger to be so drawn down as to touch the palm in two years.

Prognosis.—Although the affection is slow in its progress on the whole, it is continuous, and a wound in the palm may be caused by the nail of the flexed finger. Rarely does it become spontaneously arrested.

Diagnosis.—1. From congenital contraction; the points of distinction have been tabulated on p. 221.

2. From contraction of the tendons, the result of hemiplegia or of nerve lesions in the forearm. Here there are no fibrous bands in the palm, as in Dupuytren's contraction. And in the last-named affection the presence of nodules, adhesion of the skin, and the extension of the third phalanges all serve as distinguishing points. In Dupuytren's contraction the tendons above the wrist may be felt to move freely on passive extension of the fingers. Then in nerve-lesions, wasting of either the thenar or hypothenar eminences, or both, is present.

3. From flexion of the fingers due to adhesion of the tendons to the sheaths (Fig. 127). In this event, on attempting passive flexion, the affected tendon is immovable both in the finger and above the wrist. After deep whitlows, if the tendon sheath has been widely opened, the tendon stands up in the palm of the hand. And passive extension obliterates the prominence instead of increasing it, as in Dupuytren's contraction.

4. From contraction of the hand due to osteo-arthritis. The writer has seen all the fingers in this affection bent into the palm, and the whole fascia indurated (the hand of the patient is

figured, p. 249). But there were not in this case distinct bundles of fascia, and no one portion of the fascia was more affected than the other.

Treatment.—When the affection is at all marked, the only measure available is an operation on the fascia. Attempts have been made by gradual mechanical extension to overcome the contraction, but these have always been painful and unsuccessful, and the contraction appears to have increased afterwards. In the mildest cases extension of the fingers may be practised by the patient, but only with the hope of deferring, not avoiding, operation.

FIG. 127.—Contracted finger from adhesion of tendon to its sheath, after whitlow (Rosa F——, aged 29).

Operative Treatment.—This may be either subcutaneous or open. Of the subcutaneous methods, the best is that of Mr. Adams. It consists in making multiple subcutaneous divisions of the fascia and its prolongations. That surgeon "introduces a fascia knife with a straight cutting edge terminating in a point, and carrying it between the skin and the contracted cord, which is divided by cutting downwards very slowly and cautiously, taking care not to dip the point nor divide any of the structures except the contracted band of fascia. The first puncture should be made in the palm of the hand, a little above the transverse crease and where the skin is not adherent to the fascia. The second puncture should divide the same cord as the first, thus leaving the contracted band isolated in the palm of the hand. The third and fourth punctures divide the lateral bands, which pass to the fingers, taking care not to divide the nerves and arteries. Pressure is made after each puncture by a piece of porous india-rubber or German felt."

After the operation Mr. Adams brings the finger as nearly as possible into the fully-extended position without using any force, and keeps it thus by a well-padded metal splint (Figs. 128 and 129), applied to the flexor aspect. Full extension is not always possible, on account of the risk of tearing the skin in severe cases, and the intense pain set up by the traction on the digital nerves. In these cases it is better to make many punctures, twenty or thirty,

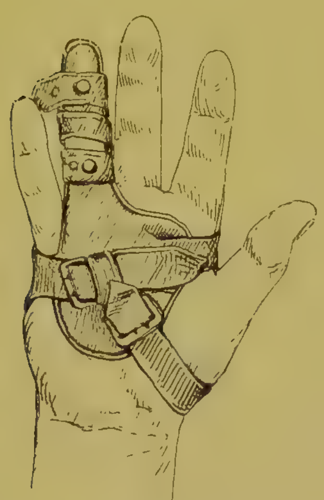


FIG. 128.

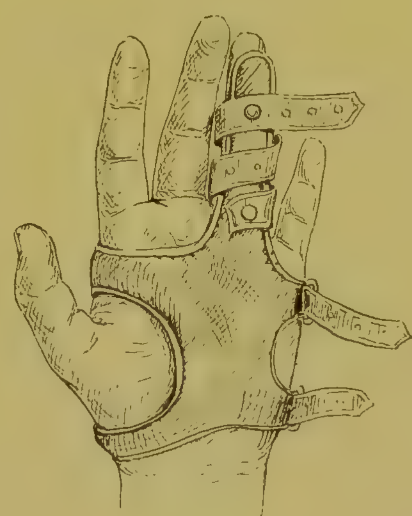


FIG. 129.

Two forms of Mr. Adams' metal splint for use immediately after section of the palmar fascia for Dupuytren's contraction.

and gradually to extend the finger. The after-treatment advocated by Mr. Adams is the constant use of the metal splint for three or four days, and then the wearing of the extension-instrument (Fig. 130), at first night and day for a fortnight. When the extension is complete it should be worn at night only for about six months. Mr. Adams' operation is most satisfactory, and with care and attention to details, the results are all that can be wished for. In nine cases I have found the results very good.

Open Methods of Operating.[1]—All the forms of open operations should be done with antiseptic precautions. Dupuytren's method is simply a transverse incision through the skin and contracted fascia

[1] For the respective merits of the subcutaneous and open operations, a paper on "The Treatment of Dupuytren's Contraction of the Palmar Fascia," by J. Macready, in the *Brit. Med. Journ.* 22nd Feb. 1887, may be consulted with advantage.

in two or three places. Goyrand[1] incises the skin longitudinally over the fibrous bands, freeing the skin from the latter, dividing them transversely and placing the fingers in extension. Ricket modified this plan by making short transverse incisions at the end of the longitudinal one, dissecting up the small flaps thus formed as far as was necessary, and then dividing or excising the bands. Busch's[2] operation consists in making a triangular flap with its base in the transverse crease of the palm, and the apex at the highest point of the hand. The flap, with as much subcutaneous tissue as possible, is dissected up, thus severing all the process of fascia attached to the skin. The offending bands are made prominent by pulling on the fingers, and are then freely divided. The disadvantage of this operation is the great retraction of the flap, which leaves a large surface to granulate up. If several fingers are involved, an oval incision, with its convexity to the wrist, answers better than a triangular flap.

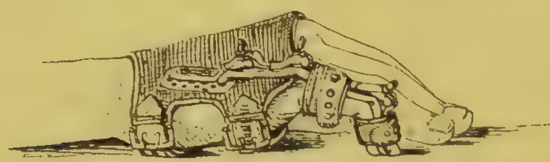


FIG. 130.—Extension-instrument for use after section of palmar fascia.

Choice of Operation.—In all cases it is my opinion that Adams' operation, when done carefully, and, if necessary, in two or even three stages in very severe cases, and with steady perseverance in the after-treatment, will meet all requirements. The advantages of the open method are that it is possible, by actually seeing the fascia, to divide all contracted bands, and, if need be, to dissect them out. The disadvantages are their greater severity, their unsuitability to aged patients—Bradford and Lovett point out that many patients with Dupuytren's contraction have sugar in the urine—the longer time involved in healing, the possibility of drainage of the wound being required, and the occasional necessity of skin-grafts to cover the granulating surfaces left by the retraction of the divided skin or flaps.

Recurrence of the Deformity after Operation.—This is most frequently due either to persistence in that form of occupation from which the conditions arose, or to want of persevering and watchful after-treatment. As a rule cases once thoroughly and efficiently treated are cured permanently.

1 Cf. a modification of this operation by Mr. Hardie of Manchester, *Med. Chronicle*, vol. i. p. 9.

2 *Berliner klin. Wochenschr.* 15 and 16, 1875.

Contraction of the Forearm, Wrist, and Fingers

In this place it is proposed to speak briefly of those forms which arise from traumatism affecting the nerves of the upper extremity, leaving other instances which arise from cerebral and spinal lesions to be considered in the chapter on "Deformities the Result of Cerebral and Spinal Paralysis."

As examples of traumatic contraction of the forearm and hand, the two following cases which came under my notice, in one of which, No. 48, a novel method of treatment was adopted, are given :—

Case 48. *Contraction of Hand after Pressure on Median Nerve : Section of all the Flexor Tendons at the Wrist : Cure.*—Edith B———, aged 4, came to the National Orthopædic Hospital, presenting this history and these symptoms.

A year ago she fell down and hurt her forearm. This was all the history that could be obtained. She was taken to the German Hospital, and the following account was kindly sent me. On admission, there was a lacerated wound at the upper part of the flexor aspect of the right forearm. Some crepitus was present, and compound fracture of the coronoid process of the ulna was diagnosed. The wound suppurated, and healing was delayed by "pocketting" of pus at the lower part of the forearm.

When she came to me the forearm was in this position. It was flexed at the elbow and pronated. The wrist was flexed, and the thumb, first and second fingers were contracted. There was anæsthesia of the flexor aspect of the two outer fingers and thumb. The hand was completely useless. At the upper part of the front of the forearm a depressed cicatrix was seen. With the history and the appearances presented, it seemed that the median nerve was irritated by scar-tissue at the point where it passes through the two heads of the pronator radii teres.

It was therefore decided to free the nerve, and with this object, an incision was made in the centre of the anterior aspect of the elbow joint, and the median nerve found; but on tracing it downwards to the pronator radii teres, the nerve was seen to be quite healthy. It was then thought that the lesion was nearer the wrist, and so the incision was lengthened. The nerve was traced beneath the flexor carpi radialis. This muscle, being in the way, was divided at its middle and the ends turned upwards and downwards. Continuing the incision more towards the wrist, and separating the muscles, about 3 inches above the wrist the median nerve entered dense scar-tissue. From this it was freed, and the scar-tissue dissected away. The nerve was then seen, for an inch of its length, to have lost its translucent appearance, and to be of about half its normal thickness. The anterior interosseous branch was also carefully examined from its origin to the upper border of the pronator quadratus. The ends of the flexor carpi radialis were united by sutures, and the wound closed. It completely healed by primary union within a week.

As the immediate result of freeing the nerve, the fingers were capable of being passively extended without pain, whereas before the operation this had not been possible.

Six weeks afterwards, feeling that no more movement was to be expected, in spite of massage, the use of the battery and passive movements, and on the ground that considerable adaptive shortening of the flexor muscles had taken place, the following procedure was carried out. The incision was carried down to the wrist, and the median nerve separated from the tendons in contact with it, and kept out of danger by a probe

FIG. 131. — Contraction of hand from pressure of scar-tissue on the median nerve in the forearm. This Fig. shows the condition in Case 48 before operation.

FIG. 132.—The same hand as in Fig. 131, after freeing the median nerve and subcutaneously dividing all the flexor tendons at the wrist.

passed beneath. Then with a blunt tenotomy knife *all* the flexor tendons at the wrist were divided, by cutting through them straight down to the bones. The fingers were then found to be capable of complete extension. The edges of the wound were united, the tendons not having been drawn together by sutures. The limb was put up in a malleable iron splint, with the wrist and the fingers and thumb flexed, and left so for five weeks. At the end of that time, finding good union of the tendons had taken place, the child left the hospital wearing a plaster of Paris gauntlet, which maintained the flexion of the wrist, but left the fingers and thumb free. She wore this gauntlet for a year, it being removed from time to time for the application of the interrupted current to the part. At the end of a year the functions of the hand were completely restored, with the exception of a little weakness in the index finger; otherwise flexion and extension were perfect. She could write on a slate, pick up a pin, and use the right hand as well as the left. The success of the case I ascribe to the absence of any pus after either operation, and to the maintenance of the wrist in the flexed position for so long a period as a year, thus preventing any undue stretching, by over-action of the extensors, of the soft band of union between the ends of the divided flexor tendons. The condition of the forearm and hand before and after the operation is seen in Figs. 131 and 132.

The next case is an example of paralysis of the musculo-spiral nerve, arising from vicious union after separation of the lower epiphysis of the humerus.

CASE 49. *Contracted Hand after Musculo-Spiral Paralysis: Operation.*—A. S., aged 8, sustained two years previously an injury to the lower part of the right arm, "the bone being broken." It was set, but the hand was not of much use to him.

On examination, the right hand was dropped and the fingers were flexed. There was anæsthesia of the outer three and a half fingers on their dorsal aspect, and the forearm was pronated. At the outer border of the humerus, and at its lower end, a large bony projection was felt.

The child was admitted to the National Orthopædic Hospital, and an incision was made down to the bony projection. The musculo-spiral nerve was found to be tightly stretched at this spot by the displacement outwards of the viciously-united lower epiphysis. The projecting portion of bone was chiselled off, and the tension on the nerve thus removed.

Considerable improvement in the power of the supinators and extensors followed, but, unfortunately, the case was not kept under treatment by the parents sufficiently long to secure a thoroughly good result.

JERK-, SNAP- OR SPRING-FINGER [1]

The description of the affection is that, if the patient closes all the fingers on the palm, on opening them he finds that one remains shut. It can only be extended by the other hand, when "it flies

[1] An excellent account of this affection is found in Mr. H. A. Reeves' *Bodily Deformities*, pp. 373-382. He gives numerous references to the subject, which may with advantage be reproduced here. They are: Notter, *Archives Générales de Med.* 1850, series iv. tom. 24, p. 142; Busch, *Lehrbuch der Chir.* Bd. ii. p. 143; Hahn, "Ein Fall von Federnden Finger," *Allg. Med. Centralztg*, 1874, No. 12; Menzel, "Ueber Schnellenden (Federnde) Finger," *Centralblatt f. Chirurgie*, 1874, No. 22; Berger, "Ueber Schnellenden Finger," *Deutsche Zeitsch. für Pract. Med.* 1875, No. 718; Zieber, "Ueber den sogen. Schnellenden Finger," *Wien. Med. Blätter*, Nos. 14-17, 1880; Vogt, *Die Chirurg. Krankheiten der oben Extremitaten*, 1881; Felicki, *Ueber der Schnellenden Finger*, 1881; Bernhardt, "Beitrag zur Lehre von Schnellenden Finger," *Centralblatt für Nenkrank*, No. 5, 1884. Mr. Reeves also briefly describes three cases on p. 375 of his work.

Abbe, "Surgery of the Hand," *N. Y. Med. Journal*, 13th Jan. 1894, also describes the affection, and gives illustrations of five cases.

open like a knife-blade with a snap" (Abbe). Sometimes there is difficulty also in flexing the finger, which is accompanied by a small jerk. According to Reeves, the affection is more often seen in the thumb, and there is often a circumscribed swelling to be felt somewhere in the course of the tendon, and the obstruction is almost always near the metacarpo-phalangeal articulation. Abbe figures his cases, and the affection is seen to be in the ring and little fingers.

As to the pathology of the affection, it appears to be due to some obstruction of the flexor tendons as they pass through the osseo-fibrous groove formed by the transverse ligament of the palm at the metacarpo-phalangeal articulation. This obstruction may be due either to narrowing of the groove, or to the tendon being enlarged, or thickening below the groove, and its passing with difficulty through it. The narrowing of the groove appears in some instances to be due to the formation of ganglia in the sheath of the tendon. Especially is this so in the case of the index finger.

A description given by Mr. Battle[1] of what seems to be this affection, although it is not specifically so stated, is that "a patient will sometimes come for relief on account of a painful place on the palm of the hand, and usually of the right one, perfectly well localised and much increased by an attempt at grasping anything, such as the handle of the door in order to open it. The pain will have existed for a variable time. On examination, if the finger be flexed, and careful examination made where most tenderness is felt, a rounded body will be found, not so large as a pea, well defined, very hard and attached to the deeper parts just at the point where it is known that the sheath of the flexor tendon of the index finger terminates in the palm. If these apparently solid bodies be cut down upon, they will be found to permit of easy separation from surrounding parts, excepting when the pedicle is attached, pear-shaped and cystic." It is therefore evident from this description that a flexor ganglion may, by the thickening it causes in its growth, narrow the groove. Nélaton was of opinion that the hard movable body the size of a pea felt in the metacarpo-phalangeal articulation was the cause of spring-finger. It is easy to understand how teno-synovitis might give rise to the affection. So much then for the probability of thickening of, or obstruction in the tendon sheath as a cause.

Now as to the tendons, Reeves states that he has found small

[1] Cf. W. H. Battle, "Some Surgical Affections of the Hand, Flexor Ganglion." *Brit. Med. Journ.* 8th April 1893, pp. 783, 784.

ganglia on the flexor tendons. There, too, thickening of the vascular fringes of the vincula accessoria tendines, from teno-synovitis, would readily explain the symptoms.

Treatment. — If a ganglion can be felt, the finger should be opened and the ganglion excised. If teno-synovitis has preceded the symptoms, blistering, and later, passive movement under an anæsthetic are to be recommended. If there should be no information forthcoming as to the cause, then fixing the finger in a metal splint, with pressure over the spot where the movement of the tendon is arrested, will cause the affection to disappear.

Mallet-Finger

This affection, a rare one, is variously described as "mallet-finger," "drop-finger," "subcutaneous rupture of the extensor tendons."

As to the cause, Morris[1] states that the deformity is not uncommon among men who engage in athletic sports. When the extensor tendons of the fingers are tense, a blow upon the end of a finger transmitting force in a direction which would ordinarily flex the finger, results in an injury to the extensor tendon, where it is attached to the dorsal surface of the last phalanx. According to this writer, the injury consists, not in a bodily separation of the tendon from its points of attachment, but rather in a thinning of the tendon on the proximal side of the principal point of attachment to the phalanx, and of the fibres which form the posterior ligament of the last phalangeal articulation; a few fibres are undoubtedly ruptured, but most of them slide away from each other, very much as the threads of a textile fabric separate when the fabric is violently stretched, but are not torn.

Fig. 133.—Mallet or drop-finger (after Abbe).

Abbe, who calls it "drop-finger," gives two cases, and both arose from slight causes.

Case 50. *Case of Drop-Finger* (Abbe). — A lady was taking off a

[1] Some references to this subject are: Abbe, *N. Y. Med. Journ.* 13th Jan. 1894, "The Surgery of the Hand," and the affection is described under the title of "Drop-finger"; R. T. Morris, "Mallet-Finger," *Medical News*, 19th Sept. 1893; M. E. Schwartz, *Archiv. Générales de Med.* May 1891, under the title of "Subcutaneous Rupture of the Extensor Tendons of Fingers," quoted in *Brit. Med. Journ. Supp.* 20th June 1891.

stocking, and pushing it down the side of her leg with the tips of her fingers, suddenly found the end joint of her ring finger had given way, and hung at right angles to the finger powerless. With the other hand she could straighten it, but was unable to support it. It appeared to have nothing but skin over the joint to hold it up.

CASE 51—*Case of Drop-Finger: Operation: Cure* (Abbe)—was that of a prominent architect, whose ring finger dropped useless at the last joint, from the slight pressure of his finger-tips pushing across a paper from which he was brushing some bread-crumbs. An operation was performed two weeks later. A linear cut was made on the back of the knuckle, and the torn end of the tendon was sutured to the periosteum of the base of the last phalanx. The result four years after was most admirable.

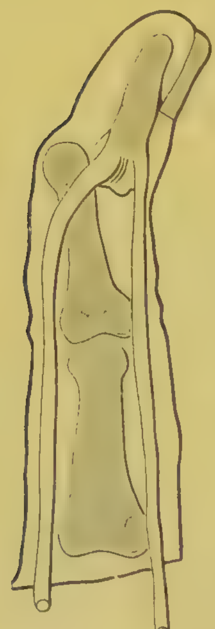


FIG. 134. – The reverse deformity to mallet-finger, occurring in base-ball players (after Abbe).

Abbe mentions that in base-ball players the reverse deformity to "drop-finger" is frequently seen. The last phalanx is violently dislocated backward, and cannot be replaced on account of the flexor tendons wrapping themselves round the head of the second phalanx, which slips through a button-hole in the capsule.

Returning to the subject of mallet-finger, Schwartz gives three cases. In two the injury occurred to the little finger, and in one to the middle finger.

Symptoms.—Immediately after the occurrence of the injury to the tendon, the last phalanx assumes a semi-flexed position. There are slight swelling and ecchymosis over the last interphalangeal joint, a circumscribed tender spot on the dorsum of the last phalanx, just below the joint, and inability of the patient to extend the last segment of the injured finger, all other movements being unimpeded.

The anatomy of the affection is either partial or complete, tearing away the attachment of the extensor tendon to the base of the last phalanx. As the result of experiments on the cadaver, Delbet was of opinion that the rupture was partial and not complete. If the case be left to itself, the last phalanx becomes fixed in the flexed position, and the use of the injured finger is much impaired on account of the formation of adhesions in the joint.

Treatment.—In the first place, the treatment should consist in the application of a straight splint to the front of the finger, so as to keep the terminal phalanx fully extended. If at the end of three or four weeks the power of full extension has not returned, the surgeon should cut down, and stitch together the divided ends of the tendon, or the tendon to the periosteum at the base of the last phalanx. Morris prefers to make a linear incision, to divide the tendon longitudinally into its two principal fasciculi, then sever each transversely on the proximal side of its thinnest part, and to advance each fasciculus to a point upon its own side of the finger near the base of the finger-nail. At this point the fasciculus is sutured to the under surface of the skin, with a suture which passes

FIG. 135.—Ulnar displacement of hand and contraction of the fingers in osteo-arthritis (H. J. L., aged 23 years).

through the skin and is tied upon the outside. This is done because the tendon makes as good union with the soft parts as it would if sutured to the periosteum, and the hold is firmer. The finger-nail is sometimes temporarily lost, as the result of encroaching on its matrix. When the advanced fasciculi are sutured in place, the last phalanx is sometimes over-corrected, and extension at the first inter-phalangeal articulation is caused. But this is merely temporary, and disappears in a few weeks, leaving a perfect finger.

OTHER ACQUIRED DEFORMITIES OF THE HAND

Amongst these there may be mentioned the contraction and ulnar displacement of the fingers occurring in osteo-arthritis. Fig.

135 is an example in a watchmaker, aged 23. This condition improved very considerably after the internal administration of arsenic and iodide of potassium, with frequent soaking of the hands in water containing bicarbonate of soda.

Another affection due to osteo-arthritis is Hutchinson's "last joint" arthritis. In these cases, mostly females, the last of the terminal phalanx is much enlarged and nodular, and the phalanx is deviated laterally.

The subject of scarring of the hands after severe burns belongs to the domain of general surgery, and it is not possible in this place to discuss its bearings.

A. Poncet[1] of Lyons has described a deformity of the hands which attacks glass-blowers. It is a severe hindrance to the usefulness of the hands, and has often been a cause of exemption from military service.

The deformity consists in permanent flexion of the fingers upon the hand, the ring and little fingers being more flexed than the middle and index. The thumb is free. The flexion is mainly at the first interphalangeal joint, and is said to be due to contraction of the flexor sublimis tendon. There is no thickening of the fascia nor contraction of the skin. The fingers deviate to the ulnar side.

The deformities arising from cerebral and spinal lesions will be considered in the chapter dealing with those matters.

[1] *Annals of Surg.* vol. viii. p. 151. Abstracted by C. R. B. Keetley.

SECTION III

RHACHITIS AND THE RESULTING DEFORMITIES

CHAPTER I

RHACHITIC DEFORMITIES

Varieties of Rickets, Congenital, Infantile, Rickets of Adolescence—Etiology—Morbid Anatomy—Symptoms—General Treatment—Deformities of the Skull, Neck, Spine, Chest, Arms—The Rhachitic Attitude.

Synonyms.—English, *Rickets*; Latin, *Morbus Anglicus, Articuli Duplicati*; German, *Die Englische Krankheit, Doppelglieder, Zwiewuchs*; French, *Rhachitisme, Maladie Anglaise*; Italian, *Rhachitide.*

Definition.—A constitutional disorder, which occurs usually in children, is associated with malnutrition, and manifests itself chiefly by changes in the bones and disorders of the digestive system.

Although a full description of rickets is out of place here, yet it is necessary to briefly give the main points of the disease before discussing the deformities.

Varieties of Rickets.—These are congenital, infantile, rickets of adolescence or late rickets, and scurvy rickets. Senile rickets alluded to by Reeves is probably osteo-malacia. As to the existence of congenital rickets Virchow is agreed, and cases have been brought forward by Shattock,[1] Henoch, and others.[2] Infantile rickets usually commences after the sixth month, and is most frequently seen between that date and the second year. Late rickets comes on about puberty,[3] and is associated with albuminuria. Clutton[4] has reported two cases. C. B. Keetley[5] reports a case in a woman aged 20 years. She had noticed for some time a marked swelling of the

[1] *Path. Soc. Trans.* 1881.

[2] T. C. Railton reports and figures a case in the *Brit. Med. Journ.* 16th June 1894, p. 1299.

[3] Lucas, *Lancet*, 9th June 1893.

[4] *St. Thomas's Hospital Report*, 1884, p. 103.

[5] *Illust. Med. News*, Sept. 1888, and *Ann. Surg.* vol. ii. p. 308.

right hip. This was variously diagnosed as dislocation, periostitis, and tumour. From the slow progress of the disease, and the sudden development of a superadded scoliosis, Mr. Keetley diagnosed rhachitis adolescentium. A wedge of bone was removed from the convexity of the femur, the bone snapped across, the adductor longus divided, and the limb straightened. Microscopical examination of the bone removed showed the changes characteristic of rickets.[1]

FIG. 136.—Late rickets, patient aged 12 years. Mr. Clutton's case. (*By permission of Messrs. Cassell and Co.*)

With reference to scurvy rickets, it has been thought by some to be scurvy and by others rickets. The factors in the causation of the disease are anæmia and an intensification of those errors of feeding which produce rickets. The symptoms are swelling of the limbs, due to sub-periosteal or intermuscular extravasations of blood, purpuric spots on the skin, spongy gums, hæmorrhage from the kidneys, and spontaneous fracture of the bones.[2]

Ashby and Wright[3] thus sum up the identity of the disease: "Drs. Cheadle and Barlow both incline to the view that they are really examples of scurvy brought on by improper food, more especially by the absence of fresh milk for the dietary. . . . Others incline to the opinion that the condition is rather an exaggerated or excessive form of the anæmia, which is usually present in severe rickets, and in our opinion there is much to favour this view."

Etiology.—Heredity plays no part in the production of rickets, nor does syphilis. The younger children of a numerous and rapidly-begotten family are very likely to suffer. Other factors are want

[1] Dr. E. Cautley records a case in a girl, aged 11. A very full description is given. It appears that the child suffered from rickets at the age of 4, that the disease had become quiescent, and then reasserted itself at the age of 10. Dr. Cautley in his article gives other references to recrudescent or late rickets, *e.g.* Ransford, *Brit. Med. Journ.* 1887, vol. i. p. 1213; Palm, *Pract.* vol. xlv. 1890, pp. 275-320; Duplay, *Gaz. des Hôpitaux*, Paris, 1891, p. 1397. Mr. Robert Jones showed a case at the Liverpool Medical Institution, *Brit. Med. Journ.* 7th Feb. 1896, p. 341.

[2] Cf. Cheadle, *Lancet*, vol. ii. 1878, p. 657, and vol. ii. 1882, p. 48. Barlow, *Med. Chir. Soc. Trans.* vol. lxvi. p. 159; and *Lancet*, vol. ii. 1894, p. 1075.

[3] *Diseases of Children*, 1st ed. p. 326.

of fresh air, sunlight, and deficient personal cleanliness. The tubercular diathesis, in so far as it is a cause of general weakness, and predisposes to digestive disturbances and diarrhœa, may be considered a factor. But the chief cause of all is hand-feeding and the use of artificial foods,[1] together with the ingestion of starchy foods, such as potatoes. A proper proportion of animal fat, proteid and earthy salts, such as exists in the mother's milk, or in properly-prepared "artificial human" milk, is absolutely essential during the first years of life.

But an insufficient quantity of milk or an excessive amount of starchy foods does not explain all cases, since a large number of children brought up in a haphazard way do not suffer.[2] The disease is most prevalent in temperate climates and in the older countries of the world, and is very marked in great cities where fresh air and sunshine are notably absent.

Various theories have been advanced. The production of lactic acid in the intestines by excessive fermentation of the amyloid constituents of food was at one time assigned as a cause. It was conjectured that the lactic acid dissolved the calcium salts from the bone, and further acted as an irritant to growing bone. This enticing theory has been disproved, and at present there is not one which will bear searching examination.

Morbid Anatomy.—The bones in severe cases pass through three stages: (1) Stage of congestion; (2) stage of softening; (3) stage of sclerosis. It is in the first and second stages that the deformities occur, which in the third stage become fixed. In stages 1 and 2 restitution is obtainable by manipulation and the use

[1] Dr. Cheadle, in introducing the discussion on rickets at the meeting of the *Brit. Med. Assoc.* in August 1888, stated that the food factor is the only factor which is anything like constant.

[2] Beneke has studied the predisposing causes of rickets from an anatomical standpoint. He found that in rhachitis the heart is of average size, but the arteries are abnormally large. Jacobi aptly says, "As it is not probable that a chronic disorder in its slow progress should work a rapid change in the blood-vessels, the inference is a sound one, that if the disorder cannot have altered the blood-vessels, these must have given rise to or be connected with the nature of the disorder." This, by the way, is in support of Beneke's observations. The large size of the arteries explains the existence of the hyperæmic condition of the bones, especially at the epiphysial junction, and of the increase of development and thickening of the bones after the morbid process ceases. The large arteries induce a low blood pressure, and therefore there is retardation of the circulation both in bone and muscle, and the latter becomes flabby and feeble in consequence. Regarded in these lights, it would seem that Beneke's observations are very important in elucidating the predisposing causes of rickets (Abstract from a paper by C. N. D. Jones on Rhachitic Deformity, *Annals Surg.* vol. ix. pp. 241-271).

of mechanical apparatus. In stage 3 operative interference in the case of the long bones is called for. The bones are affected in two places, the periosteum and the epiphysial lines. The affection consists of diminished deposition of lime-salts, with irregular and excessive calcification of the cartilaginous matrix in which growth of the bone takes place.

The periosteum is thickened, red, vascular, and does not peel cleanly off the bone, but fragments of softened bone adhere to it. Beneath it is soft, red spongy bone, arranged in layers, and in severe cases entirely replacing the normal compact tissue. It is easy to understand, then, how readily ricketty bones bend and yield, and greenstick fractures are caused.

At the epiphyses a ring of thickening is felt at the growing line, and later the whole epiphysis is enlarged. "To the naked eye the cartilage is semi-transparent or gelatinous-looking, reddish from abnormal vascularisation, and irregular at the periphery, in place of maintaining the normal even line. Microscopic examination shows the deeper or osteogenetic layer of the periosteum to be chiefly affected, and the layers of spongioid bone beneath to consist of calcified islets arranged radially to the surface of the diaphysis. Beneath the islets of the bone are large red medullary spaces."[1] The cartilage of the epiphyses under the microscope shows excessive and irregular increase of the cells and loss of definition in the columns. In the spaces between the columns much vascular round-celled material exists. Away from the growing line masses of calcified cartilage are seen, and still further much embryonic bone is present.

Symptoms.—Among the earliest are tenderness of the bones, the child crying out when moved, disordered digestion, sweating of the head, and bronchitis. The child, if it has commenced to walk, is "taken off its feet,"[2] and some bending of the bones may be seen at this stage. The complexion is of a peculiar earthy tint, and the child sits in a heap. At this time, too, "beading" of the ribs and enlargement of the radial and ulnar epiphyses are found. The disease is often complicated by laryngismus stridulus and convulsions. The spleen and occasionally the liver are felt to be enlarged, and the abdomen is distended. Dentition is delayed, and when the teeth appear, they are craggy and pitted, deficient in enamel, soft and prone to decay readily.

[1] G. H. Makins, Treves' *System of Surgery*, vol. i. p. 365.

[2] Dr. Gee says, "A child who is not idiotic or weakened by some recent disease, and who cannot walk at the age of 18 months, is either ricketty or paralysed."

The chief difficulty in diagnosis is to differentiate between congenital syphilis and rickets. The certain signs of syphilis in infants are cicatrices around the mouth, the presence of condylomata, the rash, and the existence of nodes on the shafts of the bones. Separation at the epiphysis implies syphilis. Fracture of the shaft of a bone implies rickets. When a clear history of syphilis, however remote, in the parents is forthcoming and the bones are affected before the sixth month, the presumption is in favour of congenital syphilis rather than of early rickets. Pseudo-paralysis, arising from epiphysitis, is more often seen in syphilis than in rickets, but cranio-tabies is proper to both diseases, although more common in rickets.

The deformities of the skeleton will be considered more fully, but an outline of the treatment can be conveniently placed here.

General Treatment.—The great points are first of all a change of air, either to the seaside or into the country, and alteration of the diet. All starchy foods should be prohibited, and care should be taken that the milk has sufficient cream in it; also that the milk given does not contain excess of casein, but is well diluted with whey. A teaspoonful or more of finely-divided semi-cooked meat is of advantage twice a day after the seventh month, if diarrhœa is not present. If that should exist, the juice of underdone meat mixed with barley-water is of value, and when these fail to agree, white-wine whey may be substituted. Either cream or cod-liver oil, or maltine and cod-liver oil, will be called for, while iron is necessary when the anæmia is marked. The preparations of iron which agree well are the vinum ferri, the compound syrup of the phosphate, and the tartrate.

Osseous Deformities in Rickets

The Skull.—The circumference of the head is often much increased,[1] in some cases owing to hydrocephalus. If the hand be passed over the scalp, the position of the sutures, especially of the coronal, is defined by a thickening of the bony margins. The fontanelles are of large size, and may remain open as late as the fifth or sixth year. The defective development of the bone, especially in those parts exposed to pressure, results in more or less circumscribed areas which are yielding to the touch, and give the

[1] In the discussion on rickets at the Pathological Society in 1881, an opinion was expressed that rhachitic heads are smaller than the normal, but extended experience disproves this.

impression of the so-called "egg-shell crackling." The condition is known as cranio-tabes, and is met with also in congenital syphilis. In a case which came recently under my observation at the Evelina Hospital the whole vault of the skull was so softened, that pressure at any part produced an indentation. That cranio-tabes is due to the effect of pressure on softened bone is supported by two facts. It is generally seen in the occipital region in infants, *i.e.* where the head presses on the pillow; while in ricketty monkeys the thinnest bone is met with in one or other parietal region, owing to the habit these animals have of resting in the sitting position, with one side of the head against a support.

FIG. 137.—Well-marked ricketty chest and prominent abdomen.

A prominent, square forehead, with fulness of the lateral aspect of the frontal bones, obliquity of the upper wall of the orbits, and prominence of the eyes, are characteristic of rickets. In the parietal regions the eminence on the central part of those bones is exaggerated, and taken with the enlarged frontal eminences, the natiform appearance results. This is, however, better marked in congenital syphilis. In the face the chief error of development is in the lower jaw. Makins[1] observes the "defective development of the outer wall of this bone interferes with the acquisition of the proper arched form by the body, the incisor teeth being arranged transversely, and from them the remaining teeth diverge obliquely backwards, the alveolus being somewhat inverted posteriorly, so that the teeth point inwards. The lower margin of the body is inverted (Fleischmann). The teeth appear late, and are defective in enamel, readily becoming carious."

Rhachitic Torticollis.—Phocas[2] of Lille reports three cases of torticollis in ricketty children of 10, 15, and 18 months. The head was strongly inclined to the left, the chin was elevated, and the face turned a little to the right. There was no contraction

[1] Treves' *System of Surgery*, vol. i. p. 368.
[2] *Revue d'Orthopédie*, January 1894.

of the sterno-mastoid, and the head was easily replaced, but resumed its vicious attitude when support was withdrawn. Later, the head was thrown back, and this backward tilting was harder to prevent than the lateral. Pain was not severe, but the children were peevish and resisted examination. The lateral deformity lasted about three months, and the posterior also disappeared after a time under appropriate general treatment, and the use of a rubber collar to keep the head in position. An explanation is suggested, viz. softening of the vertebræ and weakening of the muscles and ligaments, as the cause of the trouble. It is also possible that fœtal rickets may be the cause of some cases of congenital torticollis.

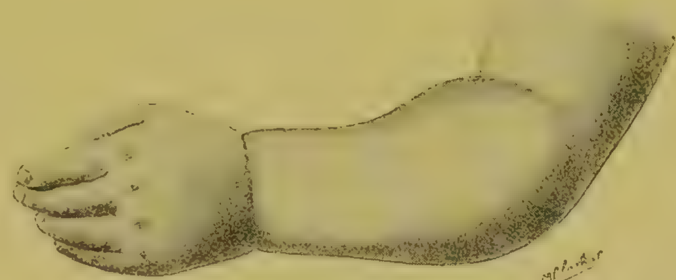


FIG. 138.—Ricketty curve of radius (Lily B——, aged 2½ years).

Spine. — The changes in the spine, which becomes at first kyphotic, and often scoliotic at a later date, are described in Section I. Chapter V. Lordosis is not uncommon in rickets.

Chest.—This subject, too, is discussed in Chapter I. Section II. on deformities of the chest. But two points in connection with this region are worthy of notice, viz. exaggeration of the curves and the occurrence of sub-luxation of the inner end of the clavicle in rhachitic children. With displacement of the bones there is frequently some scoliosis, and inasmuch as the sub-luxation is on the "convex" side of the scoliotic curve, it is probable the scoliosis may be the immediate cause, owing to the forward and upward tilting of the shoulder on the convex side, thus pushing the inner end of the clavicle out of place. Gibney,[1] in a clinical lecture, alludes to several cases, and says, "Lately we have a way of curing these that is very good. My attention was first called to it by Stimson, who had injected alcohol around the articulation, binding the parts with a roller bandage. Two or three injections serve to set up an inflammation around the joint. Several successful cases have been reported."

Rhachitic Deformity of the Arms is seen in severe cases. In the accompanying Fig. 138 the radius is seen to be prominent at

[1] *Int. Clinics*, vol. iv. 1893, p. 239.

its upper part. More frequently both bones are bent just above their inferior extremities. In the latter case the deformity is due to the habit of crawling in young children who are unable to walk. By way of treatment, daily manual efforts to arrest the curve should be made by the parents. Splints are of little use.

The Ricketty Pelvis has these characteristics. The conjugate diameter is decreased owing to the prominence of the sacro-vertebral angle. In consequence of the inward thrust of the head of the femur at the acetabulum on each side, the lateral aspect of the pelvis is flattened and the pubic arch is diminished. The tubera ischiorum approximate unduly, while the ventera iliorum are expanded by the weight of the viscera upon them in their softened state.

Fig. 139.—Typical rhachitic attitude.

The effects of these deformities of the pelvis on labour are fully discussed in obstetric works, and suitable means are there suggested of neutralising them. But in extreme cases the operation of symphysiotomy, recently taken into favour, seems to be preferable to procedures such as craniotomy, cephalotripsy, which sacrifice the life of the child, or Cæsarean section, which results occasionally in death of both mother and child.

Rhachitic Deformities of the Long Bones of the Lower Extremity are of great importance, and are discussed in Section IV. Rhachitic flat-foot is described in the chapter on Talipes.

The Rhachitic Attitude is an exaggeration and a persistence of the attitude of the infant when learning to walk. The rhachitic child stands with the feet wide apart, the thighs flexed, the knees bent, the back arched, and the shoulders thrown back (Fig. 139). Much light is thrown upon the cause of this attitude in a paper written by Arbuthnot Lane in the *Guy's Hospital Reports*, vol. xxix., especially on p. 32. But some of the lordosis is due to the prominent abdomen of rhachitic children, in addition to the causes mentioned by Lane.

SECTION IV

DEFORMITIES OF THE LOWER EXTREMITY

CHAPTER I

INCURVATION OF THE NECK OF THE FEMUR (COXA VARA)[1]

General Account of the Deformity—Etiology—Symptoms—Pathology—Diagnosis—Prognosis—Treatment.

THIS condition was described in 1889 by E. Müller,[2] who presented four cases, in patients aged 16, 17, 18, and 19 years. In all the deformity was one-sided. In 1890 Rotter[3] detailed to the Medical Society at Munich a boy of 15 with bending of the neck of both femora. Hoffa,[4] as the result of resection of the hip-joint, obtained a specimen showing very great deformity. Whitman, in his article in the *Transactions of the American Orthopædic Association,* gives four cases with photographs, some of which he has kindly allowed me to reproduce here. Before Müller described the affection in 1889, bending of the neck of the femur in the otherwise healthy bone of adolescents had been observed,[5] and Keetley's case of rhachitis adolescentium alluded to on p. 253 was, in all probability, an example of the affection under consideration.

But incurvation of the neck of the femur is not met with in

1 Much of the information on this subject has been obtained from an excellent paper by Royal Whitman, "Observations on Bending of the Neck of the Femur in Adolescence," *Trans. Amer. Orth. Assoc.* vol. vii. pp. 270-293.

2 "Ueber die Verbiegung des Schenkelhalses im Wachtthumsalter, Ein neues Krankheitsbild," *Beitrage zur Klin. Chir.* 1889, Bd. iv. s. 137-148.

3 "Ein Fall von doppelseitiger rhachitischer verbiegung des Schenkelhalses," *Münchener Klin. Wochenschrift,* 12th Aug. 1890.

4 "Zur Casuistik der Verbiegungen des Schenkelhalses," von Julius Schultz. *Zeitschrift für Orth. Chir.* Bd. i. s. 55.

5 Thus Whitman, *loc. sup. cit.* p. 287, mentions Roser, *Schmidt's Jahrbucher,* 5 Supplementband, Leipzig, 1843, p. 257; Zeis, 1851, *Beitrage zur Pathologischen Anat. und zur Pathol. der Hüftgelenks,* No. 1; Richardson, 1857, "Deformity of the Neck of the Thigh Bone simulating Fracture, with Ossific Union," *Trans. Philadelphia Path. Soc.*

adolescence only. Lauenstein[1] had in his possession specimens taken from a child, aged 6 years, who died after osteotomy for other rhachitic deformities in the lower limbs. Both femoral necks in this case were much bent. Nélaton[2] had previously noticed elevation of the trochanters in rhachitic children. Two cases have recently come under my own observation at the National Orthopædic Hospital, one in a child of 4, and the other in a child of 7. In the first-mentioned case the affection was bilateral, and the trochanter was half an inch above Nélaton's line. In the second case the left hip only was affected, and the trochanter was three-fourths of an inch above Nélaton's line. In neither was there any of the downward movement of the trochanter on traction of the leg, so characteristic of congenital hip displacement, a condition with which coxa vara has been often mistaken.

FIG. 140.—Incurvation of the neck of the femur. Outline of the depressed neck of the femur in Müller's specimen, contrasted with the normal position shown by the dotted line (after Royal Whitman).

FIG. 141.—Incurvation of the neck of the femur. Outline of the deformity in Hoffa's specimen. The dotted line shows the normal position (after Royal Whitman).

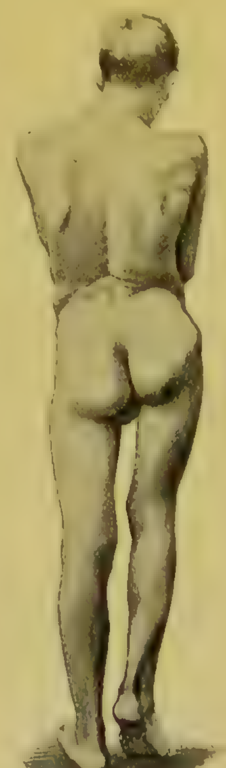


FIG. 142.—Incurvation of the neck of the femur. From a photograph by Dr. Royal Whitman of Case 52, showing the apparent shortening of the right leg, the prominence of the trochanter, the adduction and compensatory tilting of the pelvis.

With reference to the *etiology*, in the majority of cases coxa vara is due to rickets, infantile and adolescent. If the latter, the disease is then said to be "local" in its manifestation. With this opinion Whitman in his article agrees, but he thinks that in some cases the bending

[1] "Bemerkungen zu dem Neugungsworkel des Schenkelhalses," *Archiv fur klin. Chir.* Bd. xi. s. 244.

[2] Art. "Rhachitisme," *Nouveau dict. de med. et de Chir.* vol. xxx. p. 382.

of the neck is the result of over-weight, acting especially at the time of puberty.

Symptoms.—E. Müller described them as follows: "In adolescence without apparent cause, or following slight injury, the patient begins to limp, and to complain of fatigue and pain about the affected joint on exertion. Shortening of the limb is soon apparent, and is caused by elevation of the trochanter above Nélaton's line. The limb is usually extended or flexed to a few degrees and somewhat rotated outward. The motion of the joint is slightly diminished, particularly in abduction. There is no local tenderness on pressure." To these symptoms Rotter added an awkward rolling joint due to adduction of the thighs, with fatigue and pain on exertion. Royal Whitman carefully details the symptoms of the four cases mentioned in his paper,[1] and I quote two of them here briefly.

Case 52 (Royal Whitman).—"A boy, aged 15 years, was seen with 1½ inch actual shortening. This amount of shortening had all come on within one year, as at the age of 14 'he was in perfect condition.' After that age he noticed a gradually increasing limp, and the application of a cork sole became necessary. Flexion, extension, and rotation remained free, but abduction became entirely restricted. In the figure presented by Whitman adduction of the right leg, tilting of the pelvis, and scoliosis are seen (Fig. 142). It should be added that there was no up-and-down movement of the head of the femur in the acetabulum. All treatment was refused." [2]

Case 53 (Royal Whitman).—"The boy was aged 16 when he came under Dr. Whitman's observation. In infancy he was said to have had weak ankles and flat-feet. For two years he had been working as a grocer's boy, standing and carrying heavy weights. Lately there had been soreness and stiffness about the right hip, which were attributed to 'growing' pain. On resting, these symptoms disappeared. When he resumed work they reappeared in an aggravated form, and were increased by extra work, but diminished by rest. On examination, the trochanters were found to be slightly elevated above Nélaton's line, the gait was rolling in character, and abduction at the hip was limited to a third of its extent, and more marked on the right side than the left. The treatment, consisting of rest and gymnastic exercises, was neglected, and three months later he again came to the hospital, walking with much effort, the rolling gait being most marked and abduction of the legs limited 'at the line of the body.' Crutches were now ordered. Four months later the patient was seen. The adduction as the patient moved on crutches was so great that the legs were crossed, 'scissor-legged de-

[1] *Trans. Amer. Orth. Assoc.* vol. vii. pp. 270-293, "Observations on Bending of the Neck of the Femur in Adolescence."

[2] Petit. *Les jambes en ciseaux.* Cong. français des Chir. 1892, p. 733.

FIG. 143.—Incurvation of the neck of the femur. The Fig. shows the prominence of the trochanters in Case 53 (R. Whitman).

FIG. 144.—Back view of Case 53, showing the relative prominence and elevation of the trochanters, and the absence of the normal lumbar lordosis (R. Whitman).

FIG. 145.—From a third photograph of Case 53, showing the involuntary crossing of the legs in flexing the thighs on the body (R. Whitman).

formity.' On flexing the right thigh the limb crosses that of the opposite side, and with the thigh at a right angle with the trunk, outward rotation is such that the heel is in a line with the opposite anterior superior spine. With the limbs parallel and extended, separation of the knees to 3½ inches only is possible. Flexion at once crosses them. The trochanters are now 1½ inches above Nélaton's line. Dr. Whitman, in the belief that the bending of the necks of the femora had nearly reached its limit, proposed to divide those bones below the trochanters so as to obtain sufficient abduction" (Figs. 143-146).

Fig. 146.—From a photograph of Case 53, taken 6 months after Fig. 143, and showing the apparent shortening of the legs relative to the length of the body (R. Whitman).

Cases 3 and 4 of Whitman's presented symptoms similar to those in case 52 and those enumerated by E. Müller. Case 3 of Whitman's was relieved by absolute rest, regular gymnastic exercises, massage, and stretching of the affected hip and knee; case 4 by a "traction" hip-splint, massage, and exercise.

I have ventured to give the chief points of these cases, as they afford us a good description of a deformity but recently recognised and understood.

To sum up, the symptoms are :—

1. Age—generally adolescence, less often childhood.

2. Class of patients—those who carry weights or do much walking, and are subject to prolonged fatigue.

3. Onset, peculiar stiffness of the hip referred to "growing" pains. The stiffness is worse on rising after sitting for a time, but is relieved by complete rest.

4. Limping, if one side is affected; waddling, if both sides are affected.

5. Shortening, amounting to as much as $1\frac{1}{2}$ inch.

6. Prominence of the trochanters, especially on flexing the thighs.

7. Displacement of the trochanter above Nélaton's line and backwards as well.

8. Rotation outwards of the limb, and eversion of the foot.

9. Limitation of inversion and final loss of abduction, with, in

an extreme case, "scissor-legged" progression and inability to walk without crutches.

10. Tilting of the pelvis and consecutive scoliosis.

11. Rhachitis in some cases has occurred in childhood.

FIG. 147.—Unilateral coxa vara. There are seen prominence of the left trochanter, slight tilting of the pelvis, and genu valgum on the right side (R. Whitman).

FIG. 148.—Unilateral coxa vara. The effect of flexion of the right thigh in increasing the deformity is well seen (R. Whitman).

Negatively:

1. No local swelling (except that presented by the displaced trochanter) or tenderness on pressure.

2. Absence of the up-and-down movement on traction characteristic of congenital hip displacement.

3. Suppuration never occurs, nor thickening of the trochanter.

Pathology.—Hoffa's case (Fig. 141) showed that the neck of the femur had bent in such a way downwards and backwards that the head of the bone rested on the trochanter minor at an angle of 60° with the shaft, as contrasted with the normal of 28°. On section there was no evidence of previous disease, but the structural arrangement of the cancellous tissue differed from that which is usual. The femur was also rotated outward, the trochanter was raised and pushed nearer to the middle line of the body. The difficulty in flexion of the limb arises from the trochanter coming into contact with the prominent upper and posterior margin of the acetabulum. Local rhachitis may be a cause, but the incidence of the disease in patients liable to much standing and prolonged fatigue, together with absence of deformities in other of the long bones, points to the chief factor in production being over-weight acting upon a slender neck of the femur.

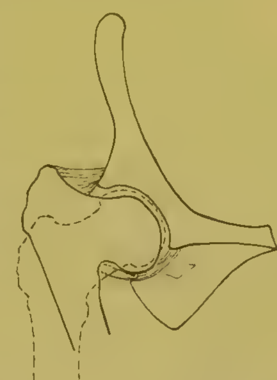


FIG. 149.—Cross-section of the pelvis and deformed femur. A scheme to show the effect of the deformity in limiting abduction of the limb. The dotted outline shows the normal relation (R. Whitman).

Diagnosis.—1. From congenital displacement of the femur. The symptoms are much alike in respect of the prominence of the trochanters, and their displacement upwards and backwards, the waddling gait and the shortened limb; but in congenital displacement the limb can always be lengthened by traction, and the gain thus obtained is at once lost on ceasing traction, while the head of the bone is felt not to be in the acetabulum.

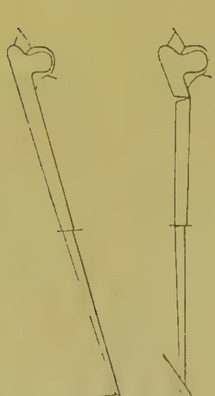


FIG. 150.—Outlines showing the effect of sub-trochanteric osteotomy in overcoming the adduction of the limb (R. Whitman).

2. From coxitis. Bruns of Tubingen[1] has observed about thirty cases of coxa vara, and concludes that of a large number of cases diagnosed as incipient coxitis, several were examples of incurvation of the neck of the femur.

3. From fracture of the neck of the femur, upper part of the shaft, or separation of the epiphysis. In these cases the history and crepitus afford a guide.

Prognosis.—Rest quickly relieves the pain, and the depression of the head and neck of the femur cease. If left to itself, the miserable condition detailed in the second case of Whitman results.

Treatment.—In the early stages entire rest, local massage, and

[1] 23rd German Surg. Congress. Quoted in *Med. Week*, 27th April 1894, p. 193.

passive motion in the direction of the limited movement will effect much. Failing these, complete recumbency and the employment of traction to the limb are of service. If the depression of the neck has apparently reached its limit, infra-trochanteric osteotomy, removing a wedge-shaped portion of the bone will do much to restore the power of abduction and inversion. The subsequent use of a cork sole will be necessary, on account of the shortening, if the affection is unilateral.

CHAPTER II

GENU VALGUM, VARUM, RECURVATUM, AND BOW-LEGS

Genu Valgum, Varieties, Causation, Morbid Anatomy, Symptoms, Prognosis, Diagnosis, and Treatment—Osteoclasis and Osteotomy—Genu Varum, Causes and Treatment—Genu Recurvatum—Curved Tibia and Fibula—Syphilitic Curvature of Tibia.

Genu Valgum

Synonyms.—English, *In-knee, Knock-knee ;* Latin, *Genu Introrsum ;* German, *Knickbein, X-bein, Bäckerbein, Ziegenbein, Kniebährer, Knieng,* and *Schimmelbein ;* French, *Genou cagneux, Genou en dédans;* Italian, *Ginocchio torti all' indentro.*

Fig. 151.—Extreme ricketty deformity and knock-knee.

Definition.—Genu valgum is a deformity of the lower extremity in which, when the legs are fully extended on the thighs, an angle obtuse externally exists at the knee-joint.

Varieties.—1. *Rhachitic Genu Valgum.*— This occurs in early childhood between the first and fourth years, although in severe cases of rickets it may be seen during the first year, and, according to Dittel (quoted by Bradford and Lovett), even at birth.

2. *Static Genu Valgum,* or genu valgum adolescentium. The onset of this form occurs between the twelfth and eighteenth year.

By some the pathology of this variety is to be found in an attack of "late" rickets. But this supposition is gratuitous, inasmuch as other signs of rickets are absent, and the knee-joints are often the only parts affected.

3. *Traumatic Genu Valgum.*—The causes of this are, (*a*) after operation for genu varum, when the correction has been excessive; (*b*) from lateral bending of the bone after excision of the

FIG. 152.—Unilateral genu valgum arising from injury (Case 54).

knee; (*c*) from fracture of the lower end of the femur or upper end of the tibia, and from separation of the epiphyses in that situation. Fig. 152 represents a case of traumatic genu valgum which came under my notice in 1893.

CASE 54. *Traumatic Genu Valgum after Injury to Lower End of Femur, Osteotomy.*—John M——, aged 12 years, was run over three years ago, and taken to Guy's. It was there found that the lower end of the femur was fractured. He was discharged with fair union. Since then the leg has been getting weaker, and now presents the condition seen in Fig. 152.

He was admitted to the National Orthopædic Hospital, and I performed an osteotomy. The result was satisfactory.

4. *Inflammatory Genu Valgum.*—This arises from acute inflammation in the shaft of the femur, or epiphysitis at the lower extremity of that bone, or from tubercular disease of the knee-joint. In the last-mentioned disease there has been destruction of the ligaments and erosion of the joint surfaces, followed by displacement outwards and backwards of the tibia, and eventually ankylosis.

5. *Paralytic Genu Valgum,* occurring as a complication of talipes valgus or calcaneo-valgus after acute anterior polio-myelitis.

The first and second varieties are of importance, and constitute nearly the entire number of cases met with; while the third, fourth, and fifth varieties are seldom seen, and it is beyond the scope of this work to discuss them at any length.

Causation of Genu Valgum.—Inasmuch as bending of the shafts of the bones constantly occurs in rickets, and many cases of knock-knee are rhachitic, it was readily taken for granted by some writers, especially before the recent and more exact observations on the subject, that the explanation of knock-knee was to be found in bending of the diaphysis. But unequal growth of the epiphysial lines is known to occur in rickets. So that the production of the deformity was assigned either to bending of the shaft or inequalities at the epiphysial line. While this statement fails to account for cases of knock-knee at all ages and under all conditions, it is certainly true so far as those early cases, occurring in the course of an attack of rickets, are concerned, and particularly so when weight has not been borne on the feet.[1] The assumption, however, of the erect position brings another factor into play. This is the position assumed by the lower extremities in the "attitude of rest." Subordinate to this, but acting simultaneously with, and influencing the question of the ultimate degree of the deformity, are other conditions, which are comprised under the term "muscular weakness." Such a state of weakness arises from over-fatigue, the bearing of heavy weights, constitutional debility, or, in childhood, the persistence to a late date of rickets.

We have then before us three causes of genu valgum, viz. (1) bending of the lower part of the shafts of the femur and upper part of the tibia; (2) unequal growth of the epiphysial line; (3)

[1] C. N. Dixon-Jones draws attention to the fact that in crawling along the floor the weight of the body is thrown on the knees and inner arches of the malleoli, thus tending to produce a genu valgum. *Annals of Surgery,* vol. ix. p. 255.

mechanical causes. The first and second causes are purely rhachitic, and have their origin in structural alterations from the beginning. The third cause is "static" in its inception.

To discuss more fully the influence of the "attitude of rest." In standing on both feet, a perpendicular line drawn through the centre of the head of the femur passes through the knee-joint, nearer the external than the internal condyle, and the wider the pelvis is in proportion to the height, the more is this line displaced outwards; so that normally greater weight is transmitted through the external condyle of the femur than the internal. But to compensate for the obliquity of the femur, and to bring the articular surfaces of the knee-joints horizontal, the internal condyle is normally $\frac{1}{4}$ to $\frac{1}{2}$ inch longer than the external. In standing for any length of time, the muscles tire and considerable strain is thrown upon the ligaments. In the lower limb the ligaments which in the "attitude of rest" bear the greatest strain are the Y-ligament of Bigelow, the internal lateral ligament of the knee-joint, and those ligaments which sustain the arch of the foot. The "attitude of rest" in standing on both feet is therefore one in which the thighs are extended on the body, the knees on the thighs, and the feet separated widely in order to give a firm base of support to the body with the least muscular fatigue. The wider the feet are separated, the greater is the pull on the internal lateral ligament of the knee, and the greater the pressure between the external condyle of the femur and the external tuberosity of the tibia. For a time the internal lateral ligament sustains the strain, but it gradually yields and knock-knee commences. At the same time with the persistence of the strain, the arches of the foot give way, and the foot is everted. The last-named complication aggravates the strain on the internal lateral ligament, and increases the pressure on the external condyle of the femur. At the same time the internal condyle, being relieved of the normal pressure on it, undergoes lengthening, which in its turn perpetuates the deformity. That this is the explanation of static genu valgum under the influence of a vicious "attitude of rest" is supported by two facts, viz.:—

(*a*) In the early stages of genu valgum a distinct space exists in the knee-joint between the internal condyle and the corresponding tuberosity of the tibia. If the limb be extended, the two parts may, by lateral pressure on the leg, be made to meet with a distinct click, and the deformity be temporarily rectified.

(*b*) If specimens of knock-knee be examined, a distinct depression, deeper than the normal, is seen on the upper surface of the external tuberosity of the tibia, pointing to atrophy from pressure. I fail, then, to see how genu valgum can be accounted for by primary lengthening of the internal condyle. Secondarily, however, lengthening of this part does occur.

The Results are as follows: 1. The gait is shambling and awkward, partly on account of the weakness of the ligaments, partly because the knees tend to cross, and in some measure on account of the coexisting flat-foot.

2. Contraction of the biceps tendon, ilio-tibial band, and external lateral ligament ensue. The biceps tendon and ilio-tibial band are felt as firm cords on the outer side of the limb, and in many instances act as hindrances to the reposition of the limb.

3. The tibia is rotated outwards. This comes partly from the contraction of the biceps, and partly from the obliquity of the bearing surface of the femur. The patella undergoes sub-luxation outwards, and in severe cases is on the outer aspect of the limb.

4. The lateral mobility is often extreme, rotation of the extended leg is often possible through an angle of 45° to 60°. When it reaches the last-named degree, some hyper-extension of the knees will be noticed on standing.

5. In those cases in which the affection is unilateral, or more advanced on one side, obliquity of the pelvis is present and one limb is shorter. Particularly is this so if genu varum exist in the other limb. Scoliosis is often a result of the inequality of the limbs.

6. The occurrence of flat-foot has been mentioned, but occasionally in severe cases of genu valgum the feet became permanently inverted on account of the efforts made by the patient to prevent spreading of the feet at the base of support. Bow-legs are sometimes present with knock-knee, and if the convexity is antero-internal, increase the deformity and the difficulty in walking.

Morbid Anatomy.—In purely rhachitic cases a curvature is seen in the lower fourth of the femur and upper part of the tibia. According to Volkmann, quoted by Reeves,[1] the lower epiphysis of the femur may also be twisted or rotated out. In some rhachitic cases there is said to be overgrowth of the cartilage at the inner side of the growing line. This is possibly secondary to the diminution of pressure through that part of the epiphysial line.

[1] *Bodily Deformities*, p. 241.

The internal condyle is longer than the external, and the inequality is readily seen if the patient be placed in the supine position, with the legs fully flexed. The external condyle is atrophied and flattened, and its articular cartilage is thinned. Sometimes the normal depression on the upper surface of the external tuberosity of the tibia is increased, while that on the internal tuberosity is shallower than natural. Reeves mentions that "an osseous spiculum is frequently present near the insertion of the internal lateral ligament in bad rhachitic examples." The elongation of the tendons and ligaments on the inner side and the contraction of them on the outer side have been already alluded to. Hypertrophy of the inner part of the growing line in non-rhachitic cases at puberty is described by Mickulicz. The hypertrophy is on the shaft side of the epiphysial line. But while Mickulicz is inclined to look upon it as the primary cause, I venture to think it is the result of insufficient pressure on that part, and is a secondary matter. The "attitude of rest" and its results in persons of weak muscular development explain, it seems to me, very fully the changes in the joints and ligaments of knock-knee at the time of puberty. I fail to see how the supposed existence of late and local rickets can have much to do with the matter. If so, where are the constitutional symptoms which normally accompany rickets?

Symptoms.—Those which are complained of by the patient are few, and consist of difficulty in rapid progression, pain and tenderness over the internal lateral ligament, and a disposition to become readily tired.

On looking at the patient when standing, the acute angle formed by the legs, the rolling gait with swinging of the pelvis, and the eversion and abduction of the knees and feet are at once seen. In advanced cases the gait is a combination of a roll and a jerk, the latter movement arising from the yielding of the internal lateral ligament as the full weight of the body bears on each lower extremity.

The outward rotation of the tibia and displacement of the patella have been noticed; but in some severe cases the tibia is rotated inwards, the explanation of the latter event being obscure. Separation between the malleoli varies from a few inches to 18 or more, and three lines drawn one through each tibia, and one uniting the two malleoli, may make an equilateral triangle.

It is well known that on flexion of the legs in genu valgum the deformity disappears. Several theories have been advanced in explanation. Bradford and Lovett[1] remark: "It would seem to be most easily accounted for by the fact that the posterior surfaces of the condyles of the femur were not so much affected, but that the deformity was produced by an alteration of the lower surfaces of the condyles alone, and that when (on flexion) the facets of the tibia ceased to articulate with the latter, the abnormality ceased—a state of affairs which coincides very well with the static theory of the production of the deformity." This expression of opinion is very similar to that of Guéniot. Mr. Reeves advances Busch's explanation, which is that the disappearance on flexion is due to the downward displacement of the internal condyle causing an obliquity of the articular line, and a consequent oblique axis of rotation on flexion. Mr. Reeves illustrates it by the mechanical arrangement of a rule jointed at *a, d*, with its limbs *b* and *c* forming an obtuse angle (Fig. 153). So long as the limbs *b* and *c* are in the same plane there is an angle prominent at *d*, but when *c* is bent on *d* to 180° the two limbs of the rule become parallel. Unfortunately for this explanation the joint at *a, d* is straight, and the illustration is not applicable to genu valgum in which the line of articulation between the bones of the knee-joint is admittedly oblique.

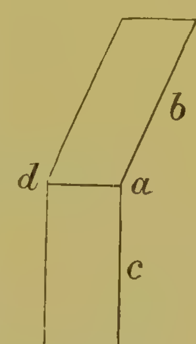


FIG. 153.—To illustrate the disappearance of the deformity in genu valgum on flexing the knee (Reeves).

It seems, then, that no valid explanation is forthcoming which will satisfy all the mechanical conditions of genu valgum. The importance, however, of this disappearance of the deformity on flexion has a distinct bearing on treatment, viz. that to rectify the deformity by mechanical appliances the knees must be kept in the extended position.

Methods of estimating the Degree of Deformity.—1. The simplest is to place the patient in the standing position, taking care that the knees do not quite touch,[2] and that the condyles are not rotated internally, and then note the distance between the malleoli.

[1] *Op. cit.* pp. 647, 648.

[2] Normally with the malleoli in contact on standing, the knees are separated by an inch or more. In order, then, to ensure a correct estimate of the deformity in genu valgum, the same relative position of the internal condyles should be obtained. Thus, in the case of an adult, it is well to place a book 1 inch in thickness, and in a child one of ½ inch, between the knees. It is a faulty and deceptive way of measuring to place the knees touching one another. The measurement at the malleoli is thereby reckoned at from 1 to 2 inches less than it really is.

2. Another method is to sit the patient upon a sheet of white paper with the toes pointing upward, and trace the outline of the limbs with a pencil. The objection to this is that the separation of the malleoli in sitting is no measure of the separation in standing, since the laxity of the ligaments at the knee-joint varies much in different individuals, and it is exactly the standing position which emphasises the real extent of the deformity.

3. Mr. Reeves measures the height of a perpendicular drawn from the base to the apex of an obtuse triangle formed by the femur, tibia, and a straight line joining the great trochanter and external malleolus. The perpendicular is drawn opposite to the knee-joint. It seems to me that the first plan is open to the fewest objections when properly carried out.

Prognosis.—This question may be considered from two points of view. Will the child grow out of it? Will an operation be necessary? In answer to the first question it may be said that if the case be a slight one, *i.e.* merely a little separation of the malleoli in walking, and the general health be good, recovery will ensue without treatment. But with any failure of the general health or excessive fatigue in walking or standing, the case will become rapidly worse.

As to the question of operation, there can be no doubt that extreme degrees of genu valgum, even with as much as 18 inches separation between the malleoli in an adolescent, can be rectified by instrumental treatment. But the duration of recumbency is so great, and this method of treatment so tedious, that in a case in which the bones no longer spring on bi-manual pressure, or if the child is over 5 years of age, osteotomy should be advised in order to save time and expense.

Diagnosis.—There can be no difficulty in recognising a case of genu valgum; the chief point is to assign the appropriate cause. The traumatic form is known by the history; the pathological by the altered outline of the joint, loss of mobility, and other signs; and the paralytic variety by other signs, such as wasting elsewhere in the limbs. Care should also be taken not to assign late rickets as a cause, unless other signs of that disease are present.

Treatment.—The three stages which bones affected with rickets undergo have been stated to be:—

1. Congestion.
2. Softening.
3. Eburnation.

In considering the treatment of genu valgum arising from rickets, these three stages should be borne in mind, as the line of treatment in any particular case must depend upon the state of the bones.

In static genu valgum there are two stages, viz.—

1. Relaxation of ligaments and muscles.
2. Osseous deformities arising as the result of relaxation.

As in rickets, these stages afford us guides in treatment. I take it that neither in the softened stage of the bones in rhachitic genu valgum, nor in the early stage of relaxed muscles and ligaments in the static variety, ought an osteotomy to be performed, inasmuch as there are at our command other and less severe measures.

The treatment of genu valgum may be placed under three headings:—

1. General Treatment; Rest and Local Manipulation.
2. Mechanical and Manipulative.
3. Operative.

But before discussing these points the question may be asked, Do slight cases of genu valgum rectify themselves? This has been touched on in dealing with the prognosis.

Mr. Rushton Parker [1] thinks that cases of slight knock-knee show a strong tendency towards recovery if the child be prevented from walking—a very difficult matter. Then again, how small is the number of adults with knock-knee who present themselves for treatment for the first time at hospitals compared with the number of children who are seen with this affection. Whitman [2] observed the proportion of knock-knee cases in 2000 adult males seen consecutively in the streets of Boston. He found only 32 cases. Gibney [3] in six years noted 276 cases of genu valgum; of these, 255 occurred in children under 14 years of age. This and the preceding observation seem to bear out the contention that as the patient attains adult life the slighter cases of knock-knee undergo spontaneous rectification. Taking my experience of the three hospitals to which I am attached, I notice that it is only severe and moderate cases which are brought for treatment, the slight forms not presenting themselves. We may then take it that in a certain proportion of cases, notably the ricketty ones, the deformity disappears spontaneously.

1. *General Treatment; Rest and Manipulation.*—If the case is that of a ricketty child, the dietary and hygienic measures detailed

[1] *Liverpool Med. Chir. Journ.* Jan. 1887, p. 119.
[2] *N.Y. Med. Rec.* 30th July 1877. [3] *Ibid.* 29th Nov. 1884.

on p. 257 should be attended to. A change of air to the country or seaside is of special value, and the child should, as far as possible, be kept off his feet. If difficulty arise in so doing, a long outside splint, reaching from the pelvis to 4 inches below the external malleolus, and with the whole length of the limb, especially the knee, well bandaged to it, is effectual. In addition, by keeping the knee extended, recovery is accelerated. Not only has "splinting" the advantage of keeping the child at rest, but if for any reason the patient pass from observation, it anticipates, so to speak, any increase of the deformity.

Manipulations are best carried out as follows:—The splint, if any, having been taken off, and the limbs having been douched with tepid water, the knee is pressed outward with one hand and the tibia inward with the other hand of the nurse, the legs being extended on the thighs. The pressure is maintained for a few seconds and then relaxed, the movement being repeated several times. At no time should pain be caused, but the pressure must be uniform, and at each sitting some improvement will be noticed. Afterwards the patient's limbs are well rubbed by the nurse. This simple procedure may be carried out night and morning. When the muscles have become larger and firmer, the child should be taught to stand and walk with the feet straight in front, and must not be permitted to assume the "stand-at-ease" position.

In the slighter static cases, rest and manipulation, with douching and shampooing the limb, will soon remedy the deformity.

2. *Mechanical Treatment.*—The scope of this form of treatment is limited by two anatomical conditions, viz. absence of eburnation of the bones in children, and, in adult cases, relaxation of the ligaments without marked elongation of the inner condyle of the femur and contraction of the biceps and ilio-tibial band. It cannot, however, be denied that good results have been obtained in even extreme cases by mechanical arrangements which have a rack opposite the knee-joint. The apparatus is put on the outer side of the limb, and is accommodated to the deformity. It is then screwed up from time to time until the genu valgum is overcome. I have seen a case in which there were 14 inches of separation between the malleoli cured in this way. But there can be no question that the treatment is extremely tedious, often painful, and detrimental to the patient's general health, on account of the long confinement.

The *principles* upon which mechanical treatment is based are very simple, viz. traction upon the knee from a stiff rod or splint taking its bearings from the great trochanter and the outer side of thigh and legs; continuous extension of the leg; no interference with walking beyond the limitation of the knee movements. There are various apparatus in which these principles are attained, but in this place only a few can be mentioned.

The simplest arrangement is two padded wooden splints reaching from the pelvis to the external malleoli. A broad band of webbing attached to the upper end of each splint and buckled around the pelvis keeps them in position above, while each is secured to the

FIG. 154.—Knock-knee before treatment by apparatus alone.

FIG. 155.—Knock-knee after treatment by apparatus alone.

outside of the limb by bandages or broad strips of webbing, care being taken to make lateral traction outwards on the knees. In place of bandages or webbing at the knees, a leather knee-cap may be fixed to each splint in such a way that it can be buckled firmly at that spot.

Bradford and Lovett use a simpler and less unsightly arrangement than the above-mentioned. Their apparatus consists of "a light steel rod attached below to a steel sole plate, and jointed at the ankle. It runs up the outside of the leg as far as the trochanter, and then the rod is bent backward and upward, to lie against the upper part of the buttock, and to serve as an arm by which the leg can be inverted if the child toes in or out in walking. The knee is drawn upon by a square leather pad pulling from the shaft opposite the knee. The upper ends of the apparatus should be buckled together posteriorly by two straps, one connecting the tips of the posterior arms, and sometimes another may be needed running across the lower abdomen connecting the shafts. By lengthening or shortening these straps, it is evident that any desired degree of inversion or eversion of the foot may be produced. Often the posterior strap alone is all that is needed." This arrangement commends itself strongly, on account of its simplicity, utility, and comparative cheapness.

A more complicated and costly arrangement is figured below (Fig. 156). It is suitable to those cases in which ligamentous relaxation is pronounced at the hip and ankles in addition to the knees, and to those in which the bones of the limb readily yield to lateral pressure through their whole extent.

FIG. 156.—Walking apparatus for severe genu valgum, not suitable for osteotomy.

The principles of this instrument are support to the limb, stretching the external lateral ligament and ilio-tibial band, and taking the strain off the internal lateral ligament, thereby enabling it to contract to its normal length. At the same time, the removal of excessive pressure allows the external condyle to grow. The difficulties of the mechanical treatment are the duration, the pain, if the case is at all severe, and, if elaborate apparatus is used, the costliness. The duration of treatment may be shortened by *division of the biceps and ilio-tibial band.* These little operations present no difficulty, and cocaine is a sufficient anæsthetic. The patient lying semi-prone flexes the limb, the movement being resisted by an assistant, so that the tendon becomes tense. The part having been rendered aseptic, the surgeon passes the knife on the flat about 1 inch above the joint vertically on the inner side of the biceps tendon, and as close to it as possible. Care is taken to guide the knife around the tendon, and the edge of the knife is turned towards it; the assistant then extends the limb, and the tendon is severed. The external popliteal nerve is in no danger if these precautions are observed. Care, however, should be taken not to transfix the tendon, as a re-introduction of the knife is embarrassing, nor should the point be dipped too deeply. If it is, the superior external articular artery may be wounded. The ilio-tibial band is readily divided on the outside of the limb. Should any doubt exist as to the exact position of the structures, the ilio-tibial band should first be identified by making it tense, and tracing it down to the head of the tibia; the structure next behind and somewhat internal is the biceps tendon, while the external popliteal nerve is internal to the biceps, and lies deeper than it. So long as the point of the knife is entered on the inner side of the tendon, and follows *closely* round in getting beneath it, no danger to the nerve can ensue.

3. *Operative Measures.*—They are:—

(*a*) Osteotomy.

(*b*) Osteoclasis.

(*c*) Forcible manual rectification by Délore's method.

(*d*) Erasion of the knee or arthrodesis, which is suitable only for some cases of paralytic genu valgum.

It is convenient, in the first place, to speak briefly of osteoclasis and forcible reduction, leaving osteotomy for fuller consideration.

Osteoclasis as a means of treatment of genu valgum has found some advocates, especially since instruments have been designed to break the bone with precision. It is held in favour in France; but, appreciating the brilliant results of Sir William Macewen's work, English surgeons have not practised osteoclasis to any extent. In France, Délens, Demons, Rollin and Mollière advocate it, and the last named have designed an osteoclast which "will fracture the lower end of the femur 2 inches from the joint without injuring the articulation."[1] Dr. Grattan of Cork has also designed a form of osteoclast which fractures bones with much certainty and cleanness.

It seems to me that osteoclasis has but one advantage, viz. a simple fracture is produced, whereas in osteotomy a compound fracture results. But there are varieties of compound fractures. If the fracture is transverse, completely aseptic, and the external wound is so slight as to heal within a few days, as occurs in osteotomy, the lesion is but little or no more serious than a simple fracture. Whereas in osteoclasis it cannot be denied that ecchymosis of the soft parts, splintering of the bone, separation of the epiphysis, and rupture of the external lateral ligament have occurred. So that the one advantage of the fracture being a simple one is a

[1] *Bull. et Mem. de la Soc. de Chir. Paris*, 1883, vol. ix. p. 885.

poor set-off against these serious contingencies.[1] I should not myself perform osteoclasis in preference to osteotomy for genu valgum. One American writer[2] thus forcibly expresses himself: "The osteoclast is an instrument of tremendous and brutal power, which I hope will never be generally adopted by American surgeons." As some one well puts it, "The osteoclast should become an historical surgical reminiscence; while Macewen's chisel should be canonised as the ideal scientific corrector of bone deformities."

Forcible Manual Rectification.—The chief advocate for this procedure is Délore, but what has been said as to the disadvantages of osteoclasis applies with equal force to forcible manual rectification. The method has been before the profession for several years, but has never commended itself to the general notice of surgeons. In experimenting on the cadaver, separation of the epiphyses of the femur and tibia, rupture of the periosteum, and laceration of the external lateral ligament have been produced.[3] In one case, which died twenty-nine days after the operation, Délore found that the external halves of the joint surfaces were not in contact with each other. He admits that frequently the external lateral ligament is ruptured. It appears to me that forcible manual rectification for genu valgum is unscientific.[4]

[1] Rédard, *Chirurgie Orthopédique*, p. 588, thus tabulates the points respecting osteoclasis and osteotomy:—

Osteoclasis.	*Osteotomy.*
1. Requires a special apparatus.	No special apparatus needed.
2. Simple fracture is produced.	Compound fracture is caused.
3. If the osteoclast is not correctly applied, the fracture is not transverse; splinters and fissures are caused.	Unless properly carried out, in fracturing the remainder of the bone, the splinters may cause damage.
4. The sequelæ are mild, demanding little watching, but some ecchymosis and limitation of movement in the joint may occur.	The sequelæ are also mild; there is rarely effusion into the joint.
5. Duration of treatment shorter.	Duration of treatment longer.

But it seems to me that from a perusal of his conclusions, Rédard is holding a watching brief on behalf of osteoclasis, and is not a thorough advocate of it.

[2] C. N. Dixon-Jones, *Annals of Surg.* vol. i. p. 257.

[3] Barbier, "Étude sur le Genu Valg.," *Thèse de Paris*, 1874.

[4] Möhring (*Zeitschr. f. Orthopädische Chir.* vol. iii. p. 201) reviews A. Zuffi's method of forcible manual correction of genu valgum. "The method is safe and sure, and relapses are rare. In 800 cases the external lateral ligament was never ruptured." The method is as follows: "The patient is laid on a table, with the affected side up, and the hip and knee of the opposite side well flexed. A block with a raised edge is placed under the internal femoral condyle. One assistant stands in front of the patient, and fixes the pelvis by grasping the upper iliac crest with one hand and the flexed knee of the opposite side with the other. Another assistant stands behind and presses over the great trochanter, to prevent injury to the hip, and over the external condyle, to give

Osteotomy.—Indications :—

1. When the bones are eburnated.

2. In children over 4 years of age, if separation is greater than 4 inches and not due to ligamentous weakness.

3. When mechanical measures have been tried and have failed, either owing to pain or hardness of the bones.

4. If mechanical measures are inadmissible on account of the patient's want of means.

5. When there is considerable elongation of the internal condyle, or much bending of the shaft of the femur or tibia.

The forms of operation in vogue are :—

I. Macewen's Supra-Condyloid Osteotomy from the Inner Side.

II. Division of the Shaft from the Outer Side.

III. Oblique Division of the Internal Condyle (Ogston) with Reeves' Modification.

IV. Osteotomy below the Knee.

V. A combination of the above.

The first three will be described in full.

FIG. 157.—Osteotomes and mallet.

I. *Macewen's Supra-Condyloid Osteotomy.*—The skin is duly cleansed and a carbolic compress put on over-night. No Esmarch bandage is necessary. The patient lies on his side, and the leg is flexed with a sand-bag beneath it. Two osteotomes should be at hand, one $\frac{1}{2}$ inch and the other $\frac{3}{4}$ inch wide.

purchase to the operator, who, grasping the leg by the calf with one hand, and above the ankle by the other, gradually forces the leg into the correct position, taking care to keep it fully extended. The leg is put up somewhat over-corrected in a plaster dressing."

The point of incision through the skin is on the inner side of the thigh, $\frac{1}{2}$ inch in front of and above the adductor tubercle. A long narrow-bladed knife is entered on the flat at this spot, and carried straight down to the bone. With the heel of the knife the incision is enlarged longitudinally to a little more than the width of the osteotome. Along the knife as a director, the osteotome is introduced and is passed to the bone, the knife being then withdrawn. The osteotome is then turned at right angles to the limb. By successive blows of the mallet the osteotome, held firmly, is driven through the inner two-thirds of the bone. Mr. Jacobson [1] says: "The direction of the bone incision is most important. The surgeon must cut transversely across the femur on a level with a line drawn $\frac{1}{2}$ inch above the tip of the external condyle. Otherwise, as in a valgus limb, the whole internal condyle is lowered, a line drawn transversely from the adductor tubercle might land the operator low down in the external condyle. The osteotome must be driven at first from behind forwards and to the outer side. It is then made to move forwards along the inner border until it comes to the anterior surface, when it is directed from before backwards and towards the outer and posterior angle of the femur. By keeping on these lines, there is no fear of injuring the artery." After each blow of the mallet, the handle of the osteotome must be moved laterally, so as to prevent locking. It is in the latter connection that the employment first of a large and then of a small osteotome is to be commended. When three-quarters of the bone have been divided, the limb is extended, and with one hand just above the wound and the other holding the middle of the leg, the limb is carried steadily inwards until the femur is felt to give. Difficulty often arises owing to the external or posterior aspects of the femur not having been sufficiently divided. The osteotome must then be re-introduced, but it is a bad proceeding; owing to the retraction of

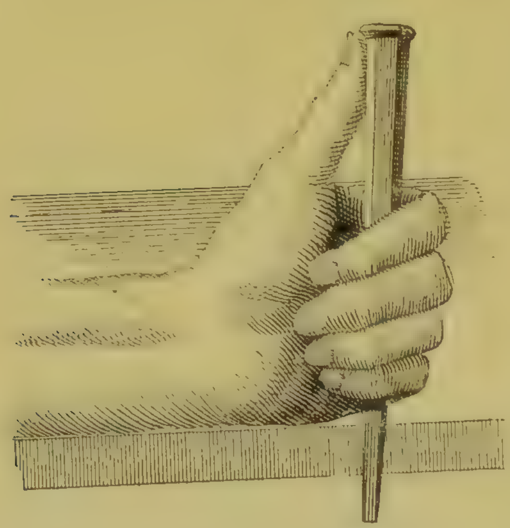


FIG. 158.—Method of grasping osteotome.

[1] *The Operations of Surgery*, 1st ed. p. 1091.

the soft parts, it is often by no means easy to make the osteotome enter the incision in the bone.

The wound is gently syringed and dressed, and the limb put up in splints in the straight position. Personally, I prefer to place a back and two side splints on for the first week, and then after rectifying any fault in the position, to encase the limb in plaster of Paris bandages. No change of dressing is, as a rule, needed. Six weeks after the operation the plaster is taken off and the patient allowed to walk on crutches. Any difficulty in bending the knee should be rectified.

In some cases, simultaneous division of the biceps or ilio-tibial band is needed to obtain good position, and in extreme cases it may be necessary to divide the tibia below the upper epiphysial line.

Accidents.—1. Septic Infection.—Sir W. Macewen [1] collected 1384 cases, of which 820 were his own. Three cases died after operation, of which two were due to septicæmia.

2. Hæmorrhage.—M'Gill [2] reported a case in which the popliteal artery was divided and was subsequently ligatured. Langton [3] recorded a case of wound of the popliteal artery by a sharp spicule of bone projecting from the articular end; considerable hæmorrhage occurred and the artery was ligatured. Gangrene set in and amputation of the thigh was performed. Unfortunately, however, death ensued. Mr. Howard Marsh [4] wounded the anastomotica magna artery, and was compelled to cut down and ligature it subsequently. Gibney [5] also speaks of a case in which the anastomotica magna artery was wounded, and he has met with severe hæmorrhage from the bone.

The causes of the hæmorrhage are: (*a*) the use of too broad an osteotome; (*b*) not dividing the posterior part of the bone with the cutting edge of the chisel pointed forwards; (*c*) allowing the chisel to slip; (*d*) abnormal course of the anastomotica magna artery.

3. The external popliteal nerve has been divided.

II. *Division of the Shaft from the Outer Side with Saw or Chisel.*—This is the procedure advocated by Sir William MacCormac. The writer uses this method almost invariably, and performs the section with an osteotomy saw.

The mode of performing this operation is as follows. The limb is duly asepticised and rotated inwards, a sand-bag being placed

[1] *Lancet*, 27th Sept. 1884. [2] *Ibid.* 17th May 1884. [3] *Ibid.* 29th March 1884.
[4] *Ibid.* 17th May 1884, p. 891. *Brit. Med. Journ.* 1884, i. 665.
[5] *N.Y. Med. Journal*, 6th Dec. 1884.

beneath it. The knife is entered at a point on the outer side three fingers' breadth above the top of the patella when the limb is extended. It is passed straight down to the bone, and cuts firmly on to its anterior and outer surfaces, so as to divide the periosteum. With the heel of the knife the wound is slightly enlarged backwards. Along the knife, now turned on the flat, the saw is introduced. At first the handle should be dropped a little so as to divide the outer wall of the compact tissue. It is then raised somewhat and cuts through the anterior wall. In this way

Fig. 159.

Fig. 160.

Genu valgum. These figures illustrate the condition of the limbs before and after osteotomy. In this case the osteotomy was done with the saw from the outer side. In Fig. 160 there is seen to remain more curvature of the tibia, which was remedied by subsequent osteotomy.

at least two-thirds of the bone is divided. By carrying the limb inwards the thin inner wall readily gives way. The wound is gently syringed and then dressed. For the first seven days the writer places the limb in a back and two side splints. At the end of that time the position is finally rectified and the limb placed in a Croft's splint or plaster of Paris bandage. The plaster is removed at the end of the sixth week, and the patient is allowed to get about on crutches.

Advantages.—Mr. Jacobson[1] states that the advantages are: "1. The femur is divided at a much narrower part than in the

[1] *Op. sup. cit.* pp. 1089, 1090.

supra-condyloid operation of Macewen, and thus it is most easily and quickly done. 2. The bone section is farther away from the epiphysis and the line of synovial membrane, in case subsequent inflammation takes place. 3. There are no important blood-vessels near."

III. *Oblique Division of the Internal Condyle.*—The limb is flexed and supported on a sand-bag. A narrow-bladed knife is entered at the mid-point of the inner aspect of the thigh and 2 inches above the adductor tubercle, and is then carried downwards and outwards firmly on the bone, until the point is felt in the intercondyloid notch. As the knife is withdrawn the skin opening is enlarged. Using the knife as a director, an Adams' saw is passed along it and the edge of the saw turned backwards. The internal condyle is then nearly sawn off. When the saw approaches the posterior part of the bone, it is withdrawn. By carrying the knee firmly inwards, the internal condyle is detached and slips up somewhat on the inner surface of the femur. The wound is dressed and the limb is placed either in wooden splints or plaster of Paris bandages.

Advantage.—The operation is of value in very severe cases of knock-knee only, when the deformity is due entirely to great elongation of the internal condyle, and it is evident that a linear osteotomy will not be sufficient to rectify it.

Disadvantages.—1. Stiffness of the joint has followed. 2. The knee is freely opened and its structures considerably disturbed. 3. The risks involved in any want of care in securing perfect asepsis are very serious. 4. Genu varum may follow, owing to the position of bone chiselled away becoming too much displaced upwards. Mr. Reeves claims that by his modification of Ogston's operation, the joint is not opened. He adds, however, "Granting, for the sake of argument, that the joint is always opened in these cases, experience has abundantly shown that practically it matters not, and in this sense the operation is properly called extra-articular." [1]

Division of the tibia as well as of the femur can only be required in very exaggerated cases, and the improvement obtained is not so great as might be expected.

To sum up the treatment of genu valgum. 1. Cases under 4

[1] *Bodily Deformities*, pp. 274, 275. Dr. G. Melloni of Rome has declared his preference for Mr. Reeves' operation over Macewen's, as it completely avoids the difficulties arising from the vicious union of fragments or from incomplete union, which, according to Dr. Melloni, sometimes occur in the latter operation. *N. Y. Med. Rec.* May 1894, p. 638.

years of age should be treated by manipulation, splints, and mechanical appliances; operative interference is not called for.

2. Cases over 4 years of age fall into two classes: (*a*) Those in which malposition of the limb is entirely due to relaxation of the ligaments, with but little overgrowth of the internal condyle. (*b*) Those in which the internal condyle is much enlarged, or the lower end of the femur twisted inwards, and the bones are eburnated.

In division (*a*) rest, splints, and walking apparatus will effect a cure.

In division (*b*) treatment by mechanical means is possible but tedious. It is better to operate, and to perform an osteotomy

FIG. 161.—Genu varum of rhachitic origin (after Rédard).

FIG. 162.—Genu varum in the left limb complementary to genu valgum in the right limb (after Rédard).

of the femur from the outside, with section of the biceps and ilio-tibial band if necessary.

Genu Varum

Synonyms—English, *Bandy-legs, Out-knee*; Latin, *Genu Extrorsum*; French, *Genou en dehors*; German, *Sichelbein, Säbelbein, O-Bein.*

Definition.—Genu varum is that condition of the legs in which a line drawn from the head of the femur to the middle of the ankle-joint falls inside the centre of the knee-joint (Macewen).

Causation.—1. In the majority of cases, rickets is the chief cause, and genu varum is, in such instances, constantly found associated with curved tibiæ. Indeed, the so-called genu varum is not limited to the knees. There is a general outward convexity of the femur and tibia, and as the knee happens to be situated very nearly in the mid-length of the limb, it is the most prominent part of the convexity (Fig. 161).

2. *Complementary.*—This variety of genu varum is unilateral, and is the antithesis of genu valgum in the opposite limb (Fig. 162).

3. *After Operation for Genu Valgum.*—I have seen cases in which the primary deformity has been over-corrected, and genu varum has resulted.

4. *Occupation.*—The following is an example:—

CASE 55. *Genu Varum from Occupation.*—A young man, aged 19 years, came to me at the National Orthopædic Hospital. The left leg alone was affected, while the right was quite straight. He had worked for five years at a printing machine, standing on the right leg and using the left exclusively for the treadle. When he became fatigued, instead of working with the leg in a vertical plane, he was accustomed to allow it to lapse outwards, thus economising the calf muscles by substituting for them the weight of the everted limb falling on the treadle.

5. *After Excision of the Knee.*—As a rule, if the limb ankylose in a vicious position, the deformity is antero-posterior, but in the following case it was external:—

CASE 56. *External Deformity of the Lower Limb after Excision: Operation.*—Edward P———, aged 13 years, came to me at the Hospital in August 1891. The history is that, when 6 years old, he hurt his left knee, and two years afterwards he underwent an operation in Dublin. From the appearance now presented by the limb, there is no doubt the joint was excised, as the patella is absent, and there is the transverse scar of an incision across the position of the lost joint.

His present condition is this. At the site of operation firm ankylosis has taken place. Above this, and about the lower end of the femur, numerous scars are seen, indicative of old bone mischief. The lower end of the femur is bent inwards, but not to such a degree as the shaft of the tibia, which is so much curved that when the boy stands on the right leg the left heel crosses the crest of the right tibia and cannot be brought to the ground. There are $2\frac{1}{2}$ inches shortening on the left side. He refused operation, and was fitted with an internal support, extending from the left tuber ischii to the internal malleolus. He did not present himself for two years. During that time he had grown considerably, and now the left foot was 4 inches off the ground and still more thrown across the right leg. On account of the disability he asked that an operation might be performed. It was pointed out there was some risk of the bone affection lighting up, but he consented to run that risk. Two osteotomies were performed, one at the lower end of the femur and the other at the upper part of the tibia, and the limb was straightened. Considerable difficulty was experienced in sawing through the lower end of the femur. The time occupied in doing so was three-quarters of an hour. This was owing to the exceedingly sclerosed condition of the bone. The limb was put up first in wooden splints and then in plaster of Paris. When the left tibia had been brought immediately beneath the left hip joint, the shortening was 2½ inches instead of 4, so that with a cork sole he walked well.

6. Occasionally genu varum is seen in adults arising from relaxed ligaments alone.

Age.—The rhachitic cases occur under 4 years as a rule, and, in the writer's opinion, are more common in girls.

FIG. 163.—Epiphysiary genu varum. The outward curve in the right limb is most marked about the upper epiphysis of the tibia, and is combined with torsion (after Rédard).

Clinical Varieties.—1. The form of genu varum usually met with is that in which the prominence of the knee is but a regular part of the arc of the circle formed by the bending of the femur and tibia outwards.

2. In rare cases the deformity is at the knee, or just above it, owing to the effect of rickets, or other causes on the ligaments of the knee, or lower third of the shaft of the femur. In such cases the external condyle elongates, and the internal atrophies, as it bears most of the weight. The external lateral ligament is also stretched.

3. Epiphysiary genu varum. Rédard[1] describes a form which has hitherto received but scant attention from authors. He says: "It comes on rapidly in patients of 12 to 16 years, especially girls, and is associated with the marked activity of the epiphyses above and below the knee at this time of life." In many cases Rédard has noticed local pains. The outward curve of the bones is most marked about the upper epiphysis of the tibia, and is combined with torsion (Fig. 163).

Degrees of Genu Varum.—These vary from a slight external projection of the knees to complete bowing of the whole extremities, so that a circle may be described within the limits of the pubes and lower limbs. It is difficult in rhachitic cases to explain the outward bending of the knees. It is suggested[2] that the ricketty

[1] *Op. cit.* p. 591. [2] Bradford and Lovett, *op. cit.* p. 674.

attitude is a factor in the production. A child with rickets stands with the lumbar spine lordosed and the thighs flexed slightly. When the latter occurs the knees are separated and the femora rotate outwards on their own axes. The line of gravity, therefore, instead of falling outside the knees, falls inside, and any softening of the bone encourages yielding externally. This explanation is plausible but unsatisfactory. With a similar ricketty attitude, genu valgum, the opposite condition, is more often seen. I venture to think genu varum arising in rickets is more likely to be due to unequal growth at the epiphysial line, *i.e.* the outer portions are more active than the inner, and in genu valgum the reverse occurs.

Symptoms.—The nature of the deformity is at once seen on looking at the patient. The line of the knee is oblique and the external condyle is longer than the inner. The deformity, if situated at the knees alone, disappears on flexion as in genu valgum. The patient walks with more security than in the latter affection. It is necessary, however, having an eye to treatment, to ascertain the condition of the ligaments and bones as to relaxation and elasticity.

Treatment.—It is conducted on the same lines as genu valgum. In cases in which the bones are soft and the ligaments relaxed, inside splints, with manipulation and massage, are sufficient. When the bones are eburnated, osteotomy at the point of greatest curvature in the limb is necessary.

Genu Recurvatum

Synonyms—English, *Back-knee;* French, *Genou en arrière.*

Definition.—A deformity characterised by hyper-extension of the knee-joint.

Occurrence.—It is seen associated with other conditions, viz.:—

1. Congenital club-foot, *e.g.* equino-varus and valgus.

2. Paralytic club-foot (Fig. 164). In an extreme case I saw, the patient could balance herself on the under aspect of the condyles of the femur with the legs hyper-extended.

3. Rickets, on account of the relaxation of the muscles and ligaments.

4. Deformities of one limb where an excessive strain has been put upon the sound limb.

5. Charcot's disease.

6. As a primary condition, it is seen in congenital displacement of the knee, and is often present in infants who are otherwise perfect.

Back-knee as the Result of Irregular Growth of the Upper Epiphysis of the Tibia.—Sir G. Humphry, Kirmisson, and others[1] have described a peculiar condition of back-knee, in which a bending of the upper part of the tibia exists in the situation of the epiphysial cartilage. The deformity is often present on both sides, and follows chronic inflammation of the knee or upper part of the tibia, and arises from excessive growth of the posterior part of the upper epiphysial line of the tibia. At first the impression given by this lesion is that of a dislocation backwards of the knee; but careful examination shows that the tuberosities of the tibia are in perfect contact with the articular surface of the femur, and that the cause of the deformity is the formation of a forward angle of flexion at the upper epiphysial line of the tibia. Corresponding to the depression in front in this situation, is a prominence which can be felt in the lower part of the popliteal space. The shaft of the tibia is consequently directed forwards and downwards, instead of directly downwards. In the absence of any chronic inflammation of bone or joint in this region, it is presumed that irregular growth of the epiphysial line has occurred.

FIG. 164.—Genu recurvatum of paralytic origin (after Rédard).

If the deformity is a hindrance to progression, a walking apparatus with a flexion spring at the knee-joint should be worn.

CURVED TIBIA AND FIBULA (BOW-LEGS)

Alterations in the shape and outline of the tibia and fibula arise from rickets, syphilis, osteitis deformans, and osteo-malacia. The fibula follows the tibia in the direction of the deformity, so that the shape and outline of the tibia are the main points at issue, and it ought, therefore, to be understood that when the tibia is mentioned the fibula participates in the same kind of changes.

[1] See a paper by R. Whitman, an abstract of which appeared in the *Amer. Med. and Surg. Bull.* 15th March 1894.

Ricketty Curvature of the Bones.—Of all the deformities arising from rickets, bow-legs are the most common and the least serious.

The pathological changes in the bones have been described on p. 256. To the touch the bones are tender and unusually elastic. The three stages of osseous rickets, viz. congestion, softening, and eburnation, are best seen in the bones of the leg. If one feels the crest of the tibia, the outline is sharp and the crest itself is deflected. The inner surface of the tibia is concave, and the curvature is rarely purely anterior, being antero-lateral, either externally or internally. The tibia is flattened from side to side, and the curve is generally most marked at the lower third. The medullary canal is often narrowed in the middle of the shaft, and enlarged at the extremities; but occasionally it is dilated throughout its whole extent. When the curvature is very marked, the medullary canal is eccentric, being nearer the convexity than the concavity of the bones. It may be so near the surface of the convex portion as to be separated from it only by a thin layer of bone, or it may actually open on the surface of the bone (Beylard). On the concave side the bone is much thickened by sub-periosteal deposit, which acts as a supporting buttress to the arch of the concavity. Frequently genu varum and curvature of the femur are present as well, but the chief curve is in the tibia. Seldom are curved tibiæ associated with genu valgum. The most common coexisting deformity is flat-feet.

The age of onset of the deformity is between the first and second year. In rare cases it appears as early as the tenth month, or as late as the third year. But taking the average age of 500 cases brought to me at hospital, I find it to be 2 years and 2 months. In private practice the attention of the medical man is drawn to the deformity in the children of the well-to-do much earlier than in the case of the poorer classes.

The tibia may be curved in almost any direction, but apart from genu varum and curvature of the femur,[1] the following *types* are found:—

1. An external curvature, and generally situated at the junction of the middle and lower third of the leg. With this there is sometimes a twist in the bones, the lower third of the leg looking inwards

[1] The presence of curvature in this bone may be shown by crossing the legs and bringing the condyles as much as possible side by side without rotation, and then noting if an elliptical space exists between the thighs.

and forming a well-marked angle, externally, with the remainder of the diaphysis (Fig. 165). In other cases the curve is chiefly at the junction of the upper and middle thirds of the legs, and the angle is prominent internally. The feet are flat and the knees are apparently close together. This variety is often mistaken for primary

FIG. 165.—Curved tibiæ from rickets in a child aged 2½ years.

genu valgum. But if the case be watched from the first, the curvature of the tibia precedes the approximation of the knees.

2. A more or less anterior curvature of the tibia, occupying the whole length of the bone, or only the upper or lower third. The heel is often raised, the foot pointed, and in walking it is in a position of equino-valgus.

3. An internal curvature is present, with flattening of the bones and the feet in a varoid position.

Of these three types the first is common and the third rare. Occasionally one sees an internal curve in one leg and an external in the other.

Prognosis.—In bow-legs there is always an inclination to spontaneous rectification.[1] This in slight cases is often complete, but in severe cases only partial. It is therefore unwise to allow any case to pass untreated, since, if the bones are soft, slight cases may very quickly become severe. The method of spontaneous rectification can be readily understood from Fig. 166 after Ollier.

Treatment.—The line of treatment depends upon the condition of the bones, whether soft or eburnated, the direction of the curve, and the age and social status of the patient. In the case of the neglected children of the poor, osteotomy is called for in less severe cases, and earlier than in children of the well-to-do, who obtain efficient supervision and suitable apparatus. All forms of curvature except the marked anterior are amenable to mechanical treatment when the bones are soft. The question of treatment may be discussed under three headings :—

1. Constitutional Treatment with Local Manipulation.

2. Constitutional Treatment with Manipulation and the Application of Splints or Walking Apparatus.

3. Operative.

1. *Constitutional Treatment with Local Manipulation.*—This form of treatment is advisable for babies who

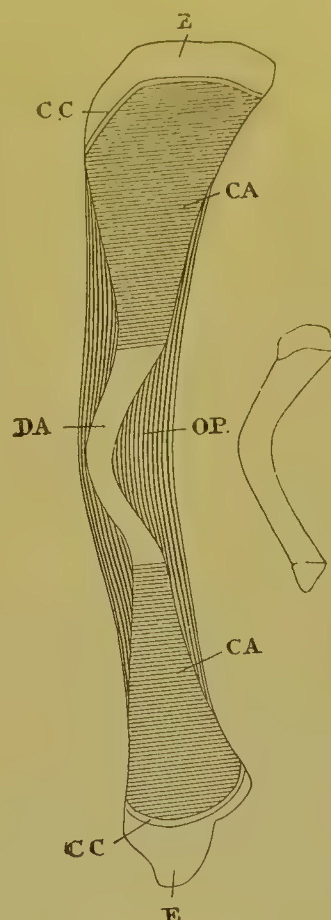


FIG. 166.—Scheme to illustrate spontaneous rectification of ricketty bones during growth (after Ollier). The small figure on the right represents a ricketty tibia in a young child. The large figure represents the same bone in an adolescent. The small figure is inscribed within the large.
DA, Place occupied by the shaft of the primitive bone which has disappeared in the progress of development ; CA, CA, the additional bone due to ossification at the epiphysial lines, which were in a right line with the shaft during the attack of rickets. This new bone CA, CA forms two cones of which the summits correspond to the extremities of the diaphysis of the infantile bone. They enlarge *pari passu* with the growth of the bone. OP, Periosteal bone, by means of which the bone becomes thicker, and the former shaft is gradually enclosed ; EE, epiphyses ; CC, epiphysial line.

[1] Kampe (*Bruns. Beitrage z. klin. Chir.* xvi. 1) is of opinion that the greater number of all cases undergo spontaneous cure. The process lasts two to four years. If the curvatures begin in the first or second year of life the legs are quite straight by the fourth or fifth.

have not yet walked, as it is a fact that curvature of the tibia and fibula is sometimes present before the child has attempted to walk; for children who are not weighty in the body; for those in whom the bones are not unduly soft, and the curve is a general rather than a localised one.

The usual constitutional means of alleviating rickets must be carried out fully, while the legs should be bathed and rubbed night and morning, and the nurse instructed to hold the leg at the knee and ankle, and using the thumbs as a fulcrum to make gentle attempts to straighten the leg. This manipulation should be performed night and morning.

A record of the curvature, by means of either photographs or tracings, as described in genu valgum, ought to be taken from time to time, and if the curve show any increase, mechanical supports are required.

2. *Constitutional Treatment with Mechanical Supports and Manipulation.*—This form of treatment is called for when a curve originally slight is becoming marked; when a child is weighty, and cannot be kept off his legs; when the curve is located in one part of the bone more than another; and when the child is under 4 years and the bones are not hardened.

The question arises, Should the form of apparatus be such as to entirely prevent the child walking? I think not in any case. All the forms of apparatus act on the principle of taking their fixed points from two bony prominences and drawing the curve towards the support. Provided this is efficiently done, the child should be allowed to use his legs, as free movement by them encourages that improved nutrition, which more than counterbalances any of the bad effects of the body-weight.

The simplest form of apparatus is an inside wooden splint from the internal condyle to the internal malleolus for external curvatures, and the reverse for an internal curvature. But in many cases the deflection of the bone is as much anterior as lateral. The single splint is then inefficient, and the difficulty may be overcome by using a trough splint of the following construction. Two straight pieces of wood or tin, of suitable length and width, are joined together so as to make an elongated rectangular splint. If the curve is antero-external, the splint is put on the inside and the back of the leg only. By the pressure of the bandage the antero-external curvature is drawn towards the angle of the splint. The same principle exists in the less cumbrous but more expensive tibial instrument (Fig. 167), in which there are rigid lateral and posterior rods fixed to the boot and knee piece, with straps passing round the leg.

In those cases where a marked anterior curvature exists, with elevation of the heel, mechanical appliances are of little or no value.

3. *Operative Measures*, viz.—

1. Osteoclasis: Manual or Instrumental.
2. Osteotomy.
3. Removal of a Wedge from the Bone.

Operative interference is called for when the bones are so hard that mechanical treatment is out of the question: in children over 4 years of age; in cases of severe anterior curvature; and in marked instances of lateral curvature.

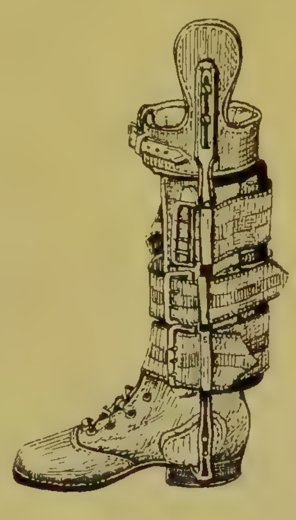


FIG. 167.
Tibial instrument for bow-leg.

With regard to the choice of operation, the majority of surgeons prefer osteotomy, but some elect to perform osteoclasis. Personally, the writer's preference is for osteotomy, because it is a more precise operation, and less damage is done to the bone and soft tissues by a clean saw-cut. It will be urged that in osteoclasis the fracture is simple, but with correct antiseptics the dangers of sepsis after osteotomy are very remote. Certain it is that osteoclasis is inadmissible: (1) if the curvature is very near a joint or epiphysis; (2) if the bone is very hard or firm; (3) if there are several curves in a limb; (4) if the curve is anterior.

I cannot help thinking that, despite guarded assertions to the contrary, considerable damage may be done to the soft tissues by the use of osteoclasts. In France the Colin's osteoclast is much employed, and in this country Dr. Nicholas Grattan, of Cork, has perfected an instrument of extreme power and, according to its inventor, of great precision.[1]

1. *Manual Osteoclasis.*—Mr. R. W. Murray,[2] of Liverpool, who has

[1] Grattan, "Twenty-seven Cases of Deformities of the Extremities treated by Means of the Screw Clamp," *Brit. Med. Journ.* 3rd May 1890, p. 1006. All these did well. Occasionally, however, laceration of the soft parts occurred. A simple may thus be converted into a compound fracture, and this occurring in a limb not prepared aseptically for such an event, with an instrument which has not been sterilised in all probability, is apt to be disastrous.

[2] "The Treatment of Ricketty Deformities by Means of Osteoclasis," *Brit. Med. Journ.* 25th Aug. 1894, p. 413.

had very extended experience of this method, having straightened no less than 311 legs in one year by it, gives the following directions: "If it is a simple curve, to break the bone at its greatest convexity, one should not attempt to break it as one would a stick; but grasping the limb, say it is the right leg, firmly at the point at which you wish to produce the fracture, and keeping the left hand perfectly steady, using the thumb as a fulcrum, slowly over-correct the deformity with the right hand until the bone is fractured. It is important that the bone should be fractured and not merely bent, for the tendency of the bent bone to resume its former position is so great that the bandages are apt to become tight and the foot to swell, or the child's delicate skin to blister at the points where the splint presses. If, however, in attempting to straighten bone, one has to use so much force as to render it uncertain where the fracture will take place, then, as the object is to straighten the bone and not simply to break it, you had better desist, and perform an osteotomy." In no one of his series of cases has Mr. Murray had a mishap.

It appears, then, that manual osteoclasis is a safe procedure, and saves the trouble and time involved in an osteotomy. But with regard to osteoclasts, if the bone requires that great amount of force to fracture it which these instruments are capable of exercising, the writer would prefer osteotomy.

2. *Osteotomy.*—The operation is a simple one. The leg is duly asepticised and supported on a sand-bag. If it be the left leg, the surgeon stands on the left side and passes an osteotomy knife on the flat through the skin over the crest of the tibia, and at the most prominent point of the curve, down over the inner surface of the bone, and then turning it at right angles, firmly grooves the periosteum. Along the knife the saw is introduced, and as the knife is withdrawn, the skin incision is enlarged to prevent the heel of the saw abrading it. With short movements the tibia is divided, taking care not to wound the structures posterior to it. There is no necessity to divide the fibula with the saw, since, when the section of the tibia is nearly complete, a firm movement inwards or outwards, as the case may be, will fracture the fibula and the remaining portion of the tibia. A counter-opening may be made for drainage. The wound is dressed and the limb is put up in plaster of Paris, and kept so for six weeks.

3. *Removal of a Wedge from the Bone.*—An open wound is necessary in this case. The size of the wedge to be removed should

be determined previously by drawing an outline of the leg on paper, and then removing with scissors a sufficient wedge of the paper, so that the model is made straight.

In this form of operation the osteotome is desirable, as it is easier to remove the wedge with it than with the saw.

Some difficulty may be experienced, after excision of the piece of bone, in getting the leg straight. This arises from two causes:—

FIG. 168.—Congenital syphilitic curvature of tibiæ (Case 57).

FIG. 169.—Front view of Fig. 168, showing entire absence of any lateral bending of the bones when the curvature is due to congenital syphilis.

(*a*) The periosteum on the posterior surface of the tibia is imperfectly divided.

(*b*) In cases of great anterior curvature the tendo Achillis is too short, and prevents apposition of the fragments. It should therefore be divided.

Non-Union after Operations.—This is so rare an event, considering the enormous number of osteotomies performed, that it is of little practical moment.

A case of non-union came under the notice of my colleague, Mr. Little.[1] He first tried freshening the ends of the fractures, and then, at my suggestion, placed living rabbit's bone in. But this failed, and Mr. Little was forced to amputate. Below the site of non-union there was most extensive fatty degeneration of all the tissues of the lower part of the leg and foot.

SYPHILITIC CURVATURE OF THE TIBIA

This variety of curvature is met with in congenital syphilis, and occasionally in acquired syphilis.

[1] *Roy. Med.-Chir. Trans.* 1891.

In the congenital form the appearance is quite diagnostic. The affection is frequently symmetrical, and occurs mainly in children under 6 years of age. I have met with six cases during the last five years. The following descriptions are of two cases which came before me at the National Orthopaedic Hospital. The appearances are seen in Figs. 168-171.

CASE 57.—*Congenital Syphilitic Curvature of the Tibiæ.*—M. E., aged 5, came to me in October 1892. There are five children in the family,

FIG. 170.—Congenital syphilitic curve of tibia (Case 58).

and this is the second child. The mother has had no miscarriage, but she suffered from a rash after the birth of this patient, who had snuffles at birth, and "red spots" on the body up to 3 years of age. There is now a peculiar earthy pallor, with the high-arched palate and the scoring round the mouth associated with the congenital taint. The mother states that this child was born at the eighth month. It should be added that the next child has also shown signs of congenital syphilis.

The deformity is shown in Figs. 168, 169. On looking at the child from the front but little abnormality is observed, except some genu valgum. A lateral view, however, shows a remarkable anterior curvature of both legs, nearly symmetrical, and affecting the middle rather than the lower third. The curvature in both cases is directly anterior, and not antero-lateral. The crest of the tibia is very rounded, and the internal and external surfaces of the bone are convex.

Right leg, outer side. *Right leg, inner side.* *Left leg outer side.*

FIG. 171.—Congenital syphilis, with marked curvature of the tibiæ. The drawings are taken from a male infant aged 3 months, who was seen at the Evelina Hospital in October 1895.

CASE 58. *Congenital Syphilitic Curvature of the Tibiæ.*—A. J. S., aged 6, came to me in February 1896. The mother has had six children, and two miscarriages, both at the seventh month. Of the six children, two died in infancy, but the cause of death is unknown. There is no history in A. J. S. of spots nor of sores round the mouth, and no sign of keratitis. On examination, the child is fairly healthy-looking. The right tibia is thickened at the middle third for 6 inches, the crest lost, and the surfaces rounded. The leg is hot and red. There is anterior but no lateral curvature. The left leg is affected to a less degree than the right. Tenderness has been noticed for eight or nine months. The patient cannot walk. The teeth are very deficient, dome-shaped and irregular. In March 1896, after the patient had been taking grey powder for three weeks, the redness and tenderness disappeared, and the forward curvature in both legs had decreased.

FIG. 172.—Suppurative syphilitic epiphysitis at lower ends of radius and tibia in an infant aged 1 month. The child died shortly after the drawings were made, and the epiphyses were found lying loose in purulent cavities.

FIG. 173.—Epiphysitis of upper end of humerus from congenital syphilis. The upper epiphysis is seen to be separating from the shaft (Guy's Hospital Museum, 1105).

As to the diagnosis from rhachitic curve, the following table serves to show the points of contrast:—

	Rhachitic curve.	*Syphilitic curve.*
Age	Generally under 3 .	Occurs up to the ninth year
History . . .	Signs of rickets present	Syphilis in parents and other signs of congenital syphilis in child
Direction of curvature .	Antero - external or antero-internal	Purely anterior

	Rhachitic curve.	*Syphilitic curve.*
Position of curve . .	Generally in upper or lower third	In middle of shaft
Crest of tibia . .	Sharp . . .	Smooth and rounded
Surfaces of tibia . .	Flat or concave .	Convex

These points afford sufficient guides in distinguishing between the two forms of curvature. If a syphilitic curve be viewed from the front there is no lateral deviation to be seen. The form of congenital disease in this event is osteo-plastic (Parrot). In the acquired form of syphilitic disease of the tibia the affection is a localised swelling or node rather than a curvature, and is rarely symmetrical. The treatment is anti-syphilitic; splints and manipulation are of no avail.

With reference to other forms of curvature, such as those arising from osteitis deformans and osteo-malacia, special monographs should be consulted.

CHAPTER III

CLUB-FOOT—GENERAL CONSIDERATIONS

Varieties and Causation of Club-Foot—Its Frequency—A Method of Examining Club-Foot—General Principles of Treatment—The Processes concerned in the Union of Tendon—The Author's Experiments and Deductions.

Synonyms—Latin, *Talipes*, *Pes Contortus*; French, *Pied Bot*, *Stréphopodie*, *Kyllopodie*, *Kyllose*; German, *Klumpfuss*.

Definition.—The term club-foot comprises those deformities in which there exists an abnormal anatomical relation of the foot to the leg, or of one part of the foot to the other. By some the meaning of club-foot is restricted to the deformity known as talipes equino-varus, but by the greater number of surgeons it is used in the wider sense just indicated.

Inasmuch as the foot is capable of extension, flexion,[1] adduction with inversion, abduction with eversion, and talipes is associated either with over-action or loss of action of one or more groups of muscles affecting these movements, so we have—

<table>
<tr><td>1. Talipes equinus, or the over-extended foot;</td><td rowspan="2">the centre of motion being at the ankle-joint.</td></tr>
<tr><td>2. Talipes calcaneus, or the over-flexed foot;</td></tr>
<tr><td>3. Talipes varus, or the adducted and inverted foot;</td><td rowspan="2">the centre of motion being at the medio-tarsal joint.</td></tr>
<tr><td>4. Talipes valgus, or the abducted and everted foot;</td></tr>
</table>

Further, the convexity of the plantar arch undergoes at each contact of the foot with the ground a diminution, and when the foot

[1] In the following pages, when the term "extension" of the foot is used, it implies pointing of the toes; and when "flexion," raising of the toes, with depression of the heel, is meant. This is not morphologically correct, but long usage gives sanction. But the term "extension" is better replaced by "dorsi-flexion," and "flexion" by "plantar-flexion."

is raised, a restoration. Hence two more varieties must be added, viz.—

5. *Pes cavus*, in which the convexity of the longitudinal arch of the foot is increased. This it is better to subdivide into *talipes arcuatus* and *talipes plantaris*, according as the front part of the foot is on a level with or below that of the heel; it being understood that in each case there is a distinct increase in the convexity of the arch.
6. *Pes planus*, in which the arch is dropped to a varying degree.

Clinically it is found that such a simplicity of arrangement does not always prevail. Frequently the deformity is compound in its character. Thus talipes equinus and varus are often combined, and talipes calcaneus and valgus. The compound forms in their order of frequency are—

1. *Talipes equino-varus.*
2. *Talipes calcaneo-valgus.*[1]
3. *Talipes equino-valgus.* } Uncommon.
4. *Talipes calcaneo-varus.* }

Taking 150 consecutive cases of club-foot which have come under my care at the National Orthopædic Hospital, and 50 which I have treated at the Evelina Hospital, or 200 cases in all in five years, talipes calcaneo-varus of the congenital variety was seen once, viz. in a child of 2, and in the left foot, while the right foot was an example of talipes calcaneus; congenital equino-valgus was seen twice, and paralytic equino-valgus five times.

The Causes of Club-Foot may be summarised:—

I. *Congenital.*

II. *Acquired.*

1. Paralytic, as a result of acute anterior polio-myelitis (infantile paralysis).
2. Spastic, as a result of hemiplegia, primary lateral sclerosis, or reflex irritation from teething and dyspepsia, giving rise to convulsions; or from partial asphyxia at birth. Other causes of reflex irritation

[1] Bonnet classified "club-foot" into two divisions—the club-foot internal-popliteal or talipes equino-varus; and the club-foot external-popliteal, or talipes calcaneo-valgus—founding his theory on the supposition that in the first variety the muscles supplied by the internal popliteal nerve, and in the second variety those by the external popliteal nerve, were affected. But in talipes equino-varus the tibialis anticus, which is supplied by a branch not of the internal but through the external popliteal nerve, is implicated. Then, again, we meet with rarer forms, such as equino-valgus and calcaneo-varus, which cannot be included in Bonnet's classification.

are an abscess in the calf or inflammation in the ankle-joint.[1]

3. Cicatricial, the result of burns. Talipes calcaneus is seen to follow deep burns on the front part of the foot.
4. Traumatic: (*a*) Injuries to bones, *e.g.* fractures and separation of the epiphyses.[2]
   (*b*) Injuries to joints. Schwartz[3] alludes to unreduced dislocation of the ankle-joint as a cause.
   (*c*) Injuries to tendons. A ruptured tendo Achillis badly treated results in talipes calcaneus.[4]
   (*d*) Injuries to nerves. A case is recorded, if memory serves me correctly, in which talipes resulted after accidental section of the posterior tibial nerve.
5. Inflammatory. After acute osteo-myelitis of one of the bones of the leg, the rate of growth is arrested in one bone, while in the other it is normal, and the foot is turned into the position of either valgus or varus. Chronic osteitis has been known to produce a like result, but in a different way. The growth in the healthy bone is normal, while in the diseased bone it is excessive. Such an instance came under my notice some years ago.
6. Talipes decubitus—a spurious form of contraction which occurs in bedridden patients from the "dropping" of the feet and the weight of the clothes. It is best marked and most intractable in alcoholic paraplegia.
7. Hysterical paralysis or contraction.

Of the acquired forms the paralytic and spastic varieties are

[1] As to the possibility of reflex irritation from an elongated and adherent prepuce causing talipes, I have not been able to convince myself. L. H. Sayre's views on the question are well known. Cf. *Orthopedic Surgery*, Lecture III. In justice to Sayre it should be added that he terms this condition "reflex paralysis," and argues that the deformity is not due to contraction. It is difficult, however, to believe that if Sayre's cases were paralytic, recovery could have been so rapid. In one case the child was able to walk fourteen days after circumcision; *op. cit.* p. 15.

[2] I have twice seen cases of valgus following fracture of the lower end of the fibula in young subjects, in whom the natural rate of growth at the lower epiphyses was arrested, while the tibia continued to increase in length, and pushed the foot outwards.

[3] "Des différentes espèces de pied bots et leur traitement," *Thèse d'agrégat.* Paris, 1883.

[4] I have also seen four cases of calcaneus which followed equinus, and due to excessive elongation of the tendo Achillis after division. The usual history is that the patient was allowed to walk about "a week or two" after the operation.

more immediately due to abnormal muscular action, and are common; while the others are rare, and amongst the curiosities of surgical literature. These latter may be termed spurious talipes. In the production of talipes we must remember that the rôle of the muscles presents itself under two very different aspects.

(α) In congenital and spastic cases a group or groups of muscles are in over-action, while their opponents are of normal or slightly less strength. The foot is therefore pulled into an abnormal position *corresponding* to the action of the more powerful muscles. If an attempt be made to replace the foot, it is either entirely resisted, or partial restoration alone can be effected. When the force is removed, the foot "flies back" to the deformed position. In these cases then the direction of the deformity is in the line of action of the affected muscles, *e.g.* talipes equino-varus from contraction of the calf and tibialis anticus muscles.

(β) In paralytic cases a group or groups of muscles are paralysed, while their opponents are of normal strength. The foot is therefore pulled in a direction *opposite* to that of the affected muscles. In early cases the foot "flops about," and complete restoration can be effected. In paralytic cases the direction of the deformity is *opposite* to the line of action of the affected muscles, *e.g.* paralysis of the muscles on the front of the leg and of the peronei causes talipes equino-varus.

Frequency of Club-Foot and its Varieties.—Club-foot is a common deformity. Mr. F. R. Fisher[1] has tabulated 3000 consecutive cases of deformities which have come under his notice. The analysis showed that club-foot occurred in 581 cases. But taken in comparison with other surgical affections, it is of rare occurrence. Rédard[2] estimates that in 1000 surgical cases, 4 of club-foot are met with. Dieffenbach admits that one instance of congenital club-foot is found in every 800 to 1000 cases. In 23,932 new-born infants Chaussier found 132 deformities, and of these 35 were cases of talipes. Of 15,229 births occurring at La Maternité de Paris, Lannelongue[3] noted 108 cases of deformity, and 8 of these were club-feet.

It is said that congenital club-foot is more common than the acquired, but this I venture to doubt. Of 200 consecutive cases under my care, 83 were congenital. Sydney Roberts'[4] statistics support my view, viz. 173 congenital cases against 223 acquired.

[1] Ashurst, *Encyclop. of Surg.* vol. vi. p. 1003. [2] *Op. cit.* p. 622.
[3] "Du pied bot. cong.," *Thèse d'agrégation*, Paris, 1869.
[4] "Club-Foot," *Phil. Med. News*, March 1886.

Sex.—Congenital club-foot is more frequent in boys than girls, and the same is true of the acquired varieties.

Heredity.—Many surgeons have observed that club-foot runs in families. Quite recently I had under my care a middle-aged man suffering from advanced flat-foot, which by treatment was much improved. Six months after ceasing attendance his wife bore him a son, who had talipes equino-varus of both feet. Adams[1] mentions a case in which the deformity persisted through three generations, and Rédard refers to a similar instance. Not only is club-foot hereditary, but the particular form reproduces itself in the children. With congenital club-foot other deformities are frequently found, such as polydactylism, club-hand, hare-lip, and spina bifida. There is now under my care a case of congenital talipes calcaneus associated with spina bifida.

In dealing with talipes it is necessary to determine the form, and then to ascertain the cause. A description will therefore be given now of a method of examining club-feet.

A Method of Examining Club-Feet.—To some a club-foot is a club-foot and nothing more. But it is imperative before commencing treatment not only to ascertain which *form* of club-foot is being seen, but also to be precise as to the *cause*. It is therefore my endeavour to draw out a rough plan of the usual method of examination, and to give illustrations in point as far as possible.

The various steps of the examination are:—

1. The history.
2. The gait on entering the room.
3. The position of the foot and limb on standing and sitting.
4. An outline or impression of the sole of the foot.
5. General examination of the affected limb or limbs as to shape, size, muscular development, diminished or excessive mobility of the joints, the temperature of the limb: the condition of the skin as to colour, integrity, and the presence of corns or thickened skin over the heels and beneath the balls of the toes. The boots should also be looked at, and any unequal wear at one or more spots noted.
6. The passive movements which may be effected by the surgeon, and the directions from which resistance is felt.
7. Localisation of the resistant ligaments and fasciæ, and of
8. Contracted or paralysed muscles. This is effected by touch, by movement on the part of the patient, and by

[1] *Op. cit.* p. 218.

9. Electrical reactions.

10. Signs of abnormal and arrested development, especially of bones. To proceed to details.

1. *The History.*—The first question asked is, When was the deformity noticed? Of course in congenital cases, if the deformity is at all marked, it is seen immediately after birth. In slight cases difficulty may arise. Mr. Reeves[1] says regarding the normal form of the fœtal foot: "In it the plantar arch is but little formed, the sole of the foot is turned in, and the anterior part slightly adducted, but the peronei are capable of turning the sole outwards. To distinguish the former natural positions from slight cases of club-foot, the infant should be placed near the fire; and if the foot be normal the child will flex the thighs upon the abdomen, the legs upon the thighs, and turn the feet out; but in equino-varus it will not be able to evert the foot." Congenital club-foot is as often double as single. Paralytic club-foot is more often single. In the latter case the information will often be volunteered that the child was quite well until about 18 months old, and then it was feverish and had a convulsion; and next morning it was unable to move the limb. In spastic cases, which are often bi-lateral, some history of asphyxia at birth, or of symptoms of meningitis, or an account of a fall, blow, or sudden shock is forthcoming. Inquiry should also be made as to rheumatism, and, if an adult, as to gout in the family. The mode of delivery is often of interest; many congenital cases have been breech presentations or one of twins. Some cases of congenital club-foot are distinctly hereditary.

2. *The Gait on entering the Room.*—The "tiptoe" forward gait of spastic cases is characteristic. In infantile paralysis, if the case be one of equinus, the toes are dragged and the heel is raised; if the affection be calcaneus, the heel is brought to the ground with much emphasis, while the front part of the foot flaps somewhat as the patient advances to take the next step. Some shortening is frequently present in paralytic cases, and evidence of this is seen in the halting gait and the drooping of one side of the pelvis and one shoulder. In congenital club-foot it should be noted which part of the foot comes into contact first with the floor. In equino-varus considerable turning in of the foot and raising of the heel is seen. Weakness of one leg, with the arm held rigid and the forearm pronated and flexed, are suggestive of infantile hemiplegia.

[1] *Practical Orthopædics*, p. 152.

3. *The Position of the Foot and Limb on Standing and Sitting.*—It is essential that the patient be examined in both positions, otherwise errors may be made. For example, in right-angled contraction of the tendo Achillis, when the patient is sitting he can bring the heel to the ground because the calf muscles are relaxed, but on standing with the leg fully extended and the calf muscles tense, the heel may be an inch or more off the floor. Again, some cases which appear to be equino-valgus when the patient is standing, resolve themselves into equinus if the sitting position be adopted with the leg placed at right angles to the knee, for the reason that in order to bring the heel to the ground in standing, with a somewhat short tendo Achillis, the foot is abducted or adducted at the ankle, and the difficulty arising from the shortness of the tendon is thus obviated. Cases of varus should be examined with the patella to the front, and the true position of the foot ascertained.

4. *An Outline or Impression of the Sole of the Foot.*—This may be obtained in several ways: either by applying printers' or ordinary ink to the sole, and directing the patient to place his foot firmly on a sheet of white paper, or by taking a sheet of smoked glass and telling the patient to stand on it; or if an outline only be desired, the sole of the foot may be well moistened with water, and the foot planted firmly on a sheet of brown paper. The outline may be rapidly put in with ink before the impression on the brown paper dries. It is valuable in cases of arcuatus and flat-foot to obtain an impression or outline at the commencement and at the end of treatment.

5. *General Examination of the Affected Limb.*—The shape of the limb, especially as to muscular wasting, and its development as compared with its fellow should be noticed. Thus in congenital and spastic cases the "swell" of the calf is at a higher level than in the healthy limb. In infantile paralysis wasting of the anterior or the posterior muscles will readily be seen, so too in the late stages of spastic cases; while the enormous calves of pseudo-hypertrophic muscular paralysis will not escape attention. The bones are often felt to be of less thickness, and not only the leg, but also the foot, is shorter than normal.

An excessive mobility at the knee-joint, especially if rotation is free in the extended position, is a factor of importance in the prognosis and treatment of club-foot, both of the congenital and paralytic varieties. Much of the inversion in talipes equino-varus is due to it, and it needs methodical correction. In infantile paralysis a flail-like condition of one or more of the joints will be evident, and the knee may be hyper-extended.

The temperature of the surface of the limb and the colour of the skin, often dusky red or blue, with the presence of chilblains and other signs of imperfect circulation, are characteristic of anterior polio-myelitis, and of some congenital cases in which spina bifida is present. The presence of corns and false bursæ indicate that undue pressure exists at the spots where they are found. Thus in right-angled contraction of the tendo Achillis a row of corns will be found beneath the heads of the metatarsal bones, and the same condition is seen in talipes arcuatus and plantaris. In old-standing cases of equinus the heel is feebly developed and small, and the skin over it quite thin, thus showing that it has not at any time come into contact with the ground. It is well to look at the boots and see if they are worn unequally, especially in the cases of so-called weak ankles.

6. *The Passive Movements which may be effected by the Surgeon.*—In most cases of club-foot the nature of the deformity is evident. But it will happen that in slight cases it is difficult to decide by merely looking at the foot if adduction or abduction is too free, and similarly with extension and flexion. The foot should then be moved passively in all these directions, and it should be noticed in which of the positions it can be placed with the greatest ease. These movements should be carried out with the child both standing and sitting.

7. *Localisation of the Resistant Structures.*—The heads of the metatarsal bones being drawn away as far as possible from the heel, any bands of plantar fascia standing unduly in relief may be seen and felt. If any doubt exist, the position of the band may be localised accurately by pressing gently the forefinger-nail on it, and its tension thus quickly ascertained. On account of their depth from the surface, it is often impossible to identify the contracted ligaments.

8. *Localisation of Contracted or Paralysed Muscles.*—This may be roughly determined by sight and touch. But in cases of infantile paralysis and in spastic and congenital cases it is advisable to put the patient through a kind of drill. Thus, when paralytic equinus is present, it is needful to ascertain if any and what degree of power remains in the extensor muscles. The patient, if sitting, should be told to try to raise the toes towards the surgeon's finger, placed at 1 or 2

inches above them. Then the dorsal flexion of the great toe may be tried in the same way, in order to see if the extensor proprius pollicis have escaped or not. Similarly in calcaneus an attempt may be made to touch the surgeon's fingers held an inch or two below the toes. To estimate the power of abduction and adduction in the foot, the finger should be placed 1 or 2 inches to the outside or inside of the foot. In paralytic cases it is essential to know if any paralysis of the quadriceps extensor be present. To do this it is not sufficient for the surgeon to hold his hand at the level of the patient's knee and tell him to touch the hand with the toes. With one hand holding the condyles of the patient's femur, the thigh should be fixed, while the other hand is held out for the patient to touch with his toes. If there is any paralysis of the quadriceps extensor, and the femur is not fixed when the patient is told to extend the leg, it will be noticed that he first flexes at the hip, and raises the thigh off the chair, thus getting a start, so to speak, and then extension of the leg is made. So that this flexion at the hip tends to mask slight weakness of the quadriceps extensor.

9. *Electrical Reactions.*—In cases of spastic paralysis the affected muscles react to the constant current with less current than normally. While in paralytic cases not only is more current required than normally to obtain a contraction from a given muscle, but if the muscle be hopelessly damaged, no reaction at all is obtained. In those muscles which are less affected the reaction of degeneration is seen, and the muscle responds for a time more readily to the galvanic current, while stimulation of the nerve gives little or no response; and both the muscle and the nerve fail to respond to the Faradic current. Then, too, in the reaction of degeneration, instead of the order of ease of contraction being

$$\begin{array}{l} \text{K.C.C.} \\ \left.\begin{array}{l}\text{A.C.C.}\\ \text{A.O.C.}\end{array}\right\}\text{equal.} \\ \text{K.O.C.} \end{array}$$

A.C.C. may equal K.C.C., or A.C.C. may exceed K.C.C., and K.O.C. may exceed A.O.C.

10. *Signs of Abnormal or Arrested Development of the Bones.*—In the case of congenital club-foot the direction of the head of the astragalus and the presence of excessive inward rotation of the bones of the leg are points of importance. Absence of the fibula or tibia,[1] or parts of those bones, and a rudimentary patella are

[1] I have an example of this in a little girl now under my care at the Westminster Hospital.

occasional accompaniments. In paralytic feet excessive prominence of the cuboid in equino-varus is a point of importance in estimating the time to be occupied in treatment.

General Remarks on the Treatment of Club-Foot.—A distinguished orthopædic surgeon (E. H. Bradford of Boston), writing on the treatment of club-foot,[1] remarks, "The literature of the treatment of club-foot is as a rule that of unvarying success. It is often brilliant; . . . and yet in practice there is no lack of half-cured or relapsed cases,—sufficient evidence that the methods of cure are not universally understood. In club-foot half-cures are practically no cures at all. The great test of the cure of club-foot is the position of the foot in walking. There should not be the slightest attempt to return to deformity at any period."[2] "None of us claim to *cure* club-foot in a short space of time."[3] "Cases of club-foot should be watched a long time before pronouncing as to absolute cure."[4]

Such are the opinions, succinctly expressed, of our American *confrères,* to whom we owe so many advances in this branch of surgery[5]; and such opinions are felt to be correct by all workers in this subject. Rapid results are the exception, and, indeed, are not to be aimed at, nor are they often, in the very nature of the cases, possible. While any undue delay is earnestly to be deprecated, the chief object in view must be the permanency of the cure. If this object can be rapidly and satisfactorily achieved by wide division of soft tissues, or ablation of offending bony prominences, so much the better. If not, then the older and well-proved orthopædic methods are still deserving of full recognition, and demand practical knowledge on the part of those whose lot it is to treat cases of deformity.

In undertaking the treatment of club-foot, the objects are two: to remove the deformity, so far as the shape of the foot is concerned; to completely restore the functions of the foot and limb permanently.

These two objects are not identical, inasmuch as a foot perfect

[1] *Trans. Amer. Orth. Assoc.* vol. i. p. 89.

[2] Bradford and Lovett, *op. sup. cit.* p. 460.

[3] Gibney, *Annals Surg.* vol. ix. p. 181.

[4] Roberts, *Trans. Amer. Orth. Assoc.* vol. i. p. 35.

[5] I might allude in passing to the value of Phelps' operation, and the extensive use of the wrench in the cure of club-foot. At the same time the successful meetings of the American Orthopædic Association, and the high tone of their published *Transactions,* bear testimony to the acknowledged position which orthopædic surgery has acquired "on the other side."

in its shape and relations to the leg may be nearly useless for easy progression, as in the case of tarsectomy I allude to later. In the process of restoration to shape, the foot may lose so much of its elasticity as to be of little use in walking. After treatment, then, not only should the foot be shapely; it must be also elastic, painless, bearing a due proportion of the body-weight on heel and toe, external and internal border, and capable of a moderate amount of exercise without weariness. Above all, no case begun in infancy or childhood can be looked on as perfect in its result unless in adult life normal and easy progression is maintained. This ideal result is not possible in all cases.

It appears, however, convenient, in the first place, to briefly discuss in the abstract the methods at our command for treatment, and then in separate sections to apply them to the various forms of club-foot.

These methods are:—

1. Mechanical.

2. Physiological—such as douching, shampooing, the proper use of the electric current.

3. Operative.

1. *Mechanical Methods.*—The employment of these methods, mainly before the era of tenotomy, for all degrees and varieties, and the failures naturally resulting from an imperfect knowledge of anatomy, rightly brought discredit on the exclusive use of apparatus. Since the introduction of subcutaneous tenotomy, and more especially of the antiseptic treatment of wounds, the tendency has been, aided by better anatomical knowledge, to become less and less "mechanical," if I may use the term, and to expedite the cure by operations, sometimes of a severe character and involving risk of limb and life.

There are, however, certain degrees of all forms of club-foot to which mechanical methods are applicable. Who, for instance, would divide tendons in the foot of a new-born infant, which, slightly inverted, is yet replaceable by the hand? Or who, in a case of rhachitic valgus, would sever the peronei tendons when the arch can be readily restored by the use of suitable apparatus? In the earlier degrees of club-foot of all forms, then, the use of retentive apparatus is a valuable adjunct to active and passive exercises. After operations of all kinds on club-foot, the employment of apparatus of some form, whether it be plaster bandages, metal splints, elastic traction, Scarpa's shoes, or the many kinds of walking instruments, commonly called "irons," is essential to complete the case and to prevent relapse. Even the advocates of tarsectomy employ some retentive apparatus, despite the confident assertion that nothing whatever will be needed once the operation is performed, as "its merits are so great and its success so far-reaching." The mere enumeration of the various apparatus would read like an instrument-maker's catalogue, and I shall content myself with a brief description of some of them in the proper place, and a mention of the principles on which their construction is based.

2. *Physiological Methods, including well-directed Exercises, Douching, and Shampooing, and the proper Use of the Electric Current.*—Dr. Phelps has well said that "the best orthopædic machine ever devised is the human hand; guided by intelligence it applies forces for the correction of deformity more delicately and perfectly than any inanimate object ever invented."[1] In the early treatment of cases of club-foot skilful manipulation can accomplish more than mechanical apparatus. But as it is necessary to retain the advantages daily gained by manipulation, some form of retentive apparatus must be used. The proper manipulations and exercises for each form of talipes will be subsequently described.

Valuable adjuncts, especially in paralytic cases, are well rubbing of the limbs, douching with hot and cold water alternately at least once a day, and the use of the constant current in preference to the interrupted or Faradic. One of the chief difficulties in the treatment of deformities appears to be that of adequate nursing. In general hospitals nurses have not the time to pay adequate attention to manipulations and the relief of pressure by instruments—details which, slight in themselves, are essential to success. Nor, owing to the demand on the resources of a large hospital from the urgent nature of so many cases, is it possible to keep cases of deformity under that prolonged observation which they undoubtedly require. Then, too, the frequent advent of new "dressers," often of unequal merit and patience, who, before they have fully learnt one class of work, pass on to other portions of their curriculum, must aggravate the difficulty.

It is scarcely a matter of wonder that with all these difficulties to contend with, surgeons have been led to adopt more radical procedures, such as tarsectomy, in obstinate cases. But I would repeat that it does not suffice for a patient to leave the hospital with a shapely foot. It must be not only useful for locomotion at

[1] *New York Med. Journ.* 4th March 1895, p. 387.

that time, but continue so for many years. This necessitates prolonged individual attention over a very long space of time.

3. *Operative Measures.*—In the majority of club-feet some form of operative procedure is imperative.

These are either tenotomy with fasciotomy, wrenching, tarsotomy or tarsectomy. As tenotomy is by far the most frequent form of operation practised, I have experimentally inquired during the last two years into the methods by which tendons unite, and in the following section I give the results of my experiments with a view to the determination of these points.

The Processes concerned in the Union of Tendons, with original Investigations by the Author.

The earlier history[1] of tenotomy is fully set forth by Mr. Adams in his work on *The Reparative Processes in Human Tendons after Division.* Mr. Adams has therein gone so fully into the matter up to 1860 that it is needless to repeat it. His own researches are so thorough that had it not been for improved methods of preparation and staining of specimens, together with the wider pathological horizon of the present day, I should not have undertaken any experiments in this subject, nor ventured to have submitted them to the reader. Mr. Adams has come to the following conclusions:—

1. That tendons are capable of perfect reproduction, except that the new material does not acquire the opaque pearly lustre of old tendons.

2. That new material is formed in two to three weeks.

3. The perfection of the process is in direct proportion to the absence of extravasated blood, and the continuity of the tendon sheath is all-important in the regenerative process; since, when consisting of loose areolar tissue, it furnishes the matrix in which the nucleated blastematous or proper reparative material is developed.

Dembowski endeavoured to ascertain the origin of the early reparative material. By injecting Berlin blue into the jugular vein, he formed the opinion that it was really composed of wandering leucocytes. This special point has been more fully studied in tendon by Grunhagen, Beltzow, Flemming, and Ponfick; in areolar tissue, by Messrs. Ballance and Sherrington[2]; and in the light of the researches of the last-named observers, by myself in tendon.[3]

[1] Mr. Adams gives a complete *résumé* of the literature of the subject in his work.

[2] *Journ. of Physiology,* October 1889.

[3] Tubby, *Guy's Hospital Reports,* 1892, and *Path. Soc. Trans.* 1892.

The views of the majority of the more recent observers, while coinciding on certain points, differ unduly in the following respects:—

1. What is the influence of effused blood on the healing process?

2. Is the tendon capable of perfect regeneration?

3. By means of which kind of tissue is the union brought about? As to this point, Korner and Beltzow declare it is the tendon corpuscles which alone induce the healing. Which tendon corpuscles do they mean? There are several kinds. Busse[1] has attempted to solve this point, but from his experiments I cannot glean any absolute information. In my experiments I have directed particular attention to this matter among others. And to the above queries I would add:—

4. Do the leucocytes take a principal or subordinate share in the regeneration?

5. What is the influence of the tendon sheath?

6. Can primary union of tendon be obtained?

Before discussing these points it is necessary for me to describe my methods of experiment and examination. The tendines Achillis of full-grown rabbits were divided with antiseptic precautions from the outer side. The punctures were closed with a sealed dressing of sublimate gauze and iodoform. An attempt was made to fix the legs by plaster of Paris, but the animal generally succeeded in eating it away. The only precaution adopted against excessive movement was to limit closely the space in which the animals were confined. They were kept for the following periods after the operation: 3, 7, 14 days; 4, 5, 8, 9, 13, and 33 weeks; and one for 13 months.

For microscopical examination, the tendon with the sheath was removed, and placed at once in Flemming's fluid (weak) of chromo-aceto-osmic acid for 24 hours, which sufficed to harden as well as to fix it. Some were then, after having been washed in water for 24 hours, stained in a mixture of alum-carmine and osmic acid (Zoltan v. Roboz' formula), as recommended by Bolles Lee.[2] This stain has a very direct selective action on protoplasm; active chromatin is stained red, resting chromatin purple, and the remainder of the cell brown. The pieces of tendon were then embedded, some in paraffin and others in celloidin. In other cases, after washing out in water, the masses were embedded at once in celloidin, cut, and stained in Delafield's hæmatoxylin and eosin, at the instance of my

[1] *Prize Essay*, Greifswald, 1891.

[2] *Microtomist's Vade Mecum*, 2nd ed. p. 85.

friend, Dr. Benecke of Brunswick. A point worth noting, if the tendon be embedded in paraffin, is its great liability to become so hard and brittle that it will not cut. This difficulty can be overcome by soaking it in cedar oil for three full days before placing it in the paraffin bath, and by clearing the cut section in cedar oil also.

Before describing the microscopical appearances of divided tendons undergoing union, it will be advantageous to briefly summarise the structure of normal tendons. In them there are, as is well known, white connective-tissue fibres, tendon cells, blood-vessels, and lymphatics, the whole bound up in a fibrous sheath, varying considerably in density and somewhat in structure. White fibrous tissue is readily recognisable under the microscope by its parallel, wavy, unbranched fibres. The tendon cells, according to the latest observations, are of three kinds: (*a*) the large fixed tendon cells seen, in section parallel to the long axis of the tendon, as oblong bodies; and in transverse section to be of irregular outline, with processes extending into the connective-tissue spaces. The cells are uni-nucleated, and the nuclei are so placed that they face each other in neighbouring cells; (*b*) migrating cells are seen, which wander freely through the inter-fibrous and lymphatic spaces. Certain of these cells have distinctive features. They are known as the "plasma cells of Waldeyer." In size they are larger than the leucocyte, they possess one or more processes, they have a large oval nucleus, and present a granular cell substance. Several cells often aggregate and form clumps. These migratory cells are very important in the process of union of tendon. (*c*) Small round cells, which are indistinguishable from ordinary leucocytes except by special stains, and then they are seen to be more eosinophilous than the leucocyte of the plasma.

Blood-vessels are found in tendon in parallel systems, but they are more numerous in that part which is attached to bone. In observations on the healing of tendon it has been noted that the process is always further advanced in that portion which is nearer the bone. The lymphatics of tendons consist, in the first place, of inter-connective-tissue spaces lined by flattened epithelial plates, and containing particularly the plasma cells; and, in the second place, of definite lymphatic vessels containing some elastic tissue in their walls.

The structure of the tendon sheath varies according to the region, but generally it consists of white fibrous tissue, yellow elastic

PLATE V (Photo-micrographs).

UNION OF TENDON

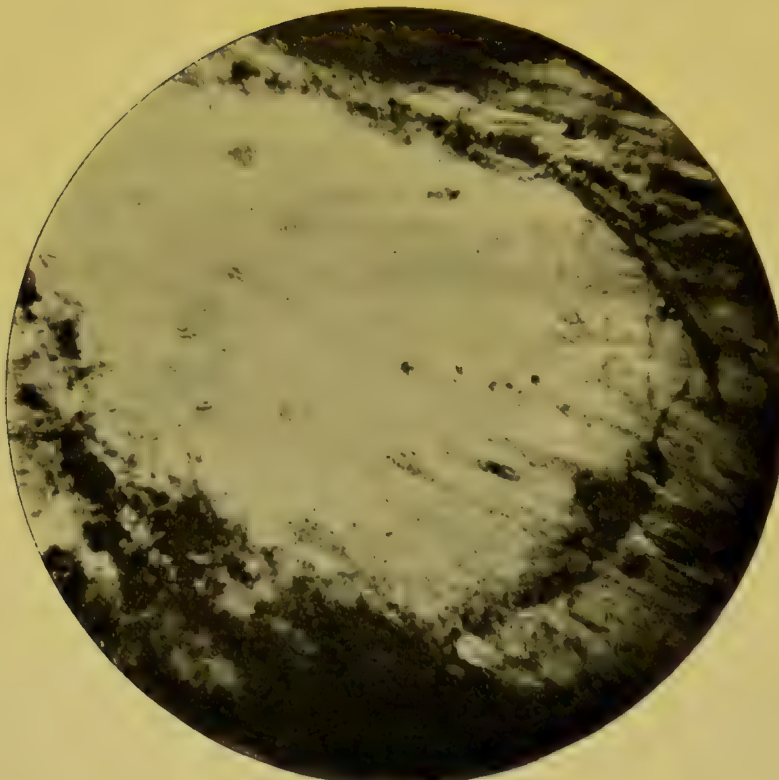


FIG. 1.

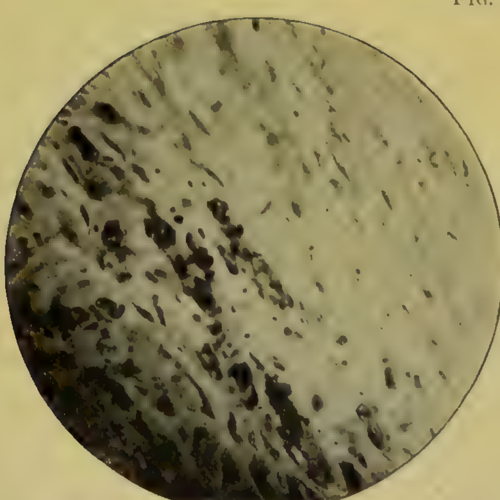


FIG. 2.

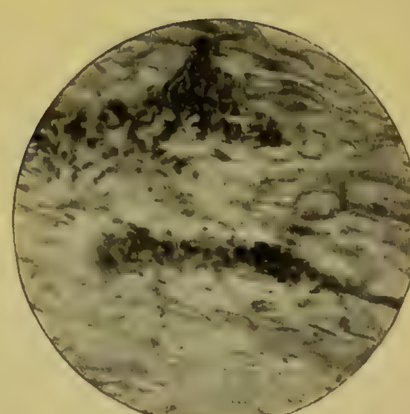


FIG. 3.

FIG. 1.—Islets of plasma-cells appearing in the uniting material. The islets are seen as dark spots on a white background (Expt. 3).

FIG. 2.—Collections of plasma-cells (vasoblasts) in the uniting material forming the boundaries of branched vacuolated spaces (Expt. 2).

FIG. 3.—Branching collections of plasma-cells (vasoblasts) about to form capillaries.

tissue, and has an ample supply of blood-vessels, the latter being of considerable importance in the healing process. It is known that the tendon is most intimately continued into the bone. In young subjects, especially at the insertion of the ligamentum patellæ, numerous cartilage cells are found between the fibres. From the ossification of such cells prominences of bone, such as the tubercle of the tibia, the adductor tubercle, and others of like nature are formed. Excessive proliferation of these cells gives origin to enchondromata and exostoses. In the normal condition we can readily understand that the tubercle will part company from the tibia before rupture of the tendon occurs.

In specimens of normal tendon comparatively few round cells are visible either between the fibres or between the fasciculi. On division of the tendon it is soon seen that the number of cells is greatly increased. At the point of section the fibres are pushed apart by the rapid development of cells, and present a frayed-out appearance. These groups of cells are in all probability the latent cells, or "schlummernde Zellen" of H. Schmidt,[1] described by him as becoming visible in fibrous tissue, after prolonged stimulus, such as "the vascular changes induced by traumatism." But more on this point anon.

EXPERIMENT 1. *Appearances immediately after Division of a Tendon.*—The ends of the tendon are cleanly cut. The tendon stumps are embedded in a complete cap of effused red and white corpuscles, the latter being few in number. In places the tendon bundles are slightly separated from each other by red blood corpuscles and a few white. It should be stated that a few drops of blood were effused at the time of operation, both externally and, as was afterwards found, in the subcutaneous tissue. Corresponding to the aperture in the skin was a minute puncture in the sheath, which, distended by blood, retained its circular outline. The tendon stumps were five-eighths of an inch apart.

EXPERIMENT 2. *Three Days after Division.*—About ten drops of blood escaped from the wound at the time of operation. The skin was adherent over the point of operation. The sheath was thickened, especially on its outer and posterior aspects. It had a reddish tinge, and showed to the naked eye minute blood-vessels. The tubular outline was still preserved, and it was well filled with uniting material, which was of the same diameter as the cut ends of the tendon. The stumps were separated seven-eighths of an inch and were slightly bulbous. The uniting material was soft, semi-fluid and deep red, and adherent to the sheath. The posterior parts of the tendon were more retracted than the anterior part.

Microscopically.—The tendon sheath is seen to be about twice its normal thickness, and is adherent to the tendon by the new material which extends beyond the divided ends upwards and downwards for half an inch. The vessels

[1] Virchow's *Archiv*, Bd. cxxvii. p. 96, and Bd. cxxviii. p. 96.

of the sheath are widely dilated. The tendon ends are becoming rapidly infiltrated with large cells, and plasma cells, which obscure the undivided fibres. The effusion between the ends consists of numerous red blood discs, whose outlines are now ill-defined. Fibrin filaments are observable between the cells. There are also many longitudinal vacuolations, some with clear-cut and others with fading margins. A few are surrounded by a continuous layer of plasma cells with well-defined nuclei -future vasoblasts —the general impressions given being that of a branching capillary vessel, but lacking the flattened endothelial lining (Plate I. Figs. 2 and 3). Occasionally the vacuolations are seen to branch, and between them are dividing plasma cells. Many of the latter have become oval, while a few are fusiform or irregular in shape (fibroblasts). Leucocytes are present in abundance. The fixed tendon cells show little or no change. The nucleus is found more towards the centre of the cells, and is less regular than normal. Many new uni-nucleated cells (latent-cells), smaller than plasma cells or leucocytes, are appearing between the bundles of the fibres.

Experiment 3. *Tendon Seven Days after Division.*—At the operation about twenty drops of blood escaped. On examination, the wound in the skin and sheath is quite healed. The latter is red but not of uniform thickness, being of greater diameter below, and tapering upwards for 1 inch until it is only half the size of the upper end of the tendon. It then becomes thicker. The sheath is firmly adherent to the uniting material. The tendon ends are separated to the extent of 1¾ inch, and the distal stump is more bulbous than the proximal. At the lower end the line of section is not traceable, and to the naked eye the parts are semi-gelatinous and reddish. The uniting substance is pink at the ends, red and diffluent in the centre, and adherent to the sheath.

Microscopically.—The clean-cut appearance of the tendon ends has now quite disappeared. The stumps are ragged, and several isolated portions of tendon substance are seen surrounded by fibrin filaments. Just above and below the point of section there are on all sides numerous plasma cells undergoing rapid division, congregated into groups, and some are bipolar in shape. Leucocytes are by no means so abundant in the regenerative material as formerly, and now most of the red corpuscles have been absorbed. A very important point in the union of tendon is the following process, which can still be observed as on the third day in the uniting material. Plasma cells are grouped together in large islets, and are surrounded and supported by a faintly-staining, somewhat homogeneous material, consisting of fibrin (Plate I. Fig. 1). In the immediate neighbourhood of the islets of plasma cells, around them and at times in their centre are masses of smaller deeply-stained uni-nucleated cells, leucocytes. It would appear that at such spots plasma cells are appearing in the fibrinous and cellular remains of the old clot, and, what is more to the point, *multiplying at the expense of the leucocytes which are ingested by them*, and now resemble "giant cells" (Plate VI. Fig. 1). This appearance has been described by Messrs. Sherrington and Ballance in their observations on areolar tissue.[1]

The leucocytes thus play a subordinate part in the process. They simply form a medium in which the plasma cells multiply, and are absorbed by the latter. From plasma cells arise later two varieties of cells, vasoblasts and fibroblasts. The former are now seen to take on their functions in this manner. The vacuolations, present on the third day, and due to fatty degeneration of parts of the clot, have now disappeared, and in their place elongated masses of plasma

[1] *Journal of Physiology*, vol. ix. p. 571.

cells are now evident. The masses are noted after a short distance to twist, and may be seen coursing freely through the new tissue, to become connected with the vessels in the muscle above and bone below, and further with those in the tendon sheath in the following way. The "latent" cells, which were small and arranged in clumps between the fibres, are now much enlarged and similar to plasma cells, and are arranging themselves in line between the tendon fibres at a short distance from the point of section. There they are continuous with the elongated masses of plasma cells in the effusion. Subsequently in the masses of latent cells between the tendon fibres and in the elongated masses of plasma cells in the effusion small channels appear whose walls are composed of a single layer of oval or rounded cells. These channels are the precursors of new blood and lymph channels for the nutrition of the scar-tissue, and eventually unite with the blood-vessels of the muscle and bone. Before this connection is complete the cells receive their nutrition from lymph exuding from the dilated blood-vessels of the sheath.

The well-defined outline of the fixed tendon cells is obscured, and they tail off occasionally. The nucleus is still single, of normal size and shape, and is not dividing. In some sections taken from another animal at this date fatty areas may be recognised in the scar tissue.

The sheath is many times thicker than normal, and active division of its plasma cells is occurring, especially opposite the centre of the gap between the tendon-ends, and an intimate vascular and fibrous connection between the sheath and uniting material has been established. It is at this spot that the beginnings of new vessels in the effusion are best marked, corresponding to the extreme dilatation and tortuous character of the vessels of the sheath.

Experiment 4. *Tendon Fourteen Days after Division.*—To the naked eye the only changes are that the sheath is opaque and white, not red. The uniting material is of considerable strength, faintly fibrillated and firm throughout, and adherent to the sheath by fine filaments of tissue.

Microscopically.—The ends of the tendon have lost all form and shape, and are blending imperceptibly with the scar tissue which is dovetailed into them. The formation of new vessels between the fasciculi is further advanced (Plate VI. Fig. 2), but the fixed oblong tendon cells show no further change. Islands of plasma cells are prominent, and many of the cells are elongating rapidly to form new fibres, which have an inclination to arrange themselves parallel to the long axis of the tendon. This appearance is visible only near the tendon stumps; but at the farthest part from them there is only a confused mass of faintly fibrous ground substance, islets of plasma cells and leucocytes as on the third day. All the red blood corpuscles and fibrin filaments have disappeared and given way to a fine ground substance formed by the processes of plasma cells. Amongst the latter, giant-cells containing four, six, and eight nuclei are seen. These nuclei are ingested white blood corpuscles.

Experiment 5. *Tendo Achillis One Month after Division.*—The uniting material is 1 inch long and as thick as the normal tendon, but not quite so firm. Under the microscope the thickening of the sheath is not so marked as in Experiment 4, and there are fewer vessels in it. The band of union shows a beautiful series of looped vessels passing down and up from the tendon stumps, and it is possible to demonstrate the direct continuity of vessels from muscle and bone to tendon, and thence to scar tissue forming anastomotic loops, which are best marked where the rounded ends of the stumps are traceable. No small round cells are visible between the tendon fasciculi, while now that blood-vessels have completely formed, plasma cells are less in evidence. All trace of leucocytes is lost; while the processes of the plasma cells from the scar tissue are insinuating themselves in all directions between the old fibres, which have lost their parallel arrangement and become wavy.

EXPERIMENT 6. *Five Weeks after Division.*—The only point of interest in the experiment lay in the fact that in dividing the tendo Achillis the neighbouring artery was wounded and a considerable quantity of blood lost, and *post-mortem* the sheath was found extremely adherent and the ends were separated more than an inch. Under the microscope and near the stumps the uniting band is more like ordinary fibrous tissue. At these spots short fibres are seen arranging themselves more or less parallel to the axis of the tendon. Many of the plasma cells which were previously swollen and slightly spindle-shaped have, after division of their nuclei, assumed a very elongated shape, and in some cases the nuclei have disappeared. The sole change visible in the fixed cells is that they are elongated slightly in places, but they are not attempting to form fibrous tissue.

EXPERIMENT 7. *Tendo Achillis Seven Weeks after Division.*—The tendon sheath is of nearly normal thickness, but is still white and opaque. A few fine adhesions are seen between it and the tendon.

Microscopically.—The sheath is now seen to be partially separated from the scar tissue. In the latter the wavy fibrillation at the ends nearest the stumps is better marked, and is proceeding towards the centre of the band. All stages of the transformation of the plasma cell into fibrous tissue, viz. from the round to oval, and thence to the fusiform nucleated cell and non-nucleated fibre, are visible. The number and size of the vessels in the scar has decreased.

EXPERIMENT 8. *Tendo Achillis Eight Weeks after Division.*—One point is worth recording in a section taken from this tendon, viz. that the process of fibrosis is best marked in the neighbourhood of the vessels in the scar.

EXPERIMENT 9. *Tendo Achillis Thirteen Weeks after Division.*—Sections taken from tendons at this date show the process of disappearance of the blood-vessels. The walls lose their sharp definition and the lumen becomes filled with a number of small round cells, which in transverse section appear as circumscribed masses of cells. The nuclei of the fixed tendon cells have now divided, and the bodies of the cells are broader and flatter, while their ends tail off, but there is no further evidence at this or at subsequent periods that these cells give rise to fibrous tissue.

EXPERIMENT 10. *Nine Weeks after Section.*—The band of uniting material is $2\frac{1}{2}$ inches long. It is opaque and dull white, lacking the semi-transparency of tendons. The minute appearances are much the same as in Experiment 9.

EXPERIMENT 11. *Thirteen Weeks after Section.*—The ends are separated 3 inches, united merely by a dull-looking fibrous cord, which to the naked eye is quite avascular. It should be mentioned that the animal had been quite unable to extend its foot for some time. Some slight adhesions are still present between the tendon and the sheath. The latter is almost of normal thickness, but is rather matted where the operation has taken place. Microscopically the conversion of plasma cells into fibrous tissue is more marked throughout the band of union, and the vessels are entirely occluded. In some places they are represented by a mere line of fibrous tissue, in others by a thick band of the same variety of tissue, *i.e.* the small round cells described in Experiment 9 as filling the lumen of the vessels have given place to fibrous tissue.

PLATE VI (Photo-micrographs).

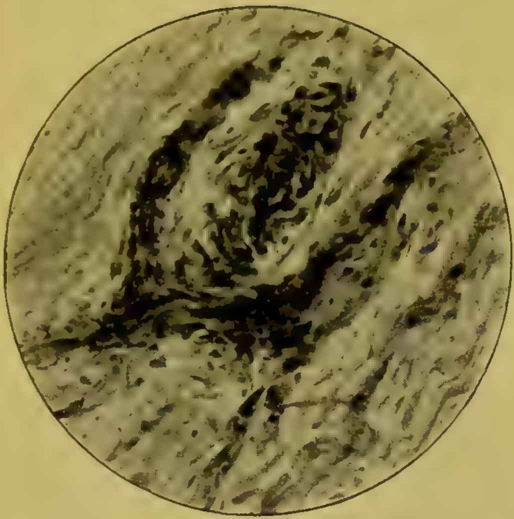


FIG. 1.

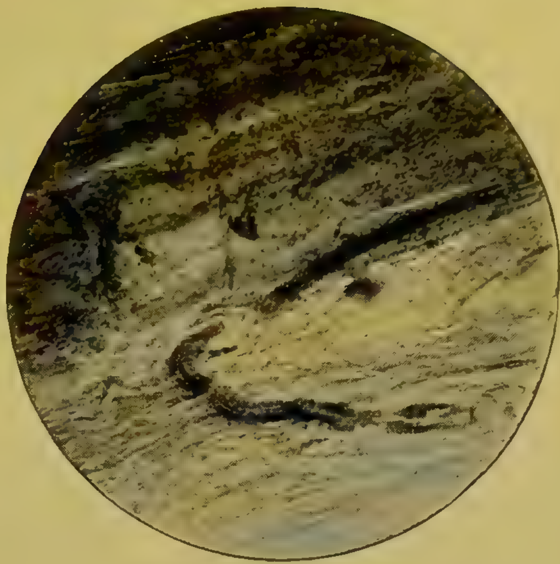


FIG. 2.

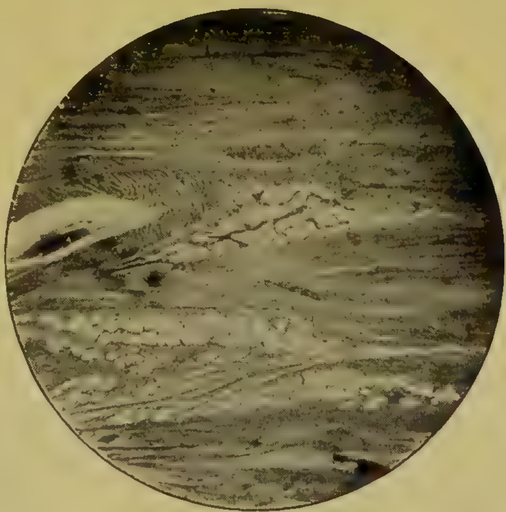


FIG. 3.

FIG. 1.—Masses of giant-cells containing ingested leucocytes. From these giant-cells or enlarged plasma-cells, both vasoblasts and fibroblasts are formed.

FIG. 2.—Complete capillary formed in the uniting material from plasma-cells (vasoblasts) (Expt. 4).

FIG. 3.—Appearances at junction of new and old tendon material, eight months after section of tendon.

EXPERIMENT 12. *Thirty-three Weeks after Section.*—The band of union is 2 inches in length and the sheath is distinct from the tendon. Microscopically, the whole of the uniting material is more closely assimilated to that of normal tendon, and the young fibres are more regularly arranged, the oval and fusiform cells being more or less in procession. But the following differences are noticeable. The fibres are by no means strictly parallel, and the spaces between them are much greater than normal; the individual fibres branch, and some of the remaining cells arising from the plasma cells resemble the fixed cells of the tendon stump in their disposition between the fibres, their more geometrical outline, and the presence of a single round nucleus. The masses of cells (the occluded blood-vessels) are very much smaller, and their outer zones are forming fibrous tissue.

EXPERIMENT 13. *Thirteen Months after Section.*—The uniting band has by this time ceased to elongate and the sheath is quite free. It is interesting to note that although there is such elongation of the band of union as to render the muscle of little use, yet there are no evidences of degeneration of the muscular fibres. Microscopical sections show, too, that the appearance of normal tendon is not perfectly regained. While many of the new fibres are parallel, some wander freely, and there is still a confusion of pattern. In addition, some blood-vessels, irregularly distributed, are seen running tortuously in the scar, and not arranged between definite fasciculi as in normal tendon. Many of these tortuous vessels are becoming gradually occluded, as shown by injection from the main artery of the limb. Some of the cells derived from the plasma cell resemble fixed tendon cells, but they are not oblong in longitudinal section.

We may therefore infer that perfect regeneration *may* be possible, but that it is far from complete at the end of the thirteenth month. It is my opinion, however, based on a study of these and other sections, that the uniting band remains scar-tissue, and nothing else, however long a period be allowed to elapse.

With respect to the processes in human tendon, they are substantially the same as in rabbits' tendon. From a study of Adams'[1] and other observers' work on human tendon, it is my belief that in man it is not perfectly regenerated even as late as three years after division.

The processes concerned in the union of tendon may be summarised thus:—

[1] *Reparative Process in Human Tendon*, p. 65.

NORMAL TENDON (Destination of the Elements in the Uniting Process).

- Fibres (dovetail into new fibrous tissue).
- Fixed cells. No share in formation of new fibrous tissue.
- Leucocytes migrate into new material, and act as pabulum for plasma cells in addition to leucocytes from the blood clot.
- Plasma cells between fasciculi.
  - Fibroblasts.
    - Fibrous tissue of scar.
  - Inter-fascicular Vasoblasts.
    - New inter-fascicular vessels running to supply uniting material.
- (Latent cells.)
  - Plasma cells.
    - Vasoblasts.
      - Inter-fascicular vessels in tendon stumps.

TENDON DIVIDED, with blood clot between ends.

- Red corpuscles absorbed.
- Fibrin absorbed.
- Leucocytes form a pabulum for new plasma cells, which migrate from the vessels of the tendon sheath and from between the fasciculi of the tendon stumps.

New plasma cells (see above).

- Fibroblasts.
  - Fibrous tissue of uniting material.
- Vasoblasts.
  - Vessels of uniting material.
    - A few permanent in scar.
    - Majority transformed into fibrous tissue.
- Cells remaining uninuclear and somewhat square, like fixed tendon cells.

The sheath thickens and becomes adherent to the uniting material. Its dilated vessels supply lymph to the plasma cells in the uniting material, and later communicate with the new vessels in that material. Subsequently the communications are closed, and the adhesions between the sheath and the scar tissue of the tendon disappear.

The questions which were asked before the experiments were described may now be answered.

1. What is the influence of effusion of blood in the healing process? As the vascular tendinous sheath is wounded in all cases, some blood must be effused, and the white corpuscles in the clot

are useful in forming a pabulum for the plasma cells. The red blood corpuscles and the fibrin are of no direct service. They are simply absorbed. Excessive effusion is to be avoided, since time is consumed in its absorption, and the energy of the plasma cells is manifested in that direction rather than in the formation of scar tissue. If the parts be unduly stretched before absorption has taken place, the uniting band is weak and feeble. Sufficient blood and no more should be effused to fill the sheath and maintain it of the same diameter as before the operation.

2. Is the tendon capable of perfect regeneration? In my opinion, it is not; in fact the destruction of the Malpighian layer of the skin is a parallel instance in so far that, if once destroyed, it is not reproduced. The whole thickness of the epidermis is never replaced if it is lost over a large area.

3. By means of which kind of tissue is union effected? It is by the plasma cell found in the connective-tissue spaces of the normal tendon, and by plasma cells which migrate from the dilated vessels of the inflamed sheath into the clot.

4. What share is taken by leucocytes? An entirely subordinate and temporary one, as they are soon absorbed by the plasma cells, forming their pabulum as they develop.

5. What is the influence of the tendon sheath? For quicker union of the tendon ends and subsequent smooth working of the regenerated cord in its sheath, it is essential that the sheath be interfered with as little as possible. If freely divided or removed, much adhesion of the uniting material to the fasciæ, ligaments, muscles, and bone occurs, cf. Experiment 6; and if contraction of the muscle recur, it is correspondingly difficult to remove by a second tenotomy. From the vessels of the sheath many of the plasma cells come, and their importance in the process has been freely insisted on.

6. Can primary union of tendon be obtained? Busse's experiments point to the impossibility of obtaining this. Some stretching of the band of union always followed, even if dovetailing of the divided ends be carefully carried out.

CHAPTER IV

THE VARIOUS FORMS OF CLUB-FOOT

Talipes Equinus, Degrees and Varieties, Morbid Anatomy, Symptoms, Prognosis, Treatment—Talipes Calcaneus, Forms, Symptoms, Diagnosis, and Treatment—Talipes Calcaneo-Valgus and Calcaneo-Varus—Talipes Arcuatus and Plantaris (Pes Cavus)—Talipes Varus—Talipes Valgus and Pes Planus—Talipes Equino-Valgus—Clinical Aspect of Union of Tendon.

TALIPES EQUINUS

Synonyms—French, *Pied bot equin* ; German, *Pferdefuss, Spitzfuss.*

THE essential features of this variety of deformity is an inability to place both the toes and heels on the ground at the same time, and the patient walks on the heads of the metatarsal bones. Subsequently contraction of the soft parts in the sole of the foot ensues, and necessitates division of the plantar fascia, and it may be of the deeper structures.

Degrees of Talipes Equinus.—The foot should normally be capable of dorsi-flexion on the leg to the extent of 18° beyond the right angle. Any condition in which this angle is diminished at the ankle-joint without inversion or eversion is rightly called talipes equinus. A few degrees of diminution are not of import, but if the foot cannot be flexed beyond the right angle, then there exists

The First Degree, or Right-angled Contraction of the Tendo Achillis. —In the examination of these cases it is essential to note that in estimating the angle of flexion of the foot, the *knee must be kept fully extended,* since shortening of the tendo Achillis is readily compensated by flexion of the knee. Unless the whole foot can be brought squarely to the ground with the heel in complete apposition, without pain or force in the fully erect position, the first degree of talipes equinus is present.

The results of this slight deformity are: 1. The formation of corns beneath the heads of the metatarsal bones.[1]

2. Slight lameness and shortening of the stride. For ease in walking complete flexion at the ankle is necessary, and if the knee be kept slightly flexed in walking the stride is necessarily lessened.

3. Some eversion and inversion of the foot occur, especially in paralytic cases, as the calf muscles become shorter. To diminish flexion at the knee as much as possible in walking, and at the same time to bring the heel to the ground, the foot is twisted inwards or outwards at the ankle, so that the muscles and tendons

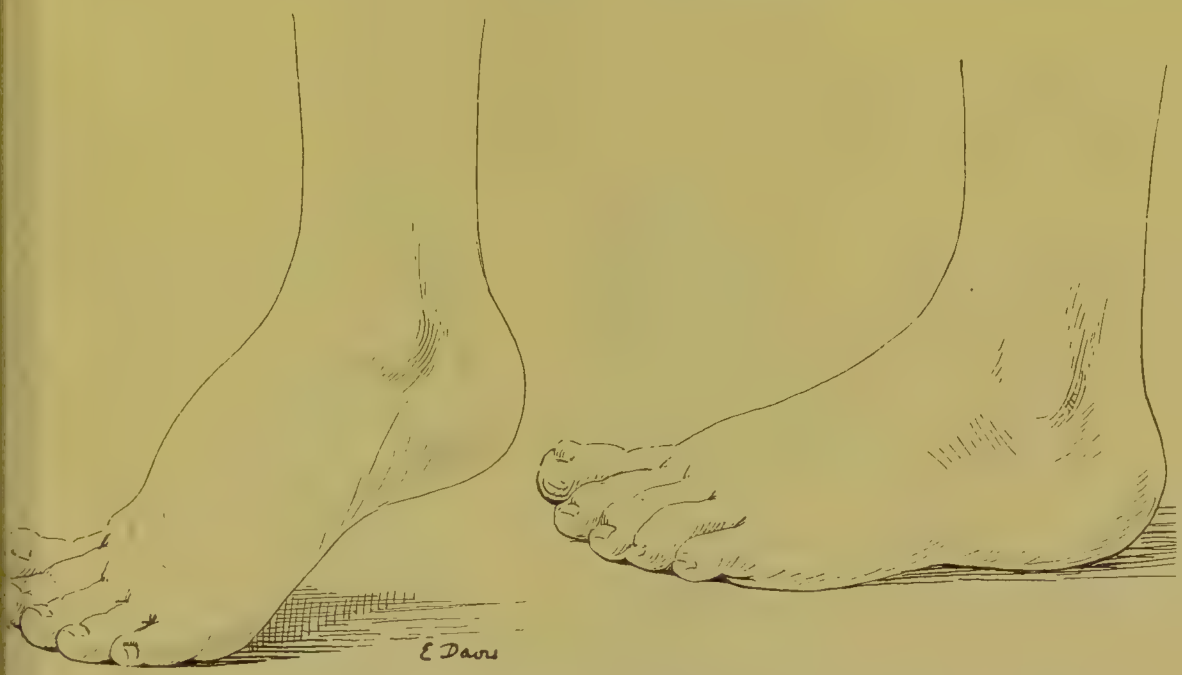


FIG. 174.—Paralytic talipes equinus, before and after treatment (Charles M——, aged 3 years).

may take as short a course as possible from the points of origin to their insertions. Many cases of so-called talipes varus or valgus are found to be equinus when carefully examined with the knee fully extended.

The Second Degree.—The heel is raised well off the ground, and a transverse crease is seen above it. Progression takes place on the heads of the metatarsal bones, and decided lameness is present, due

[1] It is a good clinical point that if a row of corns be found in this situation, either right-angled contraction of the tendo Achillis, or contraction of the plantar fascia, causing talipes arcuatus, is present. If one or two corns are found under the heads of the second, third, and fourth metatarsal, and not on the first and fifth, then Morton's disease may be suspected.

partly to the extended foot and partly to large and inflamed corns. In congenital and spastic cases a broadening of the front part of the foot, owing to the "spreading" of the heads of the metatarsal bones and separation of the toes, is seen. This appearance is all the more

FIG. 175.
Paralytic talipes equinus; the position assumed by the feet when they are suspended.

striking from the ill-developed state of the heel. Here the skin is quite thin and shows no signs of pressure; the tuberosities of the os calcis are absent, so too is the natural pad of fat. The great toe is drawn towards the middle line of the body, and the inner border of the foot is concave. This appearance simulates that of slight varus, but in the latter case the site of deformity is at the medio-tarsal, and not at the metatarso-phalangeal joint, as in the former. The limping gait in paralytic cases and the jerky step in spastic are characteristic. The plantar fascia is frequently contracted in this stage. Noticeably in paralytic cases, and to a less degree in spastic, the head of the astragalus forms a distinct prominence on the dorsum of the foot (Fig. 174).

The Third Degree is an exaggerated condition of the second.

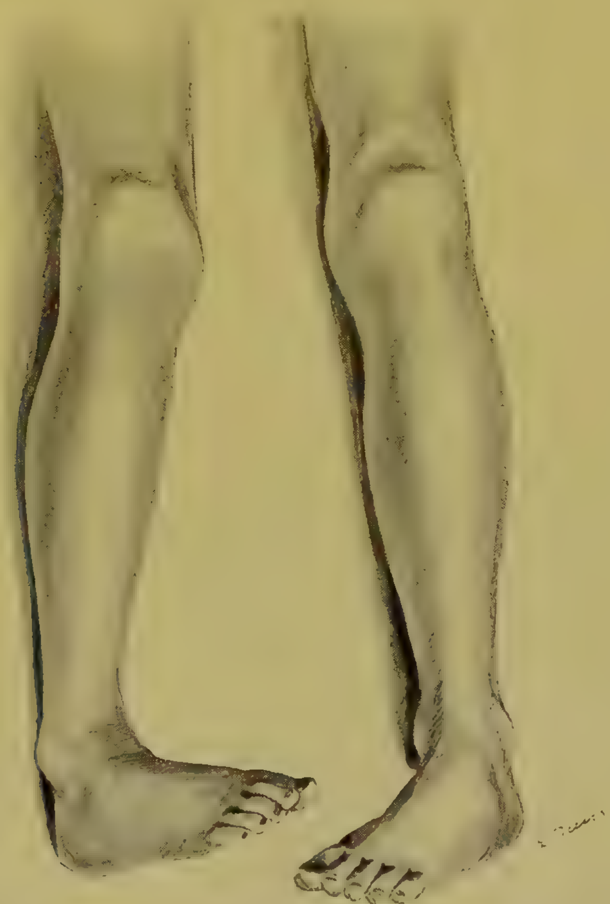


FIG. 176.—The same patient as in Fig. 175, showing the position assumed by the feet when the patient lay down.

So much extension is present that locomotion takes place on the dorsum of the foot. It is bent completely backwards, and the toes are, as it were, "tucked underneath." If one foot alone be affected in the second or third degree, the patient is often able to hobble about fairly well. But when both feet are deformed, walking may be impossible.

Occurrence and Causation.—Talipes equinus is the rarest of congenital deformities. Little, however, has recorded two, Brodhurst "one or two," and Adams three cases. The writer has met with one case in a child aged 4 months, who presented pure equinus in the left, and equino-varus in the right foot.

As an acquired deformity of the foot, equinus is the most frequent of all varieties. The causes of it are:—

(*a*) Spastic, viz. hemiplegia, spastic paralysis.

(*b*) Paralytic, from infantile paralysis and sometimes hemiplegia.

(*c*) Traumatic, injuries to the ankle-joint and anterior tibial nerve.

(*d*) Cicatricial, from burns on the back of the leg, or laceration of the calf-muscles.

(*e*) Retention of the foot in a vicious position, *e.g.* the pointed feet of bedridden patients—talipes decubitus.

(*f*) Associated with other deformities, such as shortened limb from coxitis, fracture, and separation of the epiphyses.

(*g*) Inflammation, rheumatic or tubercular of the ankle.

Practically we have to consider two classes, the spastic and paralytic.

There are essential *differences* in the feet according as *spasm* or *paralysis* is present, viz.:—

In both the congenital and spastic cases the heel is much raised, the arch somewhat deepened, but the foot is in a direct line with the leg, and there is no falling away at the medio-tarsal joint. Whereas in paralytic cases the heel and posterior part of the foot do not appear so much raised, as that the front part of the foot is dropped. In this event the head of the astragalus and dorsal surface of the scaphoid are very prominent (*vide* Plate VII.) The toes in a spastic case are hyper-extended at the metatarso-phalangeal, and flexed at the first inter-phalangeal joint, and so present a claw-like appearance. In paralytic cases of the first degree they are extended fully on themselves, and in the second degree they are hyper-extended at the metatarso-phalangeal joint, while in the third they are entirely flexed into the sole.

In all forms of club-foot the following points hold good in the diagnosis of congenital, spastic, and paralytic talipes.

In the *congenital* cases the deformity is present from birth, and is frequently bilateral. In the majority of cases it is either equino-varus or varus. Much resistance is offered to any attempt to straighten the foot; there is little or no interference with the nutrition of the foot in early cases. In the *spastic* variety one or both feet are affected. Equinus is the most common deformity; the affected muscles are tense, rigid, and resistant; the nutrition of the limb becomes ultimately affected, and the contracted muscles atrophy; the reflexes are increased. In the *paralytic* cases very often one foot only is involved; the affected muscles are lax and flabby, and give the reaction of degeneration; the reflexes are diminished or lost; the limb is wasted, and shorter than its fellow; its temperature is diminished, and it is cold and blue, and trophic lesions of the skin may be present.

The Morbid Anatomy of Talipes Equinus.—Inasmuch as the foot is not deflected laterally, and the permanent condition is one that can be nearly assumed by the normal foot, the alterations in the bones and soft parts are not marked, nor are they sufficient to prevent the foot from being restored to complete usefulness.

The Bones.—A case is recorded by Adams[1] of a man, aged 25 years, whose foot showed no "material change" in the form of the bones. They are altered in position and direction, but not in outline. The os calcis is either slightly elevated or remains horizontal. In congenital forms elevation of this bone is present, in paralytic cases it is absent. Rarely it may happen that the upper surface of the os calcis comes in contact with the posterior part of the articular surfaces of the tibia and fibula; such an occurrence, however, has been described. The head of the astragalus is directed downwards and forwards, and often stands out prominently on the dorsum of the foot; subluxation occurs at the astragalo-scaphoid joint. In severe instances the scaphoid and os calcis articulate. Reeves[2] says that the base of the fifth metatarsal bone may be nearly in contact with the os calcis. When this is so, the arch of the foot is greatly exaggerated, and there is much adaptive shortening of the soft structures in the sole.

In paralytic cases the equinus is seen to depend chiefly upon a dropping away of the foot at the medio-tarsal joint, so that the cuboid and scaphoid are also lowered in position, and displaced from the os calcis and astragalus. The metatarsal bones assume a vertical position, or are directed backwards, and are spread out at their distal extremities. In paralytic cases the compact bone-tissue is thinner and lighter than normal, and the cancelli and medullary cavities are filled with fat. Loss of cartilage occurs in those articulations which are the site of partial subluxation, *e.g.* from the

[1] *Path. Soc. Trans.* vol. iii. p. 468.
[2] *Op. cit.* p. 209.

head, superior and lateral articular facets of the astragalus, and the heads of the metatarsal bones.

Ligaments.—The dorsal ligaments are stretched, especially the superior calcaneo-cuboid and calcaneo-scaphoid, and the anterior part of the lateral ligaments of the ankle. The plantar structures are much contracted. The fascia is first affected, and then the inferior calcaneo-scaphoid and the calcaneo-cuboid ligaments are shortened. So too are the posterior parts of the lateral ligaments and the posterior ligament of the ankle. It is necessary to recognise the existence of shortening of the last-named ligament. In severe cases of long standing section of the tendo Achillis is not sufficient to reduce the deformity and to permit sufficient dorsi-flexion at the ankle. As a rule such a state of affairs is due to shortening of this ligament.

Muscles.—In paralytic feet the extensors undergo fatty and fibrous degeneration, while their opponents are shortened from want of opposition. In spastic cases Guérin says that fibrous degeneration is present.

Tendons.—In addition to the tendo Achillis, the plantar fascia and the long flexors and the peroneus longus are shortened and tense. Later the short plantar muscles retract.

Skin.—Corns and adventitious bursæ are present. In severe cases the former suppurate, and leave perforating ulcers. The skin in the sole is shortened, but after division of the deeper structures will stretch.

Prognosis.—In congenital and spastic cases, so far as the deformity is concerned, the outlook is good, as, for example, in the following case:—

CASE 59. *Spastic Talipes Equinus.*—Eva P——, aged 2, was brought to me in 1895. The history was that the child was quite healthy at birth, and nothing was noticed until she was 1 year old beyond the fact that she did not use her left arm properly. The case was evidently one of infantile hemiplegia. The left forearm was flexed and pronated, the wrist flexed, and the thumb and fingers contracted. The left knee was also somewhat flexed, and the foot in a state of equinus. I advised that the right arm should be tied up, so that the left might be used more freely, and that section of the tendo Achillis be performed. This was done with good results.

But the ultimate value of the limb for locomotion in spastic cases must depend upon the persistence of the central cause of the spasm.

PLATE VII.

Fig. 1.—Before treatment.

Fig. 2.—After treatment.

Paralytic Talipes Equinus (Case 60).

In paralytic cases we have to consider the prognosis from two points of view: (*a*) the ultimate shape of the foot; (*b*) the acquisition of voluntary power in the affected limb. As to the first point, the removal of the deformity does not prevent any great difficulty. It may be said that a shapely foot is, as a rule, obtainable, as in the following case:—

CASE 60. *Severe Paralytic Talipes Equinus: Operation: Cure.*—Walter E——, aged 9, came to my out-patient room at the Evelina Hospital with the foot in the condition seen in Plate VII. Fig. 1. The deformity was evidently due to infantile paralysis, as the limb was 4 inches shorter than its fellow, cold, and wasted. The boy could only limp. He was admitted, and the tendo Achillis and plantar fascia were divided, with the successful result seen in Plate VII. Fig. 2. By the aid of a cork sole, the patient could get about fairly well.

Nor, as in the case of talipes equino-varus, is age any bar to success. Instances are recorded of cure of the deformity at the ages of 54 and 60 years.

The second factor in prognosis, the acquisition of voluntary power in the affected muscles, is a different question. In infantile paralysis we must be guided by the number of affected muscles, and the extent to which power is lost. But it should not be forgotten that greater recovery of muscles or fibres of a muscle takes place under appropriate treatment than could at first be anticipated. If the deformity of the foot be removed, it is a matter of surprise how much power and usefulness muscles, apparently in a hopeless state of degeneration, regain, especially if, in addition to active exercise, they be douched, rubbed, and galvanised.

When the deformity arises from causes such as prolonged decubitus, we may say briefly that it presents a favourable prognosis, since there is no degeneration [1] of muscle and no ankylosis. In those cases which arise from inflammation of the ankle-joint, generally of a tuberculous or rheumatic nature, the outlook is the reverse of favourable.

Diagnosis.—Pure talipes equinus presents in the second and third stages no difficulty in recognition. It is only in the first stage of right-angled contraction that it is likely to be overlooked. Under the title of "non-deforming club-foot," Shaffer [2] has described an affection in which the heel can be placed on the ground, but the anterior part of the foot cannot be raised. It appears to be a state of imperfect flexion at the ankle and medio-tarsal joints.

[1] Except when the equinus is due to nerve-lesions.

[2] Bradford and Lovett, *op. cit.* p. 746.

It is often difficult to be sure of the cause of talipes equinus, but a careful inquiry into the history as to the mode of onset, the presence of tonic contractions elsewhere—especially of the adductors of the thighs—the absence of extreme muscular wasting, and of coldness and the excessive reflexes in spastic cases, will serve to distinguish them from paralytic cases. In the latter, if of moderate severity, before contraction of the sole has set in, it will be noted that when the foot is raised the dropping away of the front part of the foot is very apparent (Fig. 177); but this sign in some cases entirely disappears when the foot is placed firmly on the ground.

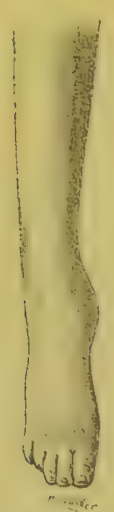


FIG. 177.—From a case of infantile paralysis. The dropping of the foot, owing to the paralysed condition of the anterior tibial muscles, is very apparent.

The Treatment of Talipes Equinus.—The treatment of paralytic equinus is conducted on the following lines. In cases of the first degree, or right-angled contraction, manipulation and exercises may be employed. Walsham and Kent describe some exercises which they have found "especially useful." "The patient stands with the soles flat on the ground, and then bending the knees and hips whilst holding the body erect, with the arms close to the side, endeavours to touch the ground with the finger-tips. This exercise should be performed, say, six times a day at regular intervals, and for five or ten minutes at a time. It may be varied by placing a wedge-shaped block of wood or other non-yielding material, $2\frac{1}{2}$ to 3 inches high, beneath the fore part of the foot, and then in like manner, whilst bending the knees and hips and keeping the body erect, endeavouring to touch the ground with the tips of the fingers." A walking apparatus with toe-elevating spring and a "stop" at the ankle-joint to prevent undue plantar flexion, is necessary by way of after-treatment, and the application of a tin-shoe at night must be enforced. But time and trouble may be saved by division of the tendo Achillis. If there is any contraction of the plantar fascia, this should have been severed previously.

In equinus of the second degree division of the plantar fascia, followed by tenotomy of the tendo Achillis, is called for. It is advisable to make sure that the front part of the foot and the heel can be placed in one horizontal plane before the tendo Achillis is divided. The condition of the toes varies. Sometimes they are in a straight line with the metatarsal bones, at other times they are "clawed." If this condition of "clawing"[1] be present, and the extensor muscles show by electrical tests but slight signs of degeneration, the extensor tendons should be divided at the roots of the toes at the same time that the plantar fascia is severed.

The immediate after-treatment consists in the use of Scarpa's shoe or plaster of Paris, according to the inclination of the surgeon. Great attention must be paid to active and passive exercises, and the use of the induced current. As soon as the union of the tendo Achillis is formed, a walking instrument may be ordered. According to the degree of paralysis of the leg muscles, so should the walking ap-

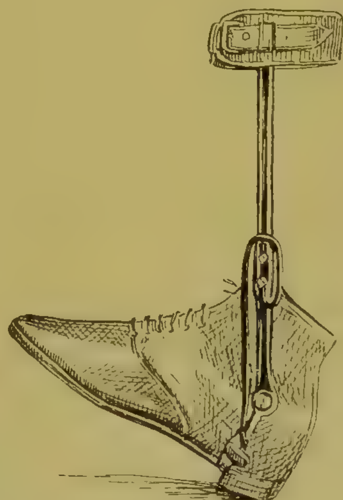


FIG. 178.—Walking apparatus, single to the calf, with toe-elevating spring, for the after-treatment of paralytic talipes equinus.

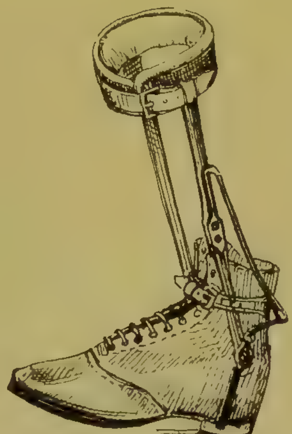


FIG. 179.—Walking apparatus, double to the calf, with toe-elevating spring, for the after-treatment of paralytic talipes equinus.

paratus be single or double to the knee (Figs. 178 and 179); and if there is laxity of the knee-joint ligaments, owing to paralysis of the extensors of the thigh, the instrument should be carried to the upper part of the thigh, or to the pelvis, if the affection is symmetrical. Double knee-caps and a ring-catch joint at the knee are helpful and convenient, and the shortening of the limb renders an additional thickness of sole necessary. One of the best means of

[1] The "claw-like" state of the toes is said to be due to paralysis of the interossei. This rests on the authority of Duchenne of Boulogne, who formulated the theory as the result of tests with the induced current. I am not aware that he verified it by actual dissection. In Walsham and Hughes' work the authors state, in a specimen of equinus with clawed toes, the interossei were healthy.

restoring the muscles when the functions are in partial abeyance, is that of walking exercise, and this can only be obtained after a division of all those structures which prevent the restitution of the foot to its normal position and the application of a suitable instrument.

In the third degree time must be given for the inflammation of the skin around corns and false bursæ to subside, and then the foot is gradually unfolded, beginning with the front part, and finally letting down the heel by section of the tendo Achillis. After this there may remain considerable plantar flexion at the ankle, and the wrench may be called for. Should the use of this instrument not be sufficient, then astragalectomy is preferable to the other forms of tarsectomy. But in paralytic cases open operations are to be avoided, if possible, owing to the low vitality of the tissues. By the gradual methods the degree of deformity which may be overcome is very considerable indeed.

The after-treatment, both immediate and remote, is similar to that in the second degree. Congenital cases are treated on the same lines.

The Treatment of Spastic Cases.—In these cases the amount of comfort obtained by tenotomy is considerable, and lasts for some years, and is permanent when the spastic process has ceased, so that the writer would perform tenotomy of the tendo Achillis. The same remark applies to cases of pseudo-hypertrophic paralysis. And in the pointed foot, the result of prolonged decubitus, especially after peripheral neuritis, tenotomy of the tendo Achillis is called for.

Talipes Calcaneus

Synonyms—French, *Pied bot talus*; German, *Hackenfuss*.

Causation.—This is an infrequent deformity. It is met with arising from congenital, paralytic, and other causes, such as want of proper supervision after section of the tendo Achillis, feeble union of the divided tendon, wound of the calf involving the tendon or posterior tibial nerve, contraction of a scar from a burn on the anterior part of the foot.

Appearances.—The feature of this distortion is the undue depression of the heel, with or without elevation of the toes. If the latter are elevated, the sole of the foot is not unduly concave. But when the anterior part of the foot and the toes are nearly, if not quite, on a level with the heel, then the concavity of the arch is greatly increased, and one form of pes cavus, or, as it is better named, talipes arcuatus, is present. Frequently in long-standing cases, on the posterior aspect of the leg and just above the heel, a prominence is seen. It is formed by the lower ends of the tibia and fibula, which become conspicuous as the astragalus and foot are drawn forwards and downwards.

Congenital Talipes Calcaneus.—Examples of this kind are not often seen. During the past five years I have met with nine cases. The notes of one case are as follows:—

CASE 61. *Spina Bifida, Hydrocephalus, Talipes Calcaneus.*—Robert M——, aged 21 months, was admitted into the Evelina Hospital on 29th October 1894 for a perineal abscess. The family history was good. There are nine children in the family, and the mother has had no miscarriage. The patient was a full-term child, and was born with a "lump" on his sacrum, which, from the present puckered appearance, was probably a spina bifida. This seems to have become spontaneously cured by ulceration. There was no history of syphilis. He has had "water on the brain" ever since he was born, but has had nothing else the matter with him until the perineal swelling appeared.

FIG. 180.—Congenital talipes calcaneus (Arthur R——, aged 7 weeks).

Both feet were in the position of pure calcaneus, the angle in both cases between the dorsum of the foot and the leg being 30°; and this angle could not be increased without pain, owing to the tonic contraction of the exterior proprius pollicis and longus digitorum. The appearances presented by the feet were similar to those in Fig. 180. Under chloroform the contracted tendons were divided, and the feet placed at once in right-angled shoes. They were kept in this form of splint for three weeks, and the child went out, but it is feared that the walking power will not be good, owing to some contraction of the adductors of the thighs. At present (February 1895) the feet remain in excellent position, and the adductor spasm is much less.

It is stated by Adams to be the rarest of all forms of congenital club-foot; but it may be permissible for me, from my own observations, to doubt this. I am aware that in infancy the flexion of the foot upon the leg is much greater than 18°, but in the four cases mentioned above there was distinct difficulty in bringing the foot to the right angle. It is stated that caries of the ankle-joint is associated with a flexion of the foot simulating talipes calcaneus.

Aspect of the Foot in Congenital Calcaneus.—The foot itself is perfectly normal in shape, but it is dorsi-flexed upon the leg, and fixed by contraction of the shortened extensor muscles at an acute angle. There is no increased arch of the foot; indeed, if the cases are seen and treated before walking has commenced, the sole of the foot is flat. Occasionally slight deviation of the foot to the one side or the other occurs, and then calcaneo-varus or calcaneo-valgus exists. There may be transverse folds on the dorsum of the foot. The complications of calcaneus are genu recurvatum, varus of the opposite foot, absence of bones, viz. complete or partial absence of the fibula, tibia, tarsal bones, or deficient and defective toes. Spina bifida, hydrocephalus, and cleft palate are sometimes associated with the deformity.

There is little or no displacement or alteration of the bones in the foot. The anterior ligaments of the ankle-joint are shortened and the posterior lengthened.[1] The muscles contracted are of course the extensors of the toes. Lonsdale[2] has described a rare complication of this form of club-foot, viz. rigidity of the knees in an extended position, with flexion of the thighs. These cases have always been breech presentations.

The *prognosis* is good as a rule, and the cases are readily curable. When the child commences to walk, the calf muscles acquire considerable power, pull up the heel and bring the front part of the foot to the ground, so as to ensure a more perfect balance.

In the *treatment* of these cases it is sufficient, when the infant is very young, to extend the foot daily several times and to shampoo the posterior muscles, or the foot may be extended under an anæsthetic, and placed in a retentive apparatus. Probably the best form is the soft iron splint, which can be removed before rubbing the leg and its angle altered as the case requires. Tenotomy and after-extension of the foot by means of a metal splint, or by Scarpa's shoe, or by plaster of Paris, are necessary if the child is over 1 year,

[1] Dr. J. Griffiths of Cambridge, *Brit. Med. Journ.* 30th Dec. 1893, describes a case of "Symmetrical Talipes Dorsalis in an Acephalous Fœtus." There was a spina bifida extending from the skull to the mid-lumbar region. In this instance the deformity at first sight resembled that known as talipes calcaneus, but in the sketches accompanying the article the heel is seen not to be drawn up and the os calcis is horizontal. The whole foot is sharply bent upwards at the medio-tarsal joint, so that the dorsum is applied to the anterior surface of the leg and there exists extension at the ankle, with hyper-extension at the medio-tarsal joint. Dr. Griffiths' contribution is interesting as showing the evolution of congenital calcaneus. It is possible that the unbalanced action of the extensor acts first by hyper-extension at the medio-tarsal joint, and then secondly at the ankle-joint as development proceeds.

[2] *Lancet*, Sept. 1855.

and if the foot cannot be extended beyond the right angle under an anæsthetic.

Acquired Calcaneus.—*Aspect of the Foot in Paralytic and other*[1] *Forms of Acquired Talipes Calcaneus.*—The appearances presented are totally different from those in the congenital form, and are essentially dependent, in the first place, upon dropping of the os calcis from lengthening of the tendo Achillis; and in the second place, upon contraction of the plantar fascia and deeper structures of the sole. The heel is abnormally lengthened and ball-like, owing to the tuberosities being prominent. This appearance is accentuated by the large pad

FIG. 181.—Talipes calcaneus of the left foot from slight paralysis of the calf muscles.

of fat and thickened skin which forms over the tuberosities, the result of undue pressure. The front part of the foot is raised, and cannot be brought to the ground at the same time as the heel. It is said that the foot is more or less everted, but in the few cases I have seen this has not been the case. At first the arch of the foot is not increased, but when the deformity is allowed to persist, the toes and the heels are approximated, so that the arch is much deepened, and talipes arcuatus (pes cavus) follows. A deep transverse groove therefore forms in the sole of the foot. The legs, especially the calves, are very much wasted in paralytic cases, and the tendo Achillis is thin and membranous.

[1] I have seen one case of spastic talipes calcaneus associated with hammer-toe. The cause could not be ascertained with certainty.

The different appearances in congenital and paralytic talipes calcaneus depend upon the following points. In the congenital form the deformity is at the ankle-joint only; in the paralytic it is at both the ankle and medio-tarsal joints. In the congenital form the posterior tibial muscles are normal in strength and prevent the dropping of the os calcis. In the paralytic form these muscles, being powerless, can neither prevent the heel dropping nor counterbalance, through the os calcis, the action of the long anterior muscles which are attached to the toes. The os calcis therefore drops, and is at the same time pushed out of its place by the extensors acting on the toes through the ankle and other joints. Partly by the pull of the extensors approximating the front and back of the foot, and partly owing to the effort made by the patient to bring the front of the foot to the ground, the deepening of the arch is progressive. So long, too, as the deformity is allowed to exist, the fasciæ and short muscles of the sole tend to contract, and to bring the head of the metatarsal bones nearer the heel. Hence the arch is increased, and is possibly represented by a deep groove.[1]

Symptoms.—While in the congenital forms the muscles are not wasted, nor is the leg cold, but the gait is awkward, slow, and ungainly; in the paralytic variety there is often lameness, and the heel strikes the ground first, while the fore part of the foot flops down. The foot can be much dorsi-flexed, and the calf is wasted, with the tendo Achillis in a lax condition.

CASE 62. *Talipes Calcaneus after Section of Tendo Achillis for Equinus.*—Harold R———, aged 15, suffered from infantile paralysis affecting the left leg when 2 years of age, and talipes equinus resulted. Five years ago the tendo Achillis was divided and the boy sent home under local supervision. He was allowed to walk about three weeks after the operation. When seen by me the left heel was exceedingly prominent, the arch of the foot much increased, and the distance from the

[1] On the connection between paralytic equinus and calcaneus, contrary as they may seem, Walsham and Hughes, p. 365, are very explicit. "In cases of infantile paralysis in which the anterior muscles and the peronei, as well as the superficial and deep muscles of the calf, are affected—that is, when all the muscles of the leg are paralysed—the foot, by reason of its weight, falls into the position of equinus, so that in calcaneus there must always be some power left in the anterior muscles or in the peronei to maintain the os calcis in a position of dorsal flexion and depress its posterior extremity. In brief, therefore, when the anterior muscles entirely escape, the foot is dorsi-flexed (calcaneus); when they are only to some extent affected, the anterior part of the foot drops forward, and more or less cavus is produced according to the extent of the paralysis of the anterior muscles; and when they are entirely paralysed, equinus, and not calcaneus, is the result."

tip of the great toe to the inner tuberosity of the os calcis was 1½ inch less on the left than on the right. There was some contraction of the plantar fascia. The fascia was divided, and he was ordered to wear a walking instrument with a toe-depressing spring in the daytime, and a Scarpa's shoe with an outside steel support at an obtuse angle and uplifting movement in the sole plate for night wear. Some improvement resulted, but as it is not sufficient, I intend to shorten the tendo Achillis and dove-tail the cut ends.

Morbid Anatomy.—Bones and Joints.—The long axis of the os calcis is oblique and in extreme cases vertical, walking taking place on its posterior surface. The position of the astragalus is altered too. It is displaced as a whole posteriorly, and the back part of its superior articulating surface may even project somewhat; while the neck and head point forwards and upwards. At the medio-tarsal joint the scaphoid and cuboid are slipping downwards and forwards from the posterior portion of the tarsus; and in early stages there is undue movement at this joint. At the ankle-joint extension is scarcely possible, owing to the contraction of the anterior tibial muscles and shortening of the anterior ligaments. The posterior ligament is correspondingly lengthened.

Muscles and Fasciæ.—Much wasting and fatty degeneration of the calf muscles ensue in paralytic cases, while their opponents are shortened and tense. The short muscles and ligaments of the sole and the plantar fascia are retracted.

Skin.—Corns and adventitious bursæ are seen on the heel, while under the balls of the toes the skin does not show the natural thickness and hardness. In paralytic cases the integument is also cold, blue, and liable to chilblains.

Prognosis.—In all cases, when the heel is much dropped and the arch of the foot unduly concave, especially if contraction of the plantar structures have ensued, the outlook is bad. The shape of the foot may be restored by section of the fascia and short muscles, but the chief difficulty consists in keeping the heel up. This is especially the case when the cause is infantile paralysis. The results of recent methods of shortening the tendo Achillis by dove-tailing and in other ways are not generally regarded as successful, although some cases have done well in Willett's and Walsham's hands [1] by an operation which consists of division of the tendo Achillis obliquely from above downwards and from before backwards, and then sliding the cut ends past one another until the necessary

[1] *Brit. Med. Journ.* 31st May and 14th June 1884.

shortening is obtained. Care is taken to stitch the two parts firmly to each other and to the skin.

Treatment.—That of the congenital form has already been alluded to on p. 340. But if the case is of a severe nature and refuses to yield to manipulation, the following tendons should be divided, viz. the extensor proprius pollicis, the extensor longus digitorum, with the peroneus tertius and the tibialis anticus. The foot is then retained in good position by some form of apparatus. Either the malleable iron splints, Scarpa's shoe, or plaster of Paris are efficient. The drawbacks to the Scarpa's shoe are its complexity, expense, and the difficulty of satisfactorily adjusting it, unless well accustomed to its use, so that pressure sores may be avoided. In the treatment of talipes the simpler the apparatus the better. In the case of Robert M——, aged 21 months, described on p. 339, the tendons were divided and malleable iron splints applied, and the foot was successfully restored. Such is the usual result if the case is seen early.[1]

FIG. 182.—Walking apparatus for talipes calcaneus with toe-depressing spring.

Acquired calcaneus, especially of the paralytic variety, is more difficult to treat on account of the alteration in the arch of the foot. The paralytic form may arise in two ways, either as a direct result of infantile paralysis or from excessive lengthening of the tendo Achillis after section for paralytic equinus.

The measures at our command for treatment are physiological, mechanical, and operative. In whatever condition the calf muscles are, they must be assiduously massaged, and the constant current applied daily until they regain as far as possible their tone.

Mechanical Treatment.—The objects are to raise the heel, to bring the toes in contact with the ground a little before the heels, and to keep the arch of the foot as flat as possible. These are effected by a walking instrument (Fig. 182), which may be single,

[1] In the *Revue d'Orthopédie* for Sept. 1892 Larabrie details a case of congenital calcaneus in a male, aged 17, in whom division of tendons failed to reduce the deformity. After removal of the scaphoid and other offending portions of bone, the sole of the foot could be placed firmly on the ground, whereas, before the first operation, merely the outer and posterior part of the foot came into contact with the ground.

or double to the calf in severe cases, having a toe-depressing spring, with a three-quarter stop at the ankle-joint, *i.e.* the joint stopped a little over the right angle to prevent the heel dropping. In most cases a rubber band or accumulator should be attached from the garter-piece to the heel of the boot, and a steel support should be placed on both the inside and the outside of the leg. For night wear a tin shoe with a quadrant is necessary. The quadrant must be so adjusted that the sole-piece is at an angle of 110° with the calf-piece, and some extension is thus obtained. One point in fixing this shoe deserves attention. The heel is first fixed firmly in its place, and then, with the left hand drawing the heads of the metatarsal bones forwards and slightly upwards, the surgeon straightens out as much as possible the structures in the concavity of the plantar arch, and finally fixes the front part of the foot in position by a bandage. The use of walking apparatus is advisable in these cases for some years.[1]

Operative Measures for Acquired Calcaneus.—They are of various kinds, viz. (1) section of the contracted fasciæ, muscles, and tendons of the sole of the foot; (2) measures designed to shorten the tendo Achillis; (3) attaching the healthy peronei muscles to the lower stump of the tendo Achillis—Nicoladoni's method; (4) arthrodesis.

1. Section of the plantar fascia and some of the short muscles in the sole is useful as a preliminary to mechanical treatment, so that the distance between the toes and the heel may be increased, and the patient acquire as flat a sole as possible to walk on. Section in the sole may be supplemented by forcible stretching with the hand or wrench.

2. *Shortening of the Tendo Achillis.*—This cannot be accomplished by simply cutting across the tendon horizontally in two places, and removing a given length. Although the stumps may be closely united by sutures at the time of operation, yet the tendon after a time becomes as long as before, and the heel drops. The recurrence of the deformity after such an operation is due, it appears to me, to two causes—continued stretching of the paralysed calf muscles, and yielding of the band of union. Various devices are practised to overcome these objections.

The methods of shortening the tendo Achillis are by

(*a*) Willett's Method.

(*b*) Gibney's Method.

[1] Judson's apparatus is also of value.

(*c*) The Z-Method.

(*d*) Transplantation of the Tubercle of the Os Calcis.

(*a*) *Willett's Method.*[1]—"A Y-shaped incision some 2 inches in length is made over the lower end of the tendo Achillis down to the tendon. At the lower or vertical portion of the incision, the dissection is continued until the tendon is fully exposed over its superficial and lateral surfaces for the space of 1 inch in length, its deep connections being left undisturbed. The tendon is now cut across at the point of junction of the oblique portions of the wound with the vertical. Next the proximal portion of the tendon is raised, with its superficial connections to the integuments intact, to the extent of fully $\frac{3}{4}$ of an inch by dissecting along its deeper surface, *i.e.* by reversing the dissection made upon the distal segment. A wedge-shaped slice of the tendon is now cut off from both segments, that from the proximal being removed from the deep surface, whilst from the distal it is taken from its superficial; in both instances the faces of the wedge-shaped portions removed being at the point where the tendon has been divided. The heel being now pressed upwards, the proximal portion, including both skin and tendon, is drawn down and placed over the distal, thus bringing the prepared cut surfaces of the tendon into apposition. In this position they are held by an assistant, whilst four sutures, two on either side, are passed deeply through the integument, then through both portions of the tendon, and again out through the integument and fastened. When the operation is completed the united edges of the wound assume a V-shaped appearance, owing to the angle of the proximal portion being now attached to the terminal point of the distal portion of the original incision."

As Walsham points out, and it is in accordance with the experience of others and myself, plastic operations on the tendons of muscles, which are affected with infantile paralysis, are successful only when some healthy fibres are present in the muscles. It is useless to perform this or the other forms of tenectomy if the calf muscles give no reaction to electric stimulation. Elongation of the degenerated muscle-fibres will follow some months after the operation.

(*b*) *Gibney's Method.*[2]— A Y-shaped incision is made. The

[1] *St. Bartholomew's Hosp. Rep.* vol. xvi. 1880, p. 309.

[2] *Vide* the paper by V. P. Gibney in *Ann. Surg.* vol. xi. p. 241. Cf. twenty-eight cases treated by his method, seventeen with a good result, eight a fair result, and three a poor result.

tendon is divided by a very oblique incision passing from below upwards and from behind forwards. The upper portion is then sutured as low down as possible on the lower, and the foot is placed well in plantar flexion.

(*c*) *The Z-Method.*—The tendon is exposed by a vertical incision over it. If necessary, the skin may be divided horizontally at the upper and lower ends of the vertical incision. The tendon, for example the right one, is divided thus. The knife is passed horizontally into it at its left edge, and half-way through it. The edge of the knife is then turned downwards, and the tendon split vertically for a variable distance according to the extent of shortening required. At the lower end of the vertical incision of the tendon the edge of the knife is turned to the right, and cuts horizontally through the remaining portion of the tendon, thus—

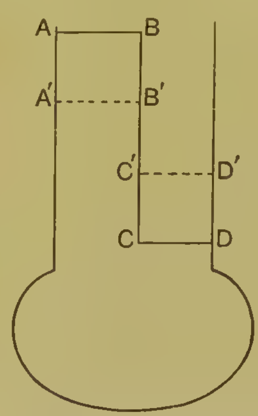


FIG. 183.—To illustrate the Z-method of shortening the tendo Achillis, by the author.

From the rectangular part ABC a portion marked out by AB A′B′ is removed, and from the second rectangular part BCD a portion C′D′ CD is removed. Each part cut out is equal in length to one-half of the amount of shortening required. The part at A′B′ is united to AB and C′D′ to CD, and the two sides of the vertical incision BC are sutured. By this operation the tendon is satisfactorily shortened, and there is not the same probability of stretching of the band of union as in some of the other operations.[1]

[1] Phocas, *Révue d'Orthopédie*, 1894, No. 5, p. 355, suggests this modification: "A median incision 5 or 6 centimetres long is made over the tendon, the sheath opened, and the tendon carefully denuded. It is then transfixed laterally at the upper end of the wound by a bistoury, which is carried down the middle of the tendon by a sawing motion. The posterior flap is cut away above and below, leaving the anterior part of the tendon thin enough to be folded on itself; and this is now done, thus shortening it one-half the length of the incision, and the fold is then stitched together with catgut. The

(*d*) *Transplantation of the Tubercle of the Os Calcis.*—This operation has been practised by Mr. Walsham. It consists in sawing vertically through the os calcis just in front of the attachment of the tendo Achillis. The lower part of the detached piece of the os calcis is then sawn away from the upper, and the latter, with the tendo Achillis attached, is fixed as low down as possible on the posterior aspect of the os calcis. Walsham reports one successful case. Before reading Walsham's account the writer had planned a similar operation, with the intention of fixing the detached piece of the os calcis, the tendo Achillis being still adherent, to the under surface of that bone.

3. *The Substitution of a Healthy Muscle for the Paralysed Calf Muscles* (*Nicoladoni's Operation*).—An incision 6 inches in length, reaching down to the external malleolus, is made along the anterior border of the peroneal tendons. The knife is then carried horizontally inwards and a flap raised. From the outer edge of the tendo Achillis a portion about 3 inches in length is taken, and the peroneal tendons, which have been turned out of their grooves and divided low down, are attached to the freshened surface of the tendo Achillis by fine silk.

4. *Arthrodesis.*—The method and value of this operation are discussed in the chapter on the treatment of spinal paralysis of children, but it may here be noted that Dr. Gwynne of Sheffield[1] has communicated one case of that closely-allied condition, calcaneo-valgus, treated by this method.

Talipes Calcaneo-Valgus and Calcaneo-Varus

Although talipes valgus and varus have not yet been described, it will not be amiss to allude in this place to those rarer and compound forms, calcaneo-varus and valgus. It is not often that one meets with them. Of congenital talipes calcaneo-varus I have met with two examples, one of which, in a child a few weeks old, is figured here. Of congenital talipes calcaneo-valgus nine examples have come under my notice. They are as follows :—

Cases 63-71.—Edwin H——, 9 months. Talipes calcaneo-valgus (left), talipes equino-varus (right). The left foot was readily cured by the use of a tin shoe with a quadrant, but the right foot required operation.

William L——, 7 weeks. Both feet affected, the right worse. Both

sheath is closed and the skin also separately. The foot is then put up in equinus in a fixed dressing.

[1] *Quarterly Med. Journ.* Oct. 1894, p. 38.

manipulated and placed in a right-angled tin shoe. In three months' time they were in good position.

FIG. 184.—Congenital talipes calaneo-varus in a child aged 7 weeks.

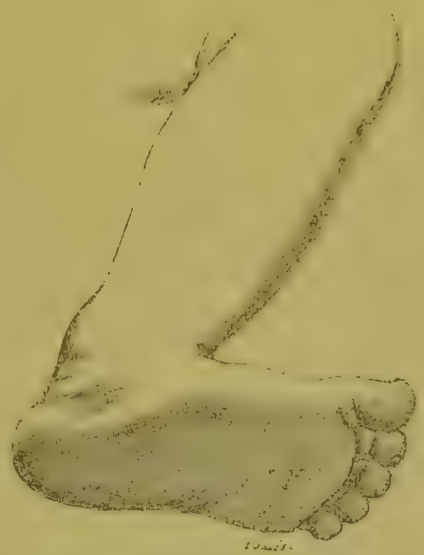


FIG. 185.—Congenital talipes calcaneo-varus in a child aged 4 months.

Winifred H——, 9 weeks. Talipes calcaneo-valgus (right), talipes calcaneus (left).

Elsie B——, 11 months. Talipes calcaneo-valgus (right), cured by manipulation.

Annie H——, 2 weeks. Slight talipes calcaneo-valgus in left foot, with green-stick fracture of left clavicle at birth.

Hugh G——, 1 month. Talipes calcaneo-valgus (right), talipes valgus (left), cured.

Reginald J——, 4 months. Talipes calcaneo-valgus (left), cured by manipulation and malleable iron splint (Fig. 185).

Charles S——, 4 months. Talipes calcaneo-valgus (both feet).

Colvin W——, 3 months. Talipes calcaneo-valgus (left).

FIG. 186.—Congenital talipes calcaneo-valgus in a child aged 9 months.

The paralytic form of talipes calcaneo-valgus is not so uncommon. Twelve cases have presented themselves for treatment during the past five years.

To return to *congenital talipes calcaneo-valgus.* The appearances of the foot are somewhat striking. The heel is depressed and the arch of the foot is lost. The outer border of the foot is raised, everted and concave, and the inner border lowered and convex. The portion of the foot anterior to the medio-tarsal joint is twisted in such a way that the scaphoid, cuneiform, and three inner metatarsal bones are pulled outwards as a whole and depressed; while the cuboid and two outer metatarsal bones are raised. The ligaments on the outer side of the foot are shortened, and those on the inner side lengthened.

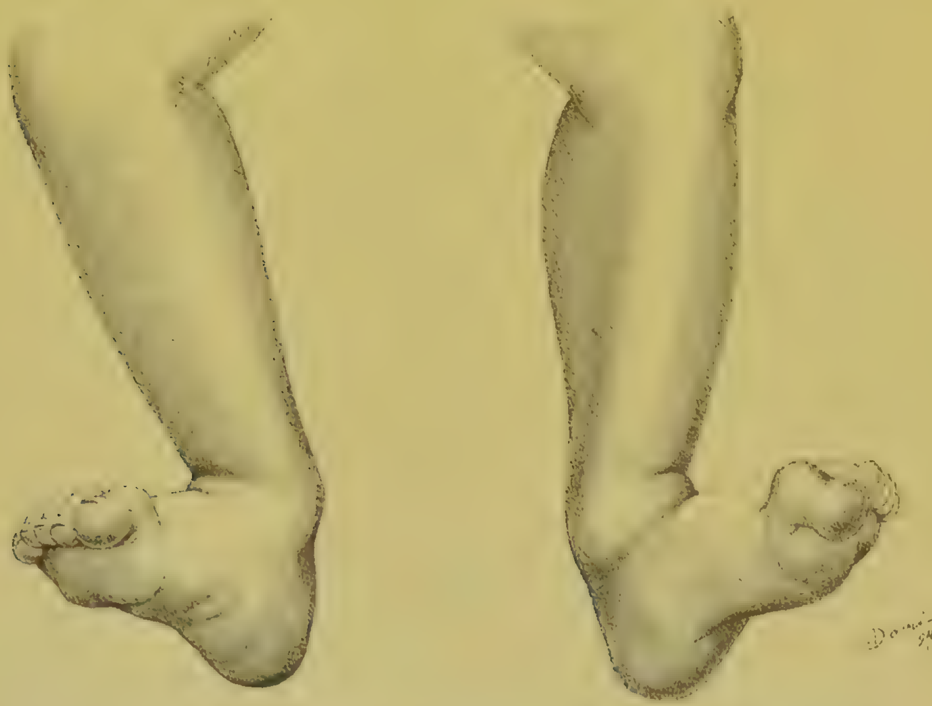


FIG. 187.—Double congenital talipes calcaneo-valgus, from a child aged 21 months, who also suffered from hydrocephalus and spina bifida.

The muscles in a condition of tension are the peronei, the extensor longus digitorum, and the tibialis anticus. The contraction of the peroneus longus accounts for the cavus condition of the sole in paralytic cases.

In *talipes calcaneo-varus* the heel is depressed and the inner border of the foot is concave. Hitherto I have met with but one example of the paralytic variety, and with two cases of the congenital form.

The peculiar twist in both these forms of club-foot renders them somewhat difficult to treat. The main deformity of calcaneus often causes trouble in treatment, and unless the accompanying varus and valgus are slight, the foot does not afterwards present a very shapely appearance. Sufficient indications for treatment are given under the headings varus, valgus, and calcaneus.

Talipes Arcuatus and Plantaris or Pes Cavus

Synonyms—English, *Hollow-foot ;* French, *Pied Creux ;* German, *Hohlfuss.*

In these deformities there is increased concavity of the arch, with corresponding dorsal convexity. According to Mr. F. R. Fisher,

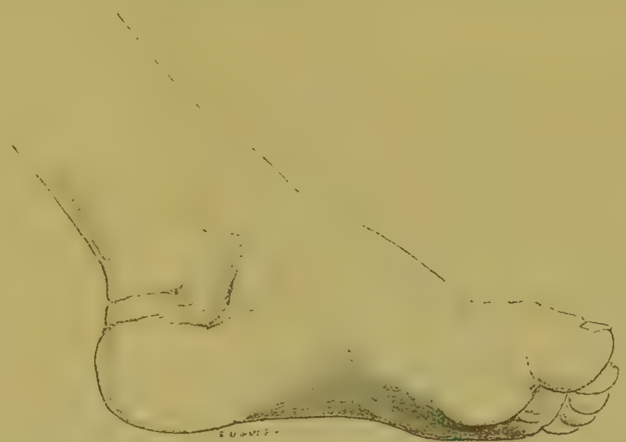


FIG. 188.—Talipes arcuatus in a boy aged 5½ years.

the term talipes arcuatus is applicable to this raising of the arch of the foot when the heel and the balls of the toes are in a horizontal

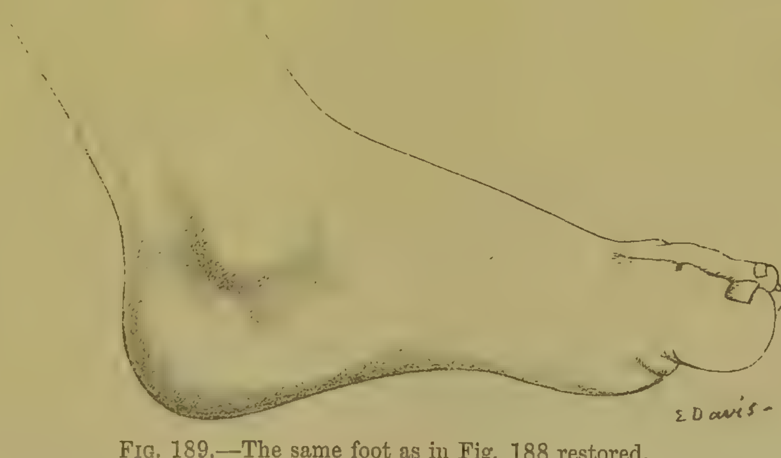


FIG. 189.—The same foot as in Fig. 188 restored.

plane. If the balls of the toes fall below the level of the heel, and the arch is at the same time increased, then the condition known as talipes plantaris is present. Pes cavus is applied to any state of the foot in which the arch is increased.

Authors divide pes cavus into two kinds, congenital and acquired. I have not met with any marked case of the congenital variety, although, according to Duchenne, some instances of pes cavus, due to paralysis of the interossei and lumbricales, are occasionally congenital but more often acquired. But I presume that any patient born with a very high arch would be looked upon as a subject of pes cavus. In such instances it is stated by Reeves that the inner division of the plantar fascia is contracted, but I have had no opportunity of verifying this statement.

FIG. 190.—Contracted foot.

Talipes arcuatus and plantaris (pes cavus) of the acquired variety are due to the following *causes*:—

1. *Slight* paralysis of the anterior muscles of the legs following dentition, measles, scarlet fever, chorea.

2. In combination with talipes calcaneus, *vide* p. 342. The condition of the distorted feet of Chinese ladies is said by Adams to be similar to that of calcaneus; but the appearance of these feet in the Hunterian Museum is rather that of talipes plantaris than calcaneus.

3. Coexisting with paralytic talipes equinus due to anterior poliomyelitis, and found in Friedreich's disease.

4. A distinct variety said to be due to the exaggerated action of the peroneus longus, and arising from approximation of its insertion and the heel, with increase of the convexity of the arch in the transverse section of the foot (*pied creux valgus*).

5. A high arch with contraction of the plantar fascia is found in children and adults the subjects of rheumatism, or in those whose parents have suffered from that affection (Fig. 190).

6. According to Duchenne the *griffe pied creux* or clawed foot follows paralysis of the interossei and lumbricales, the adductor pollicis, and flexor brevis pollicis. In this form the arch is much increased, the heads of the metatarsal bones are depressed, the first phalanges are hyper-extended, while the second and third are flexed (cf. the position of the hand and fingers in ulnar paralysis). The mechanism of the deformity is probably as follows: the interossei normally flex the first phalanges and extend the last two. They therefore oppose a resistance to the action of the long and short extensor, which by themselves over-extend the first phalanges and flex the last two. If the action of the long and short extensor be unopposed by the interossei the toes are drawn back on to the metatarsal bones, the heads of which are depressed and the bases raised, so that the arch is increased and contraction of the plantar fascia follows.

The point advanced in support of the statement as to the paralysis of the interossei and other muscles being the cause of the plantaris is the loss of irritability of these muscles to galvanism.

Apart from this point, which does not appear to me to be entirely convincing, I have always hoped for the opportunity of ascertaining by dissection that paralysis of the interossei is actually the cause at work. I cannot help thinking that in most of these cases of hollow claw-foot a degree of equinus exists sufficient to explain all the appearances without any affection of the interossei being necessarily present.[1]

To revert to talipes arcuatus (see Fig. 188) and plantaris due to slight paralysis of the anterior muscles of the legs following acute illness, I think I cannot do better than quote in a somewhat abbreviated manner the very able description of these affections given by my

[1] According to Mr. Golding-Bird, *Guy's Hosp. Rep.* 1883, vol. xiii. quoted by Walsham and Hughes, the deformity is due to the peronei muscles; the adductors then acting unduly, approximate the balls of the toes to the heel, and by taking the strain of the heel off the plantar fascia, allow this quickly to contract and render the cavus permanent. Mr. Golding-Bird does not believe that the cause is paralysis of the interossei, but arises from the extensors trying to extend the toes, which cannot be fully accomplished "owing to the fact that the proximal ends of the first phalanges only get extended, and gradually the whole bone gets pulled on to the dorsal aspect of the first metatarsal bone, producing the characteristic hammer-like toe; this also explaining the prominence of the ball of the great toe towards the sole."

colleague Mr. F. R. Fisher.[1] Regarding the subject of paralytic deformity of the foot in a new light, he has shown that talipes arcuatus, plantaris, and equinus are but degrees of deformity dependent on the same existing cause, viz. less or more paralysis of the anterior muscles of the foot and leg.

"Talipes arcuatus is characterised, as the name implies, by increase in the height of the arch of the foot; the condition presents no very visible indication of structural defect, but if an impression be taken of the sole the existence of abnormality will be at once detected. The extent of the treading surface is considerably less. This loss of treading surface is due to the presence of several small bands of contracted fascia, stretching like bowstrings across the sole of the foot, which prevent it from spreading when placed upon the ground. Arcuatus results from slight paralysis of the muscles of the leg, which is usually the sequel of scarlet fever, diphtheria, or other exhausting illness. Upon recovery from such an attack, some little awkwardness of gait may have been observed, or it may have been noticed that the shoe was worn away more quickly at the front part of the sole than elsewhere. These slight symptoms exist perhaps for a few months; they pass off, the child "grows out of" his bad habits of gait, and there is apparently an end of the matter. The transitory lameness is due to the anterior muscle of the leg being chiefly affected with loss of contractile power. During this period of existing weakness of the flexors the front of the foot becomes slightly depressed at the transverse tarsal joint. . . . When the paralysis passes off, the front of the foot is again brought to its proper position, but as growth proceeds there is a want of accommodation of the contracted tissues (in the sole)[2] to the increase in length of the other parts, and thus an abnormal degree of arching is gradually established. The condition of arcuatus develops so slowly that it seldom causes inconvenience until the age of adolescence is reached; relief is then sought from pain in the sole of the foot and from reflex muscular spasm extending up the front of the leg, both of which symptoms are chiefly due to the formation of corns beneath the heads of the metatarsal bones. . . . The pain caused by arcuatus is not infrequently ascribed to rheumatism; but the corns on the front part of the foot, the string-like bands of fascia, and the loss of treading surface ought to indicate the real source of the trouble.

[1] "On Paralytic Deformity of the Foot," *Lancet*, 1889, vol. i. pp. 142, 214.

[2] The words in the bracket are the writer's.

"Talipes plantaris is an aggravated condition of arcuatus, and forms a connecting link between the latter and talipes equinus. In this more severe state of distortion the sole is contracted and the arch deepened, as in the case of arcuatus, but the front of the foot is also depressed below the level of the heel. The early condition described as present in the slighter deformity has here become permanently established. The muscles of the leg and foot are all implicated, but the extensors of the toes and tibialis anticus are especially affected. . . . Lameness continues for a somewhat lengthened period, and the anterior muscles never recover sufficient strength to raise the depressed portion of the foot to its normal position. . . . Recovery of walking power is, however, eventually obtained to such an extent that the displacement of the foot escapes notice till about the age of 5 or 6 years, by which time growth will have increased the deformity." It should be added that the toes are frequently hyper-extended. In illustration, I quote the following case:—

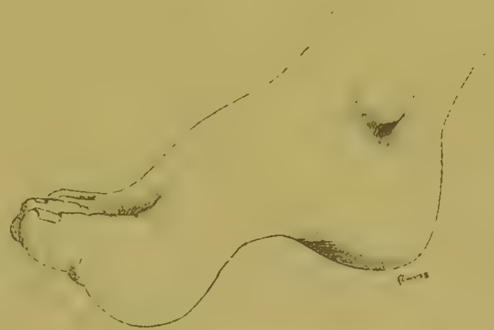


FIG. 191.—Talipes plantaris.

FIG. 192.—Tracings of soles of feet in Case 72 when standing. The right foot was in the condition of plantaris, and the left of arcuatus.

CASE 72. *Paralytic Talipes Arcuatus and Plantaris.*—Thomas G——, aged 9 years, was brought to me for pain in the feet and difficulty in walking. The family history is that the maternal grandfather suffered from rheumatism; and the mother has rheumatic pains in the legs when she catches cold. When 2 years of age the child suffered from whooping-cough, and when 6, from measles. He now complains of pains in the feet and leg.

On examination of the feet, the right presents this appearance: The fore part of the foot is dropped from the medio-tarsal joint, there is contraction of the plantar fasciæ, and a high-arched instep. The toes are hyper-extended, and the child walks on the balls of them. On the skin of the sole beneath the heads of the metatarsal bones is a row of painful corns. This foot is a good example of talipes plantaris. The left foot is an example of talipes arcuatus, *i.e.* the earlier condition of plantaris (Fig. 192). Corns are present here, but are not so large nor so painful as in the right foot. In neither case is the tendo Achillis shortened. The deformity was remedied by section of the plantar fascia and the use of a rectangular tin shoe.

It is easy to see from the very practical and lucid description of Mr. Fisher that if the anterior muscles were more fully implicated, the whole foot must drop and the varying degrees of equinus be established. The prognosis of paralytic arcuatus and plantaris is good if the case be recognised and treated early.

The *treatment* consists in division of the plantar fascia; after which extension should not be made for three weeks. Then the best apparatus is a Scarpa's shoe, with a single uplifting movement in the sole and slots with webbing for the toes. The raising of the front part of the foot should be done gradually, as some pain incidental to the rapid method is thereby avoided. A walking apparatus with a toe-uplifting spring is also useful. If there remain much rigidity of the tissues afterwards, a second operation is advisable: or considerable relaxation of the fascia may be obtained by soaking the foot in hot water containing one drachm of bicarbonate of soda to the pint, and manipulating it freely.

Talipes Varus

In most of the cases of so-called talipes varus the tendo Achillis is contracted, and hence these cases are more justly named equino-varus (*q.v.*)

Pure talipes varus is rare.

Causation.—(*a*) One form of progressive muscular atrophy, in which the peronei (peroneal paralysis) muscles are the earliest affected.

(*b*) In cases of infantile paralysis where the peronei alone are affected.

(*c*) In those severe cases of the same disease in which all the muscles except the tibialis anticus and posticus are affected—a very unusual form.

(*d*) After burns on the side of the leg and foot, the cicatrix which results drawing the foot to the inner side. Walsham and Hughes figure such a case. The specimen is in the St. Bartholomew's Museum (No. 3226, D).

(*e*) Occasionally varus is seen in spastic paralysis, and may be simulated by hysteria.

(*f*) In relapse from congenital equino-varus, the varus is often the chief feature of the deformity.

The *general appearances* of the foot are characteristic. The foot is adducted and inverted, the toes pointing inwards; the arch is increased and the patient walks on the outer edge of the foot, and the heel comes to the ground at the same time as the heads of the metatarsal bones. In this situation numerous corns and false bursæ are found. In congenital cases there is little or no wasting of the muscles, while in the paralytic cases wasting, shortening, and coldness of the limb are well marked, and there are neither the transverse nor longitudinal furrows in the sole characteristic of the congenital form.

The morbid anatomy of the congenital and paralytic forms are described in the chapter on equino-varus. There, too, the *treatment* of varus will be found detailed. It is only necessary to summarise it in this place.

1. In infants when the deformity can be nearly or entirely reduced by the pressure of the hand, manipulation and the use of retentive apparatus are called for. Later a walking instrument with a varus T-strap is necessary. If there is rotation inwards in the bones of the leg or at the knee-joint, the walking apparatus should be carried up to the thigh, or to the pelvis if inversion is persistent. A varus splint (Fig. 216) for night-wear is advisable.

2. Cases which resist an attempt made with the hand to reduce the deformity require tenotomy of the tibialis anticus and posticus, and the plantar fascia, and section of the internal lateral ligament of the ankle. They are then placed in a retentive apparatus—either the malleable iron splint, Scarpa's shoe, or plaster of Paris—and manipulated frequently. When the deformity is fully reduced, a walking apparatus of the same kind as in the first degree should be ordered.

3. Resistant cases can be reduced by tenotomy, fasciotomy, and syndesmotomy, followed by wrenching either with the hand or with Thomas's apparatus.

Tarsotomy and tarsectomy are called for when the patient is an adolescent or adult; when the treatment under headings 2 and 3 has failed after thorough trial; and when there remains no hope of reducing the deformity by less severe means. In my opinion, operations on the bones are rarely called for. If time be given and the treatment not hurried, the deformity will "come out." Haste in treatment is the bane of orthopædic surgery, and is responsible for many failures. Phelps' open operation has been done in these cases, but inasmuch as it is an operation on the soft parts alone, I fail to see how it can alleviate distortions in the bones, unless it be combined with wrenching; or unless the operation be extended, so that the astragalo-scaphoid joint is freely opened.

Talipes Valgus and Pes Planus

Synonyms—French, *Pied bot valgus, Pied plat;* German, *Plattfuss.*

Here it is proposed to deal with pes planus and talipes valgus due to the following causes, viz. the congenital, spastic, paralytic, rhachitic, traumatic, and the so-called pathological, while the subject of the painful flat-foot of adolescents and adults will be reserved for a future chapter.

Definition.—In pes planus there is merely dropping of the arch; in talipes valgus not only is the arch dropped, but the foot in front of the medio-tarsal joint is also twisted, so that the inner border is lowered and convex, and the outer is raised and concave, the sole of the foot looking somewhat outwards.

Pes Planus.—This condition is either congenital or acquired. In infants the sole of the foot is always flat, on account of the presence of a large amount of fat in that situation, the small size of the tuberosities of the os calcis, and the absence of the arch. The latter originates from the stimulus of walking acting on the long and short muscles of the foot. A state of flat-feet is common amongst certain races, especially the Jewish, Negro, and Kabyle, and is hereditary. It is a persistence of the normal state of the feet at birth.

By some a well-developed instep is considered a sign of good breeding and high training. While, according to C. Féré and G. Demanké,[1] pes planus is very frequently seen in epileptics, and ought to be considered a sign of degeneration, or rather of non-development.

Acquired pes planus is met with in those who walk bare-footed, and I have noticed that people who walk about the house in thin slippers, or with none at all, lose the arch of the foot. Rédard states that he has often observed pes planus in those afflicted with congenital sub-luxation of the hip, and when the deficiency is

[1] Quoted by Rédard, *op. cit.* p. 799.

unilateral the planus is on the affected side. Adolescents with long thin feet, "long-waisted in the feet," are particularly liable to develop pes planus if they stand much or carry heavy weights. The condition of the feet may remain as planus, or it may pass into spurious valgus. Rheumatism and gout are associated with loss of the arch, and the sole becomes flat. I have now under my care a girl who suffered from rheumatic fever five years since, who is tall for her age, whose feet are very long and flat, and who is suffering from marked anæmia. In spite of rest, proper manipulation, and suitable apparatus, the feet remain obstinately flat, and contraction of the extensor longus digitorum is now setting in.

Congenital Talipes Valgus.—*External Appearances.*—These, as mentioned above, consist of flattening of the arch, eversion of the sole, convexity of the inner and concavity of the outer border of the foot. In some cases the tendo Achillis is lengthened, and then calcaneo-valgus is present; if it be shortened, equino-valgus results. Adams regards shortening of the tendon as one of the ordinary conditions of confirmed valgus, especially in its congenital form, and with this view Reeves agrees.

Occurrence.—In the statistics published by Tamplin, of 1780 deformed feet, 42 were examples of congenital valgus. In 17 both feet were thus affected. In 15 other cases, not included in the above 42, there were valgus in one foot and varus in the other. Of 200 cases of club-foot coming under my notice, congenital valgus existed in 6.

Association of Valgus with other Congenital Deformities.—1. The most frequent and easily recognised congenital deformity is partial or entire absence of the fibula. Numerous cases are recorded by English and foreign surgeons. A case of partial absence of the fibula was shown at the Pathological Society[1] by Mr. L. A. Dunn, which I had the opportunity of seeing. The details are as follows:—

CASE 73 (L. A. Dunn).—"The child, aged 8 years, is the subject of a defect in the development of his right fibula. The foot is everted, and the inner malleolus is very prominent, giving rise to the appearance of a Pott's fracture. The external malleolus is present, but does not reach lower than the inner one. About an inch above the tip it seems to end. The upper third of the bone appears fairly normal, but gradually fades away into the peronei muscles. In the interval the bone appears to be entirely absent. There is no history of accident, and the foot has been noticed to grow out ever since he was 2 years old. The tibia is slightly curved forwards, but is otherwise healthy."

[1] *Path. Soc. Trans.* 1889, p. 272.

It is interesting to notice that the foot in these cases is almost always in a position of equino-valgus, and that the tibia is incurved at the junction of the middle and lower third; it is also shortened. The convexity of the curve looks either directly backwards or forwards. At the summit of the convexity a depression of the skin is often seen, and the skin is adherent to the bone. One or more toes are absent, and the muscles of the leg are atrophied. The malformation is generally unilateral.

A case, illustrating the co-existence of intra-uterine fracture of the tibia and absence of the fibula with congenital valgus, came under my notice in 1892. The details are as follows:—

CASE 74. *Congenital Talipes Valgus; Absence of Fibula; Intra-Uterine Fracture of Tibia.*—Basil M——, aged 6 weeks, was the first child. At the fourth month of pregnancy his mother fell on a fender, striking the leg and arm, but she was not aware that she struck the abdomen. This was the account she gave, but it must be accepted, as all such stories should be, with reserve. The child had talipes equino-valgus in the right foot, and at the junction of the lower fourth of the tibia with the upper three-fourths was a very marked anterior curvature. At the most prominent part of the curve a dimpling of the skin was seen. The dimple was scar-like in appearance. The fibula could not be felt. At that time I regarded it as an intra-uterine compound fracture, and, curiously enough, although when first I saw the case the tibia was quite strong and firm, yet on the child's coming to me two years later, there was a distinct false joint at the most prominent part of the curve. The tibia was shortened ½ an inch. There was also webbing of two fingers of the left hand and one digit was wanting. From the dimpling of the skin and the subsequent false joint, this may have been a veritable case of intra-uterine compound fracture.

FIG. 193.—Extreme congenital valgus from absence of the fibulæ (Meusel).

Fig. 193, taken from a case of Meusel's, is very interesting. The man had double valgus of a pronounced type, and complete absence of the fibulæ. The deformity was hereditary, several of his brothers and sisters, and his child, aged 6 months, being similarly afflicted.

2. Presence of an anterior convexity in both tibia and fibula, with talipes valgus. Adams says that this class of case is the most numerous, and adds that "twenty to thirty" have come under his observation. "In these cases the leg below the knee is very much shorter than the opposite limb, and there is always a sharp curvature forwards of the tibia and fibula in the lower third, the prominence of the convexity being 1 to 2 inches above the ankle-joint; and in every case there has been a deep dimpled depression of the skin reaching to the bone with which it was adherent, over the most prominent part of the convexity of the tibia." Shortening becomes more marked as growth proceeds, even to the extent of 5 or 6 inches when adult age is reached.

3. The tibia and fibula are present, of normal outline, but shortened. In these instances equino-valgus may occur.

Prognosis of Congenital Valgus.—The influence of the first two varieties of mal-development on the prognosis of the case is disastrous, but congenital valgus not associated with these deformities is readily amenable to treatment if taken early, and relapse is less liable to occur than in varus, since the anatomical conditions are less complicated. Relapse may be prevented by careful attention to manipulation and the construction of the boots.

Symptoms of Congenital Valgus.—In all young infants the arch of the foot is absent, so that the deformity may not become apparent until the child begins to walk. Then it will be noticed that—

1. After walking a short distance the child cries on account of pain on the inner side of the foot.

2. There is little or no movement in the tarsal joints, while the motion at the ankle is limited on account of the contraction of the tendo Achillis which frequently co-exists.

3. The peronei, extensor longus digitorum, and perhaps the calf muscles are retracted, and react more strongly to galvanism.

4. There is also great difficulty in inverting the foot passively.

5. The eversion of the foot and loss of the arch are marked on standing.

6. The sole having been smeared with printers' ink, the outline obtained by standing on a piece of white paper is fuller than normal.

Acquired Valgus.—Apart from the common flat-foot of adolescents and adults, acquired valgus is not a common deformity, but if we include flat-foot,[1] then the number of cases closely approximates, or even exceeds that of equino-varus.

Appearances in Acquired Valgus.—In most varieties there is no eversion of the foot, but merely falling of the arch, convexity of the inner border, and some concavity of the outer border of the foot. In congenital valgus the deformity of the foot is double from the first. There is always eversion at the medio-tarsal joint. However, in spastic valgus, and in other forms of long standing, some eversion sets in eventually. It, in paralytic and rhachitic cases, undoubtedly arises from the weight of the body being borne mainly on the inner margin of the foot. Structural shortening of the extensor communis digitorum and peronei results, so that the outer border is raised from the ground and the sole is everted. Adams points out that, from the loss of flexion and extension at the ankle-joint, due to the inner border of the foot coming prematurely into contact with the ground, shortening of the calf muscles takes place and equino-valgus is developed. This event happens in cases of long standing, and feet so affected are particularly difficult to treat. In all cases the internal malleolus is unduly prominent, so too are the head of the astragalus and the tuberosity of the scaphoid. The child is then said to have "its inner ankle growing out." The foot is elongated, and assumes a "boat- or canoe-shape."

The *pathology* of acquired valgus is unbalanced action of the peronei, and, in some cases, of the extensor communis digitorum: the tibialis anticus, extensor proprius pollicis, and sometimes the tibialis posticus being either paralysed, or, as in spastic valgus, being of normal strength but overcome by the excessive strength of their opponents. The essential anatomical feature of the deformity is relaxation of the internal lateral ligaments of the ankle, of the calcaneo-scaphoid, astragalo-scaphoid, and scapho-cuneiform ligaments, and of those uniting the cuneiform and three inner metatarsal bones. In this relaxation the inner and middle part of the plantar fascia participate, so too do the short muscles of the great toe. While in the outer longitudinal arch of the foot the ligaments, muscles, and fasciæ are proportionately contracted. The bones are altered in position, but rarely in shape, except in long-standing cases. The head of the astragalus is directed downwards and inwards, the scaphoid is

[1] It is proposed to limit the term flat-foot to the painful broken-down feet of adults and adolescents, employing the expression talipes valgus for all other varieties in which the arch of the foot is lost.

rotated so that the tuberosity is brought downwards and inwards, and there is a space between the two bones, while the inferior surface of the os calcis is twisted slightly outwards. Bursæ and corns, and even perforating ulcers form over the bony prominences on the inner margin, and cause great pain. The position of the vessels and nerves is little altered. So far as I am aware, ankylosis does not occur in valgus except in some bad cases of adolescent flat-foot.

In the section on talipes arcuatus that peculiar form " pied creux valgus," or valgus with increase of the arch, has been adverted to. It is said by Duchenne to occur in spastic valgus, and to be due particularly to exaggerated action of the peroneus longus. This curious form has been closely studied by the French surgeon, and he points to the following as its characteristics :—

1. The increase of the plantar arch, and the lowering of the heads of the metatarsal bones.

2. The diminution of the transverse measurement of the fore part of the foot, especially at the heads of the metatarsal bones.

3. The torsion of the front part of the foot producing oblique folds in its plantar aspect.

4. A displacement outwards of the calcis from the astragalus.

5. Considerable prominence of the tendon of the peroneus longus below the external malleolus.

1. *Paralytic Valgus.*—Of pure valgus arising from infantile paralysis I have met with but few examples. It is stated that paralytic valgus assumes two forms :—

(*a*) In which the peroneus longus is not affected ; and then the appearance of the foot is that of valgus, *i.e.* the foot as a whole is abducted, but the arch is retained or increased.

(*b*) In which the peroneus longus is paralysed, and then the arch drops, and the foot is abducted by the peroneus brevis and extensor communis digitorum, but is not everted.

It is interesting to notice that in the same patient one frequently sees varus or equino-varus in one foot, and valgus or equino- or calcaneo-valgus in the other, the varoid deformity being in the right, and the valgoid in the left foot, *e.g.* :—

CASES 74-79.—Eva C——, aged 2½. Right foot, varus ; left foot, valgus.

Edgar G——, aged 9. Right foot, equino-varus ; left foot, calcaneo-valgus.

Edwin H——, aged 9. Right foot, equino-varus ; left foot, calcaneo-valgus.

Jennie W——, aged 12. Right foot, equino-varus; left foot, valgus.
Frank A——, aged 9. Right foot, equinus; left foot, equino-valgus.
Rose Q——, aged 8. Right foot, equinus; left foot, calcaneo-valgus.

In paralytic valgus of the less severe degrees the tibialis anticus alone is affected, but in the more severe degrees the tibialis posticus and the muscles of the calf are implicated as well; and then calcaneo-valgus results. The affected muscles do not respond to the interrupted and the constant current, and are found to be in a state of fatty or granular degeneration.

The symptoms are similar to those of congenital valgus, except that in early cases the foot is not everted, and there is the peculiar relaxation of the muscles accompanying infantile paralysis, together

FIG. 194.—Rhachitic talipes valgus in a child aged 18 months.

with wasting, coldness, and blueness of the limb. In addition, on the outer side of the crest of the tibia a groove is seen which corresponds to the atrophied tibialis anticus. The extensor communis digitorum and peroneus tertius are tense.

2. *Rhachitic Valgus.*—Among the many cases of rhachitis one does not find so many instances of valgus as one might expect. It is probably due to the fact that rickets takes children "off their feet," and there is consequently in but few cases yielding of the plantar arch. When it does exist it is a well-marked deformity (see Fig. 194).

The point of importance is to remember that rhachitic flat-foot may and does persist, and leads to painful flat-foot in adult life. I have had no opportunity of dissecting a ricketty flat-foot, but the adult rhachitic skeletons in museums show considerable alteration in the shape of the bones. It is frequently associated with genu valgum.

3. *Traumatic Valgus.*—After Pott's fracture, dislocation at the ankle, or severe sprain with rupture of the internal lateral ligament, the foot may remain permanently carried outwards, and after a time the arch of the foot gives way.

The accompanying Fig. 196 is taken from a patient who came to my Out-patient Clinic.

CASE 80. *Spasmodic Valgus after an Injury.*—J. S., aged 34, six months ago had a violent blow on the outer side of the foot. He was treated at a general hospital and the foot placed in plaster of Paris. From the history obtained it seemed that a fracture existed at the lower third of the fibula. On examination,

FIG. 195.—Rhachitic talipes valgus in a child aged 2½ years.

FIG. 196.—Spasmodic eversion of the foot after injury to the fibula.

there were fair flexion and extension at the ankle, but no abduction nor adduction, and any attempts to produce these movements gave rise to considerable pain. Just above the external malleolus was a distinct thickening of the fibula. The appearances are well shown in Fig. 196, and the foot was then in a state of painful spasm and everted.

Rare cases of separation of the epiphyses of the tibia or fibula are recorded which have been followed by varus or valgus.

4. *Spastic Valgus.*—Instances of this are excessively rare. The deformity may be due to convulsions in young life or to hysteria at a more mature age. An example is given by Adams.[1]

[1] *Club-Foot*, p. 401.

5. *Valgus associated with other Causes.*—Acute periostitis and osteomyelitis interfering with the growth at the epiphysial line cause inequality in the length of the two bones. According as the tibia or fibula is affected, so varus or valgus result. The following interesting case might with propriety be quoted :—

CASE 81.—*Congenital Syphilis, Shortening of left Leg, Valgus in the right Foot.*—Florence G——, aged 15, came to me complaining of pain in the right foot. She said that when she was about 1 year old there was, from her mother's account, considerable stiffness of the left knee.

On examination, there are scars about the mouth, leucomata in the left cornea, and the central incisors are notched. The left leg is $\frac{1}{2}$ inch shorter than the right, and just above the lower extremity of the left femur a distinct thickening is felt. The right foot is valgoid.

In this case it seems that a syphilitic epiphysitis occurred at the lower end of the femur, interfering with the rate of growth of the bone, hence the shortening on the left side. As a consequence, more weight has been borne upon the right side, and the foot has developed valgus.

Prognosis of Acquired Valgus.—This must necessarily vary with the cause, the amount of deformity, and the length of time it has existed. In traumatic and rhachitic valgus the outlook is not favourable; while in the paralytic form much recovery of power may be looked for in early cases. And in late cases the form of the foot can be restored, and much assistance given by means of supports, so that the patient is able to get about comfortably.

The Treatment of True Talipes Valgus—Congenital Talipes Valgus.—Cases of slight degree of eversion of the foot, in which there is little or no rigidity of the muscles, may be cured by manipulation. Even if there is considerable valgus when the child stands, so long as the muscles are not so tense as to prevent the foot being replaced by the hand without pain, manipulation and the use of a walking instrument with an outside support to the knee, and a valgus pad and T-strap will effect a cure. The heel of the boot should be slightly raised on the inner side, and carried further forwards than on the outer side, so as to give support to the arch of the foot. It is also well to have the inner border of the sole thicker than the outer. At first this apparatus is not to be worn continuously. In the early stages of treatment half an hour will be sufficient, and the time during which the instrument can be worn with comfort can be gradually increased until the patient is able to go about in the apparatus all day. The walking apparatus should be worn for at least a year, and the inside malleable iron splint at night for six months.

If in congenital valgus rigidity of muscles is present, tenotomy of the peroneus longus and brevis and extensor communis digitorum should be done, and be followed by the employment of one form or other of retentive apparatus. The malleable iron splint, so applied to the inner side of the leg and foot as to bring the latter gradually into position, is the writer's preference.

The treatment of paralytic valgus is to be conducted on the same lines, and in marked cases tenotomy of the same muscles will be required, with the like care in the use of retentive, walking, and night apparatus. Special attention must be given to passive exercises and the use of the galvanic current.

In spasmodic valgus the rigidity of the muscles is such that somewhat extensive division of tendons is needed before the foot can be brought into position. In a case detailed by Mr. Adams in his work on *Club-Foot*,[1] in which both knees and feet were contracted, twenty-two tendons in all about the knees and feet were divided.

Rhachitic cases merely require suitable support and constitutional remedies.

Pathological valgus, or that variety which is a sequel to acute and tubercular arthritis of the ankle, or ostitis of the bones of the foot, demand considerable thought before the foot is interfered with. Much will depend upon the disease being entirely quiescent; the freedom of the tendons in their sheaths, both structures being only too often involved; and upon the patient's wish for improved powers of locomotion. If all these conditions are present, then interference is justifiable. If not, it is better to leave the foot alone rather than to undertake a rectification which may after all be of little value.

In traumatic valgus, particularly that following Pott's fracture, much improvement may be obtained by active and passive exercises sedulously carried out, and, if need be, forcible rectification may be done where there exists much stiffness at the ankle-joint. Failing this, and if locomotion remains painful and ungainly, removal of a wedge-shaped portion of bone from the tibia and fibula may be considered. The base of the wedge is made on the inner side.

[1] Appendix, Case 4. Mr. Adams heads his description thus: "Case of rigid muscular contraction of both lower extremities, occurring in infancy and allowed to remain unrelieved until adult life, when severe deformities of both feet and knees entirely deprived the patient of the power of walking."

Talipes Equino-Valgus

After the references which have been made to the frequent association of equinus and valgus in both congenital and paralytic club-feet, and the separate description given of both of these conditions, it is unnecessary to allude further to them except to utter a word of caution. Cases exist which are equinus and nothing else, but which at first sight appear to be equino-valgus. The shortened tendo Achillis prevents the heel being brought to the ground unless some abduction or adduction takes place either in the ankle or calcaneo-astragaloid joint. Abduction occurs frequently, and the appearance of equino-valgus results. If the knee be fully extended, and an attempt made to flex the foot at the ankle, such flexion is found impossible unless the foot first be somewhat abducted, so relaxing the tension of the tendo Achillis.

Fig. 197. — Congenital talipes equino-valgus from absence of the fibula (after Rédard).

The treatment of congenital and paralytic cases includes manipulation, tenotomy, and the use of retentive apparatus.

In discussing the treatment of club-foot much consideration must be given to the question of tenotomy, and in the "Clinical Aspect of Union of Tendon" I have endeavoured to point out some matters of interest not only in union of the tendons about the foot, but elsewhere.

Clinical Aspect of Union of Tendon

If careful subcutaneous division be practised without the admission of micrococci, and the part be subsequently kept at rest, regeneration of the tendon to a very useful degree results. If, however, any suppuration occur, the union is delayed, and frequently the tendon contracts such adhesions to its sheath as to be useless. Division of the flexor tendons at the wrist by broken glass or dirty knives too often results in impairment of the functions of the hand. But I have demonstrated that clean subcutaneous division of all the flexor tendons at the wrist can be practised most successfully. Two cases are appended. Case 82 is instructive as showing the cause of the ill results after accidental division, and Case 83 (the author's) is repeated here as an incentive to that free subcutaneous division of tendons which alone can restore the normal movements of the parts. It seems that the chief factor at work in the non-union of tendon in the first of the cases quoted below was the great distance between the two parts of the tendon-ends, and to a slightly less degree the formation of granulation tissue in the interval after suppuration. The new tissue acted as a block to the complete restitution of the normal fibrous tissue.

CASE 82.—*Accidental Division of Tendons by a Garden Knife; Healing of Wound by Granulation; Loss of Function of Part; Operation with the Object of uniting the Tendon; Restoration of Movement*[1] (T. Preston Gosling).—Eight weeks previously the patient, while trimming rose-trees, allowed the knife to slip, and inflicted a transverse wound on the outer side of the left wrist. Healing took place by granulation. When seen the thumb was flexed into the palm and adducted, and the only active movement which remained was extension of the terminal phalanx; at the base of the metacarpal bone there was a transverse scar an inch long on the outside of the left wrist. Just below this the distal ends of the tendons of the extensor ossis metacarpi pollicis and primi internodii pollicis were felt, but the position of the proximal ends could be only indistinctly made out 5 inches off in the back of the forearm. Dr. Gosling decided to operate, with the view of uniting the ends of the tendons. An incision was made along the interval between the proximal and distal ends. The latter were found at once, and it was discovered that the synovial sheath was blocked at the site of the scar for $\frac{3}{4}$ inch by a mass of connective tissue. This was removed, and the proximal ends drawn down to within nearly $\frac{3}{4}$ inch and fixed by sutures to the distal ends, and the wound closed and the thumb put up fully extended. The wound healed by first intention, and all the active movements of the thumb were restored.

This case is very instructive for the following reasons:—

1. The granulation tissue from an ordinary wound, not necessarily arising from the tendon sheath or tendon substance, does not appear to be transformed into any material capable of replacing normal tendon.

[1] *Brit. Med. Journ.* 11th April 1891, p. 800; cf. also Dubreuil, *Rév. d'Orthopédie*, Nov. 1892.

2. In man regeneration of tendon-substance can be effected over an interval of $\frac{3}{4}$ inch, and in the tendo Achillis, I believe, of an inch and more. In rabbits such regeneration appears to occur even if the interval be $1\frac{1}{2}$ inch.

CASE 83.—*Subcutaneous Division of all the Flexor Tendons at the Wrist for Contracted Hand; Complete Recovery of Movements of the Hand.*[1]—The patient was a child, aged 4, who a year previously had injured her right forearm, but the details of the injury could not be ascertained. Suppuration occurred; the median nerve was involved in scar tissue, evidently the result of pocketting of pus. I operated to free the nerve, and found it compressed at the junction of the upper three-fourths with the lower fourth of the forearm. As free movement did not follow, it was decided to divide subcutaneously all the flexor tendons at the wrist. This was accomplished, and the hand and forearm placed in a splint, keeping the wrist, thumb, and fingers flexed. Passive extension of the thumb and fingers was begun at the end of the tenth week, and continued daily. But for a year a plaster of Paris gauntlet was worn, to prevent any over-extension of the wrist, with consequent abnormal lengthening of the band of uniting material in the flexor tendons. To this precaution I ascribe the success of the case. A year after the operation the patient could use a knife or fork with the right hand, write on a slate, and pick up a pin. Figs. 131 and 132 illustrate the appearances of the hand before and after treatment.

A very valuable contribution to the clinical aspect of union of tendon has been made by Dr. Wolter[2] under the title "On the Functional Prognosis of Tendon Suture." Therein the probabilities of good union with and without suture are discussed according to the particular tendons affected. It is possible here merely to summarise the main points.

The Extensor Tendons of the Hands.—If these be divided better results may be expected than in the case of the flexors, since less retraction follows, owing to their closer attachment to the sheaths, the integument, and to one another. But the retraction is greater when division occurs above the wrist than below it.

Extensors of Thumb when divided at Back of Wrist.—Retraction in this situation is about 1 cm., owing to the tendon and its sheath being more or less bound down by periosteum. When division occurs over the metacarpal bone the central end will retract as much as 10 cm., since the tendons play freely on the sheath, and the latter is very loosely attached to surrounding structures. At

[1] *Lancet*, vol. i. 1895, p. 1111.
[2] *Archiv für klin. Chir.* Bd. xxxvii. Heft 1; and *Annals of Surgery*, vol. ix. p. 55.

the metacarpo-phalangeal articulations the prognosis is especially good, as the tendons are bound down to the capsule of joint, and cannot retract even though the joint has been opened.

Flexor Tendons at Wrist-Joint.—The slightest shortening of these tendons interferes with extension of the hands and fingers; for it is known that only by the strongest extension the flexor tendons which follow the excursion of the bones are stretched *ad maxima* and lie close to the bone, so that their length just suffices. Extension will be hindered by the slightest adhesion between the cicatrix of the flexor tendons and the skin; and still worse is it when several flexor tendons are matted together in a dense scar. At the wrist two fasciæ are found, the superficial of which is strongly attached to the surface of the flexor carpi ulnaris, and partly assists in forming sheaths for the tendon of the palmaris longus and the flexor carpi radialis; the second or strong deep fascia binds down the remaining flexor tendons and the vessels. Therefore after division of the tendons of the flexor carpi radialis, flexor ulnaris, and palmaris longus, the cicatricial process is isolated and takes place above the second fascia, and the prognosis will be much better than if the deeper tendons are severed. The tendon of the palmaris longus retracts $\frac{1}{2}$ inch when divided at the wrist, and that of the flexor carpi radialis nearly an inch. These measurements are obtained by ascertaining the excursion made by the tendons at that spot in passing from dorsal to palmar flexion.

Tendons divided in the Palm of the Hand.—The results here are more favourable than at the wrist-joint. The retraction of the sublimis is a little more than $\frac{1}{2}$ inch, and of the profundus a little less.

Flexor Tendons divided over Phalanges.—The central end retracts slightly on account of the vinculæ. Most retraction takes place over the first phalanx and at the base of the second. As much as $\frac{1}{3}$ inch follows. The prognosis for tendon-suture in the region of the first phalanx is better than at the other phalanges.

Tendons divided on the Dorsum of the Foot.—The prognosis here is good. Two cases are quoted by Wolter, and as a matter of clinical experience we know that union is good, although retraction to as much as $1\frac{1}{4}$ inch usually occurs.

Section of Tendo Achillis.—If division take place 1 inch from its insertion in adults, there is but little separation of the divided ends, and the heel may still be slightly raised. If division occur above this point there is a gap of over 1 inch. The results in primary and secondary suture of this tendon have been good. Various methods of shortening this tendon for talipes calcaneus have been adopted, notably by Willett and Walsham (see p. 346), and by Anderson.[1] The method advocated by the last-named surgeon was applied by Keen[2] to the flexor tendons of the wrist in a case of post-hemiplegic contraction.

[1] *Lancet*, 18th July 1891.
[2] *Brit. Med. Journ. Supplt.* 12th Dec. 1891.

CHAPTER V

CONGENITAL AND ACQUIRED TALIPES EQUINO-VARUS

Paralytic and Spastic Equino-Varus—Congenital Equino-Varus, its Appearances, Morbid Anatomy, Etiology, Obstacles to Reduction, Prognosis, and Diagnosis.

Synonyms—English, *Club-foot, Reel-foot;* Latin, *Pes Contortus;* French, *Pied bot;* German, *Klumpfuss.*

THE causes of equino-varus are either congenital or acquired. In the latter case there is a further subdivision into spastic, paralytic, traumatic, and articular. The causes of spastic talipes have been adverted to in the general remarks on talipes (p. 307), and it is not necessary to repeat them. Paralytic equino-varus is due to acute anterior poliomyelitis. Traumatic equino-varus is the result of fractures, dislocations, or separation of the epiphyses at the lower ends of the tibia and fibula. Inflammatory processes in the ankle and tarsal joints, whether rheumatic, gouty, tubercular, or syphilitic, are responsible for the articular forms of equino-varus. The common varieties of talipes equino-varus are the congenital, spastic, and paralytic. It will serve to make our remarks more clear if it is at once stated that the term "club-foot" is applied *par excellence* to talipes equino-varus; and in this chapter when the term club-foot is used talipes equino-varus is the form alluded to. Further, the congenital form of pure talipes varus is very rare or almost unknown. From other authors' and my own observations, there can be no doubt that the congenital deformity is a compound form, with adduction and inversion of the front part of the foot, and extension at the ankle-joint. One[1] of the most recent continental authors on orthopædics describes the congenital cases as varus in nature; and therein he follows the practice common amongst English and foreign surgical writers.

[1] Dr. Paul Rédard, *Traité Pratique de Chirurgie Orthopédique*, Paris, 1892.

Acquired Talipes Equino-Varus

Causes.—The chief are (1) infantile paralysis and (2) spastic affections. The rarer causes are hysteria,[1] fractures in the neighbourhood of the ankle, dislocations, and arthritic inflammation either tubercular or syphilitic in origin. Infantile paralysis affecting the peronei and the extensor muscles (the tibialis anticus often excepted [2]) leaves full scope for the action of the opposing muscles. Hence the raising of the heel and the inversion of the sole. The latter condition is due to the powerful traction of the tibialis posticus, flexor longus digitorum and pollicis, which all pass behind the internal malleolus obliquely into the sole to their attachments. In spastic paraplegia the adductors and invertors of the foot are excessively contracted, as in the thighs and elsewhere. A rare form of progressive muscular atrophy affects the peronei and the extensor muscles, and results in talipes equino-varus (Charcot, Tooth).

Fig. 198.—Spastic talipes equino-varus in a woman aged 35 years.

Case 84. *Spastic Talipes Equino-Varus of Right Foot.*—Ada P——, aged 15, is the fourth child in the family. The family history is good and none of her brothers and sisters are affected. When 15 months old she had an attack of "water on the brain." The head is now somewhat longer than natural, but more suggestive of the natiform shape of congenital syphilis than the hydrocephalic skull. There is much prominence of the frontal and parietal eminences, the bridge of the nose is de-

[1] See Walsham and Hughes, *op. sup. cit.* Fig. 204, p. 328.

[2] In some cases the extensor proprius pollicis escapes, and extension and flexion of the great toe are normal.

pressed, but the central incisors are not notched, nor are there scars about the mouth. The right foot is in a position of equino-varus, of which compound deformity the equinus is the more marked feature; and its whole structure is very rigid. She walks on the heads of the metatarsal bones; on the skin over these points numerous corns are seen. The heel is drawn up and the tendo Achillis is tense. The muscles of the calf are small, very firm and rigid, and the reflexes are exaggerated. The right forearm is semi-pronated and the fingers are flexed. By division of the tibiales, plantar fascia, and the tendo Achillis and the application of suitable apparatus a useful foot was obtained.

FIG. 199.—Extreme spastic talipes equino-varus in a woman aged 44 years.

CASE 85.—Edward S——, aged 5 years, was similar in many respects to the preceding patient. The history relates that he had "inflammation of the spine" at the age of 2 years. In his case the left foot was deformed and there was rigidity with flexion of the left forearm and fingers of that hand. The foot was restored by the same measures as in Case 84, but the forearm was left untouched; for it has been shown that these cases do not give good results until the spastic process has ceased in the central nervous system.

Two other cases of spastic equino-varus have come under my notice associated with microcephalus. One of these I operated upon, performing craniectomy for the microcephalus and tenotomy for the talipes, and I was successful in the result of both operations.

Morbid Anatomy.—The anatomy of paralytic equino-varus can be readily understood by reference to the separate descriptions of equinus and varus arising from infantile paralysis (pp. 333 and 383). To recapitulate shortly. In this form the deformity consists not so much in the raising of the heel, as in the dropping of the front part of the foot at the medio-tarsal joint. At this joint too the inversion is situated. Therefore we find the os calcis is nearly horizontal, while the astragalus is so placed that its neck is directed somewhat downwards, but its neck is not twisted inwards as in

FIG. 200.—Paralytic talipes equino-varus. The extensor proprius pollicis has escaped, hence the hyper-extension of the great toe.

the congenital deformity. The bones in front of the medio-tarsal articulation are deviated inwards. The affected muscles are found to be fatty and extensively degenerated, while the calf muscles and often the tibialis anticus are strongly contracted. It is the dropping of the front part of the foot which gives the dorsum of the foot its rounded appearance, and induces secondarily that contraction of the plantar fascia so common in these cases.

In the spastic variety the equinus predominates, and there is a marked raising of the os calcis by the tendo Achillis, the astragalus being directed as a whole downward, and there is more inversion at the medio-tarsal joint than in the paralytic form.

Prognosis.—Cases of paralytic equino-varus when seen early are readily amenable to treatment, and the deformity can be cured, but the chief difficulty is to prevent relapse. This tendency can be neutralised by persistent attention to the affected muscles, seeking

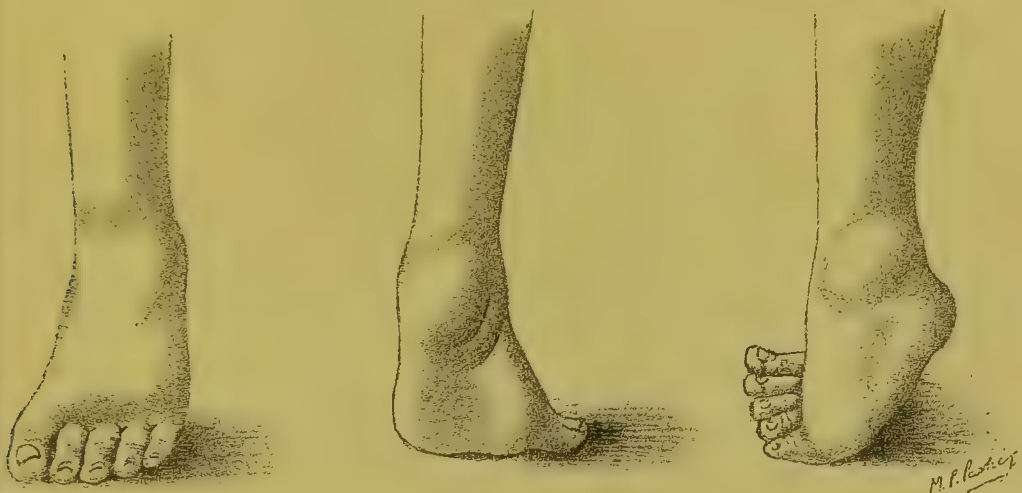


FIG. 201.—Three views of a foot affected with paralytic talipes equino-varus.

to restore them as far as possible by the proper use of electricity, douching, and shampooing; at the same time taking care that the foot is retained in its restored position by suitable apparatus. As

FIG. 202.—Spastic talipes equino-varus in a boy aged 17 years.

I have before remarked, it is astonishing how much some of these paralysed muscles recover, especially if the patient is put on his feet as soon as possible after the distortion is completely removed, and he is thus given full scope for his powers of locomotion. The prognosis of the spastic form is not so good. Like congenital cases, they show an extreme tendency to relapse; and this is not to be wondered at when we consider that the exciting cause of the lesion is not at rest for many years.

The diagnostic points of paralytic and spastic equino-varus are given on p. 398.

Congenital Talipes Equino-Varus

The Nature of the Deformity.—This consists in the following:—

1. The heel is raised and the foot is extended, *i.e.* in a position of plantar flexion.

2. The sole of the foot and the toes are adducted and brought to the middle line instead of being directed to the front.

3. The internal border of the foot is raised to a varying degree, and bent upon itself, so that it is concave. With this the adduction of the great toe is often very marked, the first inter-digital space being wide; and the great toe is somewhat flexed in contrast with the small toes, which are extended. In some cases the great toe appears to be almost capable of opposing itself to the other toes. This is an approach to a reversion in type to the Quadrumana.[1] The incurvation of the great toe is a distinct clinical feature of these cases, and gives a clumsy appearance to the foot when the deformity of other parts is cured.

Fig. 203.—Congenital talipes equino-varus.

4. The external border of the foot is convex, is in contact with the ground, and forms the main point of support in progression.

The deformity is situated in two places:—

A. In the foot, chiefly in the neighbourhood of the medio-tarsal joint, and to a less degree at the tarso-metatarsal and metatarso-phalangeal articulations, the last two joints being capable of being moulded into the correct position, while the medio-tarsal joint is frequently incapable of being so.

[1] For a perfect example of "opposing" power in the great toes, see a remarkable case by the author, *Lancet*, 17th Feb. 1894.

B. At the ankle.

Due recognition of the sites of the deformity is essential to proper treatment. The back part of the foot, *i.e.* behind the medio-tarsal joint, must serve as a fixed point for the correction of the front part. And fixation of the back part can only be obtained by leaving the tendo Achillis intact until the front part is restored.

Some cases show a curious rotation of the front part of the foot. Instead of the anterior portion being rotated so that its inner border is raised and forms part of the same curve as that of the posterior part, it is twisted upon the os calcis and astragalus at the medio-tarsal joint, and is rotated so that the inner border comes to the ground at the same time as the outer, or even sooner. Many of these cases of double twist in the foot have the much-separated big toe already spoken of, and no doubt the partial power of opposition of the first digit to the remaining toes explains the twist. The chief interest lies in the difficulty of entirely overcoming the deformity, and obtaining a shapely foot by treatment.

Frequency of Congenital Equino-Varus.—Bessel-Hagen[1] noted 15 congenital deformities of the feet in 13,668 births at full time in the Charité Hospital at Berlin. Of these 15, 10 were varus or equino-varus, 2 were valgus, 1 was calcaneo-valgus; in one case there was varus of one foot and calcaneo-valgus of the other; in the remaining case varus of one foot and valgus of the other existed. Sydney Roberts has collected 168 cases of congenital equino-varus, and 5 of equinus as against 136 cases of acquired varus, and 87 of equinus. Congenital club-foot is more frequent in boys than girls. Of 147 cases, Heine reckoned 97 boys and 50 girls; and of 245 cases of Bessel-Hagen's, 156 were boys and 89 girls.

Double congenital varus is more usual than single. In the latter event, the deformity is more often on the left side than the right. Very frequently with club-foot of congenital origin meningocele, spina bifida, partial or complete amputation of the limbs, absence of fingers, polydactylism, syndactylism, and absence of the bones of the leg or foot are found to co-exist.[2]

[1] *Ueber die Pathol. des Klumpfusses*, etc., *Verhandl. d. deutscher Ges. f. Chir.* 1885, and *Die Pathol. und Therapie.* Petters, Heidelberg, 1889.

[2] An analysis of 60 of my own cases of congenital equino-varus gives the following results: boys 42, girls 18, both feet affected 44, right foot alone 8, left foot alone 8. In one case equino-varus of the right foot and equinus of the left, in another, calcaneo-valgus of the left and equino-varus of the right co-existed. In one instance the index and third fingers of the right hand were crossed and united, in another hydrocephalus, in a third congenital hydrocele, and in two others spina bifida, and in one a congenital sacral tumour were also present.

Appearances of Congenital Equino-Varus in the Infant.—1. The heel is elevated, and cannot be brought to the ground with the knee extended.

2. The foot is adducted and rotated so that the dorsum looks outwards, forwards, and downwards, and the sole upwards, backwards, and inwards.

FIG. 204.—Congenital talipes equino-varus in an infant aged 7 weeks.

3. The inner border is raised and more or less approximated to the leg, and is also concave. The outer border is convex, and when the foot is brought to the ground, it alone comes into contact.

4. The affected foot is smaller than its fellow, on account of the delayed development of the limb.

5. The heel is very small, and the skin does not become thick and hard on it.

6. The internal malleolus is buried and lost in the concavity which the inner border of the foot makes with the leg, while the external is more prominent than natural.

7. In thin children the dorsum of the foot is irregular, owing to the displacement of the head of the astragalus and the prominence of the anterior extremity of the os calcis.

FIG. 205.—Back view of Fig. 204.

Degrees.—The deformity varies according to age. 1. In slight cases the foot can be momentarily replaced by manual force. And it is necessary to remark that infants who have not commenced to walk usually hold the foot in a position of slight varus.

2. In the second degree the foot cannot be replaced manually. On attempting forcible reposition there remains some adduction or extension of the foot, and the sole cannot be planted squarely on the ground and the great toe is much separated from the second.

In the latter case the peculiar external rotation of the foot (the doubly-twisted foot) mentioned above is seen.

3. In the third degree, which is seen in children and adults,

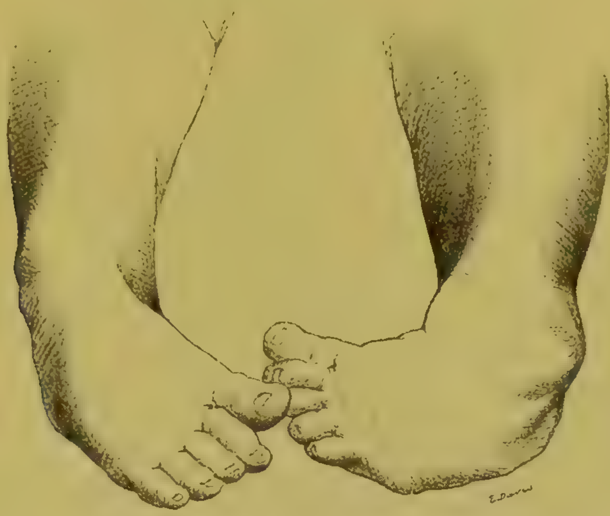


FIG. 206.—Congenital talipes equino-varus in an infant aged 3 months.

the foot is in a rigid and resistant state, with strong contraction of the soft parts.

4. In the fourth degree the deformity is inveterate and of old standing, and much malposition of the bones is present.

FIG. 207.—Appearance of congenital talipes equino-varus in an adult aged 39 years.

Appearances of Congenital Equino-Varus in an Adult.—When the child first places its foot on the ground in walking, if a slight degree of varus exist, the weight of the body is sufficient to overcome it. If more than the first degree is present, then the weight of the body accentuates the deformity, and the following effects are observed as the patient grows older :—

The internal border of the foot looks directly upwards, and the weight of the body is borne by the external border and, in severe cases, by the dorsum. The sole looks directly inwards and often upwards, and the dorsum downwards and outwards. The plantar fascia and the tibialis anticus are felt to be firmly contracted. The heel is considerably raised, small and pointed, and covered by thin and tender skin. Two creases (Fig. 207 and Plate XII.) are seen in the sole of the foot, one transversely opposite the medio-tarsal joint and the other longitudinal, starting posteriorly from near the mid-joint of the transverse fold and running to the first interdigital cleft. Adams says[1] that "the presence of these creases are at once diagnostic of the congenital nature of the affection, and may with certainty be relied upon."

The skin of the external border and dorsum is thickened and studded with corns, which inflame and suppurate from time to time, and render locomotion temporarily impossible. Between the skin and the bones bursæ form, which are also liable to inflammation. The foot is always shorter and smaller than its fellow. In this tardy development the leg shares, and a shortening of 1 inch in the leg is not unusual. The muscles are also smaller, although they may be as firm or firmer than in the unaffected limb. The roundness of the calf is higher on the side of the deformity, so that the greatest measurement of the calf is nearer the knee-joint. Coldness and blueness of the limb are absent.

Symptoms.—The name "reel-foot" or "reel-feet" expresses the character of the gait when both feet are deformed. In walking one foot must be lifted over the other and the patient appears to waddle. This may cause that distortion of the head and neck of the femur, which undoubtedly exists in these cases. From time to time the feet become very painful, and the patient has to lie up. But with boots made to the shape of the feet much activity is possible, and adult patients frequently prefer to continue to walk with the deformity rather than undergo the drastic procedure of tarsectomy sometimes proposed by surgeons. Indeed, Mr. Keetley stated[2] that a patient, whom he was called to attend for some other cause, who was affected with double congenital club-feet, one of which had been tarsectomised, was far better pleased with the deformed foot for purposes of locomotion than he was with the foot which had been operated upon. In the patient's opinion, the elastic deformed

[1] *Club-Foot*, 2nd ed. p. 144.

[2] *Brit. Orth. Soc.* 31st Jan. 1895.

foot was more helpful than the rigid, although well-shaped tarsectomised foot.

An impression of the outline of the sole taken upon brown paper with printers' ink will reveal the adduction of the foot, and give evidence of the extent to which the sole touches the ground (Fig. 208). The corns and bursæ which form have already been alluded to. In some cases the suppuration and ulceration arising from them is so severe that amputation has been resorted to.

FIG. 208.—Tracing of the sole from a case of congenital talipes equino-varus associated with spina bifida.

Morbid Anatomy. — The observations of Little,[1] Adams,[2] Parker and Shattock[3] in this country, of Nélaton[4] and Rochard[5] in France, of Bessel-Hagen[6] and Volkmann[7] in Germany, of Hartley[8] and others in America, have rendered us conversant with the morbid anatomy of congenital equino-varus. A thorough description of the morbid anatomy of this affection has been furnished us by Messrs. Walsham and Hughes in their recent work on *Deformities of the Foot.* Much skilled attention has been paid to this subject, and on the main points authors are agreed, viz. that there exists extension of the astragalus upon the leg at the ankle-joint, with twisting downwards and inwards of its head and neck, an inward subluxation of the scaphoid, elevation of the tuberosities of the os calcis, and rotation of the same bone around its vertical axis, so that the anterior extremity is directed more internally than normal, carrying with it the cuboid which is adducted together with the bones in front of the medio-tarsal joint. As to the minor details, it is necessary to consider their characters at two periods of life: (*a*) before any attempt at locomotion has been made by the patient, and (*b*) in adult life. A close attention to these details, even at the risk of being tedious, is important, as bearing on the various modes of treatment.

At birth the foot is largely cartilaginous, and in talipes the foot is defectively modelled under the influence of varying con-

[1] *On Deformities*, 1853.
[2] *Club-Foot*, 2nd ed. 1873.
[3] *Congenital Club-Foot*, 1887.
[4] *Archiv Général de Med.* April 1891.
[5] *Revue d'Orthopédie*, 1st Sept. 1891.
[6] *Die Path. des Klumpfusses, Verhand. d. Deutsch. Ges. f. Chir.* 1885.
[7] "Zür Aetiologie der Klumpfusse," *Deutsch Klinik*, Berlin, 1863.
[8] *N. Y. Med. Rec.* 18th Aug. 1894.

ditions shortly to be discussed. So long as the bones remain "in cartilage," they may still be moulded to a normal shape; and the recognition of this fact seems to me to be a strong argument against any form of resection of the tarsus[1] in children, unless simpler orthopædic methods in skilled hands have been given a fair and prolonged trial, not to be measured by weeks. In adults the false modelling is to a certain degree fixed, but by no means irretrievably so, and can be altered by tenotomies, manipulation, and wrenching, if the patient and surgeon are content to proceed without haste and gradually unfold the foot.

It will be a good plan to describe the conditions found in the infant, and then to note step by step the effects of the upright position and of locomotion upon the shape of the bones and the alteration in outline of their articular surfaces.

The Bones.—*The Astragalus.*—The mean angle of the neck of the *fœtal* astragalus in eleven cases measured by Parker was 38°, and the mean angle of twenty adult astragali was 10·65°, *i.e.* some inward deflection of the neck is a normal condition in the fœtus. In a talipedic astragalus the angle of the neck, as measured by the same writer, was 53°.[2] Scudder[3] by more extended observations has shown that the mean angle of twenty fœtal astragali was 35·75°, of forty-three adult astragali it was 12·32°, of astragali from seven cases of equino-varus it was 50·05°. Normally then the obliquity of the neck diminishes from fœtal to adult life. In the talipedic fœtus the obliquity of the neck conforms closely to that observed in the anthropomorpha. According to some authorities the neck is increased in length.[4]

In a talipedic infant, before it has walked, the astragalus is extended at the tibio-tarsal joint, so that only the posterior part of

[1] There are, however, some cases in which varus is cured but the equinus cannot be overcome, owing to a lock at the ankle arising from the abnormal shape of the articulating surfaces and shortening of the posterior ligament. In such cases an exploratory operation is justifiable after the failure of orthopædic measures.

[2] Hartley states that the downward and inward inclinations of the neck are respectively 45° and 65°, against 15° and 45° in the normal. According to Hueter this is the chief cause of the plantar flexion. Walsham and Hughes (*Deformities of the Foot*, p. 99) remark: "We call special attention to the downward deflection of the neck, since this condition does not seem to have received from authors the attention it undoubtedly deserves. We regard this downward deflection as one of the chief obstacles to the rectification of the equinus position of the foot."

[3] "Cong. Tal. Eq.-Varus," *Boston Med. and Surg. Journ.* 27th Oct. 1887.

[4] In two astragali examined by Kocher, the first from a talipedic patient, aged 1 year, had an abnormally long neck, while the second from a new-born infant was only lengthened on the outer side. Quoted by Hartley. *N. Y. Med. Rec.* 18th Aug. 1894.

the superior articular surface enters into the ankle-joint, while the anterior part is extruded. As a result the superior surface is narrower transversely than normal. Owing to this displacement the posterior surface is feebly developed, and is represented by a thin ridge of bone. At the same time only one-third of the external facet is in contact with the fibula, the anterior two-thirds remaining uncovered. The internal surface alone is fully opposed to the internal malleolus, but in so doing its vertical disposition is lost, and it becomes oblique from below upward and inward. The anterior or scaphoid surface looks downward and inward instead of forward, and its upper part projects beneath the skin of the dorsum of the foot; on the inferior surface the relative size of the articulating facets is reversed, the internal being larger than the external. The interosseous groove between the facets is prolonged considerably inward. The head, instead of being spherical, is flattened from side to side, and often subdivided into two facets by a vertical fissure, the internal facet alone articulating with the scaphoid, while the external is occasionally covered with opaque partially-degenerated cartilage.

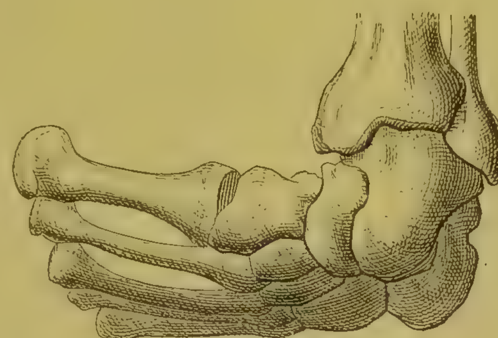


FIG. 209.—Skeleton of part of a foot affected with congenital talipes equino-varus (Musée Dupuytren; after Rédard).

The *adult* abnormal astragalus presents several new features. A transverse section of its body shows that it has lost its square form, and has become trapezoid; and in advanced cases it is triangular, with its summit placed internally. The bone protrudes in a decided manner from the ankle-joint, and its anterior part is abnormally developed. The clinical importance of this fact is considerable. The anterior part of the articular surface is so large that any attempt to replace it between the malleoli causes locking of the bones, and extension is permanent. The neck is unduly lengthened, especially on its external aspect; and the head is oval, being flattened from above downwards. At the junction of the body and neck in extreme cases is a new facet for articulation with the scaphoid; while anteriorly the internal of the two facets mentioned above as existing on the head in the fœtal state is more fully developed than the external, which in adult life has almost entirely lost its cartilage.

The Os Calcis.—In the fœtal club-foot the os calcis is elevated posteriorly and rotated upon itself, so that its longitudinal axis is directed from above, forwards, downwards, and inwards.[1] At the same time the anterior part of the bone is bent inwards. The elevation of the tuberosity prevents the heel coming into contact with the ground, hence its shortening and mal-development. On the anterior part of the superior surface an additional facet is seen for articulation with the fibula, while that which articulates with the astragalus has become broader in the transverse than in the longitudinal direction, and permits flexion, extension, and rotation. The anterior surface is directed more inwards than normal, and does not fully articulate with the cuboid. The sustentaculum tali is either rudimentary or suppressed, owing to the pressure of the astragalus and of the scaphoid in severe cases. In the adult the angle made by the os calcis with the leg often approaches 160°. The bone is also rotated from above downwards and from without inwards upon itself to the extent of 60°, so that the external face is inferior, while the fibula articulates with the superior external border. The anterior facet, which normally articulates with the cuboid and is pointed directly forwards, is now bevelled off from without inwards and backwards. The peroneus longus trends into the sole of the foot, not through a groove in the cuboid, but is reflected around the external inferior margin of the calcis. There is no doubt that the subluxation of the cuboid and the salient angle it forms with the calcaneum is one of the chief obstacles to the reduction of the varoid deformity in the adult club-foot. In other respects the condition of the adult calcis is an exaggeration of the talipedic infantile bone.

Cuboid.—In the fœtal foot its position is not much altered. In shape it is more quadrilateral than normal, and in adults it is seen to be still more so, and is considerably displaced from the os calcis, especially internally. Its dorsal surface becomes more fully developed than the plantar, and from this hypertrophy arises the prominence on the external margin of the foot.

Scaphoid.—The fœtal and infantile bone is twisted so that its longest axis is nearly vertical, while its internal tuberosity is raised, and it is often in contact with the internal malleolus, a new facet being formed on that process where they touch. Some years after-

[1] The persistent obliquely-inward rotation of the calcaneum is often difficult to overcome by treatment, and may remain as a permanent defect after the anterior part of the foot has been unfolded, and the tendo Achillis freely divided.

wards this bone is found to be much atrophied, and its tubercle has very nearly disappeared from constant pressure. If, as sometimes happens, the scaphoid is subluxated internally, it constitutes a formidable hindrance to reposition of the parts.[1]

The Cuneiform and Metatarsal Bones, and the Phalanges.—The former are but little altered in an early stage, but they are arranged one behind the other rather than side by side. At a later date this is accentuated. The metatarsal bones present no change in the fœtal foot, while in the adult their shafts show a rotation even to 90°. The dorsal surface is also more developed than the plantar, and looks inferiorly. A considerable curving of the fourth and fifth metatarsal bones with the convexity dorsally placed is also observable. The first phalanges are extended and the others flexed.

FIG. 210.—Skeleton of an adult foot the seat of congenital talipes equino-varus (Guy's Hospital Museum).

The Relative Position of the Internal and External Malleoli.—The internal rotation[2] of the tibia and fibula is frequently extreme, so that the anterior aspect of the lower end of the tibia and fibula becomes internal, consequently the external malleolus is anterior to the internal, and the transverse axis of the ankle-joint runs from

[1] For the purpose of comparison the following list, drawn up by Hartley, of the nearthroses in the infantile and adult club-foot may be given. In the infantile foot the following are found: 1. On the mesial side of the internal malleolus is found an articular facet, which articulates with a similar facet upon the mesial and superior surface of the navicular bone. This articulation is entirely separate from the ankle-joint, and against its capsule rests the tibialis posticus tendon as it descends beneath the navicularis. 2. Between the internal malleolus (its inferior surface) and neck of the astragalus. 3. Between the malleolus externus and the calcaneum. In Hartley's specimen from an adult, aged 22, the nearthroses are more numerous, and are as follows: (1) Between the posterior border of the tibia and the calcaneum. (2) Between the internal malleolus and the navicular. (3) Between the internal malleolus and the cuneiform (internal). (4) Between the external malleolus and the calcaneum. (5) Between the sustentaculum tali and the inferior surface of the navicular bone. (6) Between the navicular bone and the talus at the junction of the body and the neck. (7) Between the postero-internal border of the cuboid and the calcaneum beneath and anterior to the sustentaculum tali.

[2] That this was so was demonstrated by Case 87, p. 426.

behind and internally forwards and externally. The line of the ankle-joint, viewed from the front after incision into it, passes upwards and outwards towards the fibula, instead of being transverse. As a remote change, ankylosis of the bones occurs. In the Musée Dupuytren in Paris are specimens illustrating ankylosis of the os calcis and cuboid, the astragalus and scaphoid, and the calcaneum and astragalus, occurring in congenital club-foot. Frequently the bones are somewhat atrophied, and their tissue rarefied.

Although for the sake of emphasis I have delineated the conditions at their extremes, one must not forget that the final conditions of extremely distorted feet, and even of ankylosis, are reached only in adult life, and are the results of the adaptation of the bones to the position assumed by the foot in its function of weight-carrier. Hartley says: "Although the abnormal positions take place before the use of, and at the time of, the formation of the muscles, rectification does not take place afterwards, because the bones have become altered in shape and the muscular attachments are approximated. The earlier in fœtal life such malpositions are initiated, the more pronounced will be the subsequent deformity. After birth the muscles tend to maintain or increase an existing deformity. In the adult congenital club-foot, however, there is added another factor to the production and intensification of the deformity, namely, the weight of the body in walking. These changes, so far as this dissection has shown, consist: (1) In an excessive increase of the deformities found in the bones of the new-born. (2) In additional nearthroses. (3) In an increased extension at the ankle-joint. (4) In a marked supination and adduction in the calcaneum. (5) In an extensive displacement of the navicular and cuboid bone to the mesial side of the astragalus and calcaneum. (6) In a pronounced rotation of the tibia and fibula."

The Ligaments.—Those on the dorsum and the external border are elongated, and those in the sole and on the internal border are contracted; and the posterior ligament of the ankle[1] is much retracted. R. W. Parker lays special stress on the ligaments of the astragalo-scaphoid joint, and describes a capsule at this spot formed by the superior astragalo-scaphoid ligament, the fibres of the anterior ligament of the ankle-joint, the anterior portion of the deltoid, and the inferior calcaneo-scaphoid ligaments. These, reinforced by some

[1] This is sometimes a cause of failure after operation, and after tenotomy of the tendo Achillis the deformity may be overcome by patient manipulation and continued stretching.

fibres from the tibialis anticus and posticus tendons, "form an unyielding capsule of great strength." Of these structures I am of opinion that the most important is the anterior part of the deltoid ligament, and I am in the habit of dividing it at the same time as the tibialis anticus tendon in cases of congenital club-foot. The plantar fascia, the calcaneo-cuboid, and the other ligaments of the sole undergo adaptive shortening, and contribute their quota to the sum-total of deformity.

The Muscles.—In the infant there is scarcely any difference if the muscles of the affected be compared with those of the normal limb, but if the deformity continue the muscles do not acquire the same size as those of the normal limb. Also some contraction of the short muscles of the sole occurs, the muscles especially implicated being the abductor and short flexor of the great toe. If there be spina bifida, or any other condition present in which nerve lesions occur, then fatty degeneration is found. Muscles which are much restricted in their action, *e.g.* the extensor brevis digitorum, undergo atrophy, but not, in the absence of nerve degeneration, any fatty change.

The Tendons and their Directions.—If a line be drawn from the external tuberosity of the os calcis upwards, forwards, and inwards, so as to pass through the sustentaculum tali and the neck of the astragalus, the muscles whose tendons pass internally and externally to the foot may be divided into two groups accordingly, namely, an internal and posterior, which act as flexors of the toes, adductors and invertors (supinators) of the foot, and an external and anterior group, which are extensors of the toes, abductors, and evertors (pronators) of the foot. If, as frequently happens, the tendo Achillis becomes shortened, it must have an immediate and remote effect upon the position of the foot. In its shortening the gastrocnemius approximates its origin and insertion first by extension at the ankle, and then by one of two movements, namely, inward or outward rotation of the calcis. With the extended foot, inversion is more possible than eversion, and the calcis is rotated in such a way that the inferior surface is nearer the middle line than the superior, hence the tendo Achillis becomes displaced to the inner side. It therefore follows that the tendo Achillis once displaced inwards acts immediately as an extensor, and remotely as an invertor of the sole, or, to be more correct, as a supinator.

The alterations in the position and direction of the more important tendons in an infantile foot dissected by Rochard were as follows: "The tibialis anticus was displaced on to the inner aspect of the lower end of the tibia, and passed over the internal malleolus perpendicularly to the internal cuneiform bone. The long extensor of the great toe also passed over the internal malleolus. The common extensor was displaced inwards, while the peroneus tertius had disappeared." The peroneus longus passes into the sole of the foot, not through a groove in the outer and under surfaces of the cuboid, but is displaced backwards on to the os calcis, and goes round its inferior and external border, and therefore runs a shorter course to its insertion. In the infantile club-foot the tibialis posticus is tense, but it is not markedly altered in direction unless the varus be severe, when it is found on, rather than behind, the internal malleolus; in the adult the tendon lies on the process, and then passes directly downwards to the scaphoid tubercle across the angle between these bony points. The flexor longus digitorum is displaced forwards at the internal malleolus, and then in the adult descends abruptly to the sole of the foot, not, as in the normal condition, passing beneath the sustentaculum tali. The flexor longus pollicis does not groove the astragalus, as this is displaced forwards, but passes almost vertically downwards over the inner surface of the calcis.

One striking point about the tendons in the adult is their abnormal length and tenuity. The latter condition is well marked in the tendo Achillis, and their length is due to the shortness of their muscular bellies.

The Vessels and Nerves of the infantile foot are but little altered so far as their relation to the tendons is concerned. Frequently the posterior tibial artery and nerve are displaced towards the inner malleolus.

The Skin and Subcutaneous Tissue.—Over the external border and dorsum in severe cases these are much thickened. On the skin numerous corns form, and in the subcutaneous tissues false bursæ are developed. Inflammation and suppuration occur from time to time.

Remote Lesions.—The inward rotation is not confined to the foot, but is found elsewhere as a primary condition in the limb, notably as excessive internal (not external, as some books state) rotation in the lower third of the tibia and fibula; less often it is seen at the lower part of the femur, and rarely as an inward incurvation of the neck of the femur with advancement of the anterior margin of the great trochanter. According to Cruveilhier, the interosseous space becomes obliterated. On account of the difficulty in walking, the knee and hip joints become adapted to abnormal positions, some of the ligaments being relaxed and others contracted, so that after a time, according to some writers, ankylosis, partial or complete, either in the flexed or extended position, occurs. This I have not seen, but great laxity of the ligaments of the knees is met with as, I believe, a primary condition; and in the form of genu recurvatum it is a distinct hindrance to safe progression (Fig. 211). The thigh and the section of the pelvis on the affected side are atrophied, and scoliosis is occasionally seen as a complication. The frequent co-existence of hare-lip, spina bifida, club-hand, deficiency of the bones of the leg, syndactylism, and polydactylism are noteworthy from an etiological point of view.

FIG. 211.—Congenital talipes equino-varus associated with genu recurvatum (after Rédard).

The Obstacles to Reduction in Congenital Talipes Equino-Varus.—I. In the infant, obstacles arise mainly in the internal lateral ligament of the ankle, the plantar ligaments and fascia, the tendons of the tibialis posticus and anticus and the tendo Achillis, the astragalo-scaphoid and calcaneo-scaphoid ligaments, and lastly, from the vicious direction of the neck of the astragalus. At the age we are speaking of, these obstacles may be overcome by tenotomy, fasciotomy, division of the ligaments, manipulation, and patience.

II. In the adult the chief difficulties arise: (1) From the abnormal shape of the bones, especially the downward and inward deflection of the neck of the astragalus, and in severe cases the fixed subluxation of the cuboid and scaphoid; (2) from the partial or entire obliteration of the old joints, and the difficulty of bringing the proper joint surfaces in contact, as, for example, in the case of the ankle where the anterior part of the upper articular surface of the astragalus is much too broad to be pushed back between the malleoli; and this condition acts as a grave hindrance to the reduction of the plantar flexion, and has led to the operation of astragalectomy; (3) from the formation of new joints; (4) from fixation of the ligaments and tendons in their abnormal attachments and course; and last but not least, from the difficulty of bringing any pressure to bear on the skin of the foot, already tender from pressure, and now liable to sores; and in open operations from the defective power of healing frequently seen in congenital club-foot.

Etiology.—The causation of congenital club-foot is still doubtful, although much light has been thrown upon it by the labours of R. W. Parker, to whose writings I am indebted for many of the remarks which follow. It would appear that the matter may be discussed under four headings:—

I. Arrested development of the bones of the leg.
II. Causes arising from nerve lesions.
III. Mechanical causes, due to malposition or compression of the fœtus *in utero.*
IV. Abnormal development of the bones of the foot.

I. *Arrested Development of the Bones of the Leg.*—In discussing the subject of talipes valgus, I have recorded instances of deficiency, partial or complete, of the fibula. In an analogous manner some cases of varus and equino-varus exhibit absence of the tibia. But such a marked deficiency of development in the leg is the exception in congenital equino-varus, yet it is at present the single cause on which all agree. The other supposed causes are open to doubt in some particulars.

II. *Causes arising from Nerve Lesions.*—In some cases meningocele, encephalocele, hydrocephalus, and spina bifida co-exist. These are very few in proportion. Of 668 cases of congenital varus collected from the London hospitals, only two were affected with spina bifida.[1] One is constrained to admit that the majority of cases of club-foot show no condition likely to give rise to irritation or paralysis of nerve, and in many cases of meningocele and spina bifida club-foot is absent. Then again, the *post-mortem* examination of patients who have suffered from this form of varus reveals no disease of the nervous system. So that the "nerve" theory fails to explain the majority of cases. It has been held by some that the deformity is due to partial asphyxia at birth, resulting in convulsions. But in the absence of definite examples, carefully collected and impartially examined, this opinion cannot be advocated.

III. *Mechanical Causes, due to Malposition or Compression of the Fœtus* in utero.—Cruveilhier taught that congenital deformities of the foot depended rather on the pressure of the parts together than

[1] Quoted by Bradford and Lovett, *op. cit.* p. 455.

of the uterine wall. Parker,[1] in support of the theory of abnormal position *in utero*, figures a fœtus with talipes calcaneus and fixation of both hip and knee-joints, the former being flexed, and the latter hyper-extended or recurvated, and he claims that the latter are analogous conditions to congenital club-foot, inasmuch as in all there is shortening of the ligaments. Martin[2] believed that he had met with sixty cases of club-foot due to deficiency of the amniotic fluid.

From the figures given by Parker it is easy to understand that, owing to intra-uterine packing, the foot may, during fœtal life, be retained in one position, which becomes fixed. As a rule the position is such as to lead to some small degree of equino-varus even in presumably normal infants, and they subsequently lose this tendency to inversion when they commence to walk. If the position is more decided, then an abnormal condition of the foot arises, either double talipes equino-varus or equino-varus in one and equino-valgus in the other, or calcaneus in both. In support of his contention Parker cites a considerable quantity of pathological evidence,[3] and a careful perusal of this in his work on congenital club-foot will well repay the reader.

IV. *Abnormal Development of the Bones of the Foot.*—Inasmuch as a capacity for inversion may be considered as physiological during fœtal life, this inversion being associated with some obliquity forwards and inwards of the neck and head of the astragalus, the opinion was expressed by Hueter[4] that the direction of the articular facets of this bone in new-born children places the foot in the varus or supine position, which is substituted later by the prone position, owing to the weight on the foot in walking. It appears that Hueter confounded cause and effect, as he further thought the supinators became adaptively shortened in fœtal life, in consequence of the inward displacement of the astragalus and front part of the foot. The converse is more probable.

Pathological observation and comparative anatomy disprove

[1] *Congenital Club-Foot*, pp. 32, 33.

[2] *Memoire sur l'Etiologie du Pied bot*, Paris, 1839.

[3] He states that the following appear to be the most common modes of production: (1) By accidental locking of parts; (2) by locking of parts due to abnormal position of the limbs; (3) by exceptional positions of the limbs independently of locking; (4) by uterine environment from actual or relative deficiency of the liquor amnii; (5) by congenital absence of certain bones.

[4] *Archiv für klin. Chir.* vol. iv. part i. p. 125 *et seq.*; and Virchow's *Archiv*, vol. xxv. p. 598.

these assertions. In the anatomy of fœtal club-foot I have described the head of the astragalus as exhibiting two facets, the inner articulating with the scaphoid, and the outer, not in contact with this bone; the existence of the latter facet proving that the scaphoid had at some earlier period of intra-uterine life approximated fully to the head of the astragalus as it does normally. Parker aptly cites the fact that in the anthropomorpha the neck of the astragalus is naturally oblique, and remains so through life, yet these animals are not talipedic.

To sum up. (1) A small proportion of cases are due to deficiency of one of the bones of the leg. (2) A few are dependent upon nerve lesions, cerebral or spinal, especially spina bifida. (3) The cause of the majority is not absolutely settled by the data at our command, although Parker's observations as to the influence of intra-uterine position should go very far to remove much of the variance of opinion which exists on the subject.[1]

The Prognosis of Congenital Equino-Varus.—The points in any given case on which information will be sought are the following:—

1. Can a perfect foot be obtained?
2. Will a shapely foot result from treatment?
3. Will the patient be able to walk comfortably and rapidly?
4. What possibility is there of relapse, and if relapse occur, can the foot again be rectified?
5. The duration of time during which treatment is necessary?

1. *Can a perfect Foot be obtained?*—It is necessary to inquire what this is. I take it to be one in which the inner border of the great toe is in the same vertical plane as the inner margin of the patella, which can be abducted voluntarily from the median line when the whole limb is extended, which carries a due proportion of the body weight on the inner margin, which can be abducted during locomotion. The answer to the question is contained in these points:—

(*a*) The age at which treatment is begun and the degree of deformity. It is quite certain that many cases of congenital varus

[1] Bradford and Lovett, *op. sup. cit.* p. 455, remark: "The conclusion to be derived from all this (a notice of the various theories) is that it may be said that we are entirely ignorant of the causation of club-foot." But it is only fair to add that the American authors continue their remarks thus: "The subject of the causation of club-foot has been carefully investigated anew by Parker and Shattock . . . and their investigations seem to point to retarded rotation as the cause of the deformity."

of the first and second degrees are cured if treatment is begun before walking is attempted. At this tender age the bones are largely cartilaginous, the ligaments are elastic, and the muscles are not structurally shortened, therefore there is every prospect of successful treatment. The time when treatment should be instituted will be more particularly dwelt on in the section on the practical details of that branch of the subject. It is sufficient here to say that the earlier it is begun, the more hopeful is the prognosis. Cases of the third degree, especially after weight has been borne on the deformed feet, seldom give perfect results.

FIG. 212.—Relapsed talipes equino-varus, from want of perseverance in after-treatment.

(*b*) The amount of rigidity present. If rigidity is due to contraction of muscles, tendon, and fasciæ, much improvement will be obtained; but, naturally, the greater the rigidity, the longer will be the duration of treatment. If rigidity is due to altered shape of articulations, although the foot may become useful for progression, yet the result is rarely ideal.

(*c*) The presence of other deformities, *e.g.* genu recurvatum, undue laxity of the ligaments of the knee, excessive rotation of the tibia, fibula, and femur, complicates matters. Although the varus may readily be cured, yet it is difficult to overcome these troubles without the use of retentive apparatus and proper physiological measures, such as rubbing, douching, and the use of electrical stimuli in the instances of genu recurvatum and laxity of the ligaments of the knees; and in those cases of excessive rotation of the bones, an operation such as osteotomy will be called for to compel all parts of the limb to assume their natural positions.

(*d*) Persistency in treatment. There can be no doubt that many cases of club-foot are cured for a time, but that, owing to want of due care, or occasionally to negligence on the part of parents, relapse takes place. It happens not unfrequently that a child leaves the hospital well able to walk, and the immediate result is all one could wish for. The parents are enjoined to bring the child up for observation every three months. Instead of so doing, they fail to attend for two or three years, and then come with the naïve remark that "the foot is going back." A typical instance is the following:—

CASE 86. *Relapsed Talipes Equino-Varus.*—A. B. was operated on in infancy for double talipes equino-varus; after tenotomy the position of the feet was completely rectified. Walking instruments were ordered, and the mother instructed in their application and use. Nothing more was heard of the child for some time. He was brought when he was 4 years old because he was walking badly. The feet had completely relapsed, and he was walking on the external malleoli and borders of the foot. The mother said she could not keep the irons on, nor the night-shoes applied because they made the child cry.

It is the duty of the surgeon to insist that relapse, especially of congenital talipes, is a likely event so long as growth is going on, and every care must be taken to prevent it. The occasional want of this caution, but still more the negligence of the parents in not giving due heed to it, bring great discredit at times, and too often unjustly, on the treatment of club-foot; and as a result tarsectomies are done, it may be in the hope that the so-called radical procedures will in the future avoid all necessity for persistent care. As to this last point, my experience is that such is not the case; even tarsectomies relapse.

2. *Will a shapely Foot result from Treatment?*—In slighter degrees of varus the answer may be given in the affirmative. But in many instances there will always remain the "square-toed" appearance, and the foot is ungainly. Still so long as it is useful, this unsightliness is not of primary importance.

3. *Will the Patient be able to walk rapidly and comfortably?*—Again the question of degree must be a dominant factor. But it may be generally said that the less the bony framework is interfered with by excision and such drastic measures, the more elastic will the foot remain. If due recognition were only given to the great share that steady orthopædic treatment and patience must have in the treatment of club-foot, failures would not so often be seen. It follows that the less cicatricial tissue there is about the foot after treatment, the less the distortion will be likely to recur, although the case may pass from observation. Even if the case relapse, better results can be obtained than if the parts have been badly mutilated by any severe procedure.

Reference has already been made to the case of a man with one tarsectomised foot and one untreated deformed foot, who much preferred the deformed to the tarsectomised foot because of its greater elasticity.

4. *What Possibility is there of Relapse?—If the relapse occurs, can the foot be afterwards rectified?* There is every likelihood of relapse in congenital cases unless persistent care is exercised all through childhood and adolescence. But relapsed varus is capable of much improvement by the methods detailed in the next chapter.

5. *The Duration of Time required for Treatment.*—This must depend much on the degree of the deformity and the method adopted. The slower orthopædic methods are effectual but tedious. A deformity of moderate severity can be removed by manipulation and wrenching in a few weeks to a month. Active treatment is necessary only for weeks, care for years.

The Diagnosis of Congenital Equino-Varus.—In early childhood there will be no difficulty in distinguishing congenital from paralytic varus. The history of distortion of the feet from birth, the absence of wasting of the muscles, the sufficient circulation in the limb, and the presence of the longitudinal and transverse furrows in the sole will serve to prevent a congenital being confused with a paralytic equino-varus. If spina bifida, or deficiency of the bones of the leg, or syndactylism is present, then a case which may be presented to us is certainly one of congenital origin.

In later life, when the muscles in a case of congenital equino-varus are wasted, some difficulty may arise, but attention to the points in the subjoined table will be of much assistance.

Diagnostic points of congenital and paralytic equino-varus in the adult:—

	Congenital.	*Paralytic.*
History . . .	Affection has existed from birth	Affection first noticed during second year, and preceded or accompanied by measles, teething, and may be ushered in by convulsions
Feet affected . .	More often both . .	More often one
Circulation . .	Good . . .	Feeble. Limb is cold, blue, and clammy
Wasting of muscles .	Little marked . .	Extreme
Electrical reactions .	Present or slightly diminished in wasted muscles	Entirely lost in wasted muscles
Deficiency in growth of bones	Not very evident .	Much shortening of leg and foot
Furrows in sole	Present . . .	Absent
Prominences on dorsum of foot	Several, and general outline is irregular	Head of astragalus is prominent, but general outline is rounded

From spastic paralysis the diagnosis of congenital equino-varus is more difficult. But the presence of rigidity of the knees, adduction of the thighs, flexion of the forearm, and contraction of the hand are points sufficiently distinctive of spastic paralysis. The hysterical form of equino-varus readily disappears under an anaesthetic.

CHAPTER VI

THE TREATMENT OF CONGENITAL EQUINO-VARUS

Treatment of Slight Cases of Equino-Varus by Manipulation and Retentive Apparatus—Treatment of Moderate Cases of Equino-Varus by Tenotomy, Fasciotomy, Use of Retentive Apparatus, and Wrenching—Tenotomy and its Technique—Syndesmotomy—Inversion of the Limb and its Treatment.

In this chapter it is proposed to enter at some length into those methods with which I have practical acquaintance, and to succinctly state those which have been found of use by surgeons of experience. It is impossible, however, within the limits of the present work either to describe all the operations which have been recommended or to notice all the apparatus which are in vogue for the restoration of the foot to its normal position and its subsequent retention there. To the elaborate works of Hoffa, published in Germany, of Rédard in France, of Bradford and Lovett in America, and more recently of Walsham and Hughes in this country, I must refer the reader for such other information as he may require.

What are the Objects of Treatment in Congenital Club-Foot?—They are: (1) To bring the foot into its normal position. (2) To keep it in that position by preventing any possibility of the return of the deformity.

To accomplish the first object, three methods of treatment are in use:—

(*a*) Manipulation.

(*b*) Operative measures such as tenotomy, wrenching, wide division of all the resistant structures, and removal of offending portions of bone, the latter operations being comprised under the general term tarsectomy.

(*c*) Physiological measures, as rubbing, douching, and the application of the electric current.

In many slight cases manipulation only is required; in severe cases a combination of manipulative and operative; and in all cases due attention to physiological measures.

To accomplish the second object, viz. retention after reposition, apparatus of some kind must be used, and the value of various kinds of apparatus has been and still is a matter of discussion.

When should Treatment be commenced?—In infants there is no reason for delay, rather on the contrary. Manipulation may be begun immediately after birth, and there is good authority in support of the view that tenotomy is a justifiable procedure during the first week. Provided it is performed skilfully and with antiseptic precautions, and that the infant is in good health, it is a slight matter. It is an error to defer operation until the child attempts to walk.[1] Valuable time is lost, and the distorted bones are more firmly set in their false positions. Children too, when they begin to crawl about, rest much on the outer border of the foot, a habit which aggravates the deformity and increases the difficulties of treatment. "There is a vast difference between a child in arms and walking, since when the child is in arms the case is yet free from the complications and difficulties caused by the body-weight falling on the club-foot. The first twelve months are most important. So much can be done with all the tissues soft. It is noteworthy that during the first year so rapid is the growth of the foot that it more than doubles its size in proportion to the rest of the body" (Judson).

Treatment of Slight Cases, or Cases of the First Degree.—This degree may be defined as an exaggeration of the natural inward deflection of the foot at birth and for some months afterwards. The feet in this degree can be—

(*a*) Brought to a straight line with the leg by manipulation or even everted, but when the pressure is relaxed, they spring back to their original position.

(*b*) They cannot be fully dorsi-flexed when they are straightened or everted.

1 Mr. Adams says: "The liability to interruption of treatment from infantile complaints is much less to be feared within the first few months than at a later period; and when the foot has been completely cured, I have never seen the deformity return in consequence of a few weeks' illness.

"It is of the utmost advantage to complete the treatment of the club-foot before the commencement of dentition, when children are generally fretful and become liable to so much illness that interruptions from this cause may really be feared. Moreover at a late period children are so much stronger that they often resist all treatment with great violence, and in a passionate child I have known hernia produced from this cause." (*Club-Foot*, 2nd ed. p. 233.)

Such cases can be treated by manipulation alone, or by manipulation combined with massage and retentive apparatus.

Method of Manipulation.—The movements to be practised are abduction and eversion at the transverse tarsal and sub-astragaloid joint, and flexion and extension of the whole foot at the ankle, finishing up with circumduction. In all these movements care should be taken that the grasp of the left or fixing hand of the surgeon is made by the thenar eminence and the whole length of the opposing fingers, and not by the tips alone. By so doing more pressure can be borne by the infant than if the latter are dug into the foot.

FIG. 213.—Congenital talipes equino-varus of the first degree in the right foot, and of the second degree in the left foot (E. L. S., aged 5 weeks).

To abduct and evert, the foot is firmly taken in the surgeon's left hand at and below the ankle-joint in the way indicated above, and holding the front part of the foot firmly but lightly with the right hand, the foot is gradually abducted as far as it will go without causing pain. It is held in that position for a few seconds, and then allowed slowly to return to its original position. This manœuvre should be repeated for five minutes, and supplemented by eversion at the transverse tarsal joint. Then flexion and extension at the ankle-joint are practised for another five minutes, and finally circumduction a few times. Twice or three times a day these exercises should be repeated, and the surgeon should see that the mother or nurse is fully competent to carry them out; simple massage of the foot and leg, especially of the anterior tibial and the peronei muscles, should be further enjoined. It is perhaps a small matter, this of exercises, but one more point remains to be noticed. If the movements are rough and sudden and cause pain, reflex contraction of the contracted muscles sets in, and little can be accomplished at that sitting, or at any other, as the infant soon becomes fractious. Treatment by manipulation alone calls for a considerable amount of intelligence and persistence, is very tedious, and requires to be supplemented by some form of retentive apparatus. As an adjunct manipulation is also extremely valuable in the after-treatment of the more severe degrees.

Manipulation combined with Retentive Apparatus.—At the National Orthopædic Hospital it is largely the custom to employ the flexible metal splint (Figs. 214 and 215). It is a straight well-padded piece of soft iron, strong enough to neutralise the contracted muscle, but sufficiently flexible to be bent to any angle. The method of application is as follows. The splint is first bent so as nearly to fit the outer border of the leg and foot. It is then, by three or four turns of a bandage, fixed to the leg, and the foot is slowly abducted to the splint and held in position by other turns of the bandage. Gradu-

Fig. 214.—Flexible metal splint.

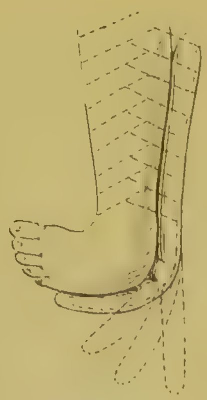


Fig. 215.—Method of applying flexible metal splint.

ally the angle of the splint can be diminished until the foot can be fixed in a straight line with the leg without pain. This suffices to control the varus.

For the equinus the splint should be bent to the right angle, and fitted to the back of the leg and sole of the foot. In this stage it is better to employ two splints, one in the manner just mentioned, and a second on the outer side of the leg and foot. The splints are to be worn night and day, being removed for a short time when manipulation is practised, and immediately re-applied. Careful attention should be given that undue pressure on the malleoli and other bony prominences is avoided, otherwise sore places will result. More efficient, but more expensive than the above, is Mr. Adams' varus splint (Fig. 216). It consists of a thigh-, calf-, and foot-piece, jointed at the knee with a free joint, and at the ankle by a single rack-and-pinion movement. The extension above the knee is very useful in controlling inversion, which is frequently found to exist at the knee or in the leg in these cases. On the outer side of the foot-piece is a toe-wire, with a strap for overcoming the inversion of the foot. By it and the rack-and-pinion movement at the heel the deformity can be overcome. It is best to partially reduce the varus in the first place by the flexible splint, and to use the varus splint later. For slight cases of equino-varus, and in the after-treatment of talipes equinus, Little's rectangular tin-shoe (Fig. 217), or the tin-shoe with a quadrant movement (Fig. 218) at the heel, is useful.

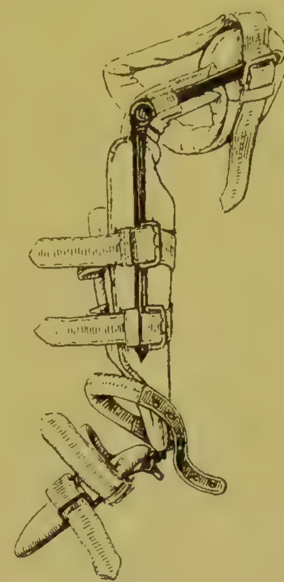


FIG. 216.—Mr. Adams' varus splint.

Bradford and Lovett[1] speak highly of Taylor's varus shoe and of a modification of Bell's apparatus for the mechanical cure of club-foot. In place of the above apparatus a simple splint can be made of gutta percha, poroplastic felt, or papier maché. The employment of plaster of Paris, with repeated fixation of the foot held in it as nearly in a corrected position as possible at each application of the bandage until the plaster is firm, has some merit. It is especially applicable to that class of patients whose parents are too poor to obtain apparatus of any kind. Among these people, too, there is reason to believe that the surgeon's instructions will not be

FIG. 217.—Little's rectangular tin-shoe.

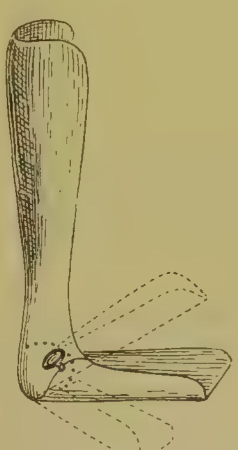


FIG. 218.—Tin-shoe with quadrant movement at heel.

[1] *Op. cit.* pp. 464-468.

carried out, and it is better to put on some form of apparatus which cannot be readily removed. A point in the application of plaster is that after the flannel bandage or cotton wool has been put round the leg, the first figures of eight of the plaster bandage should be very wide ones, reaching from the toes to the upper part of the leg, and passing from the inside below to the outside above, thereby increasing the outward leverage on the foot. Care should be taken not to indent the plaster with the fingers while holding the foot in position during setting. The bandage must be re-applied at least twice weekly, the foot being manipulated, massaged, and additionally corrected each time. This method requires much effort and persistence on the part of the surgeon. It is only the lightest cases of congenital club-foot which are permanently cured by manipulation and retentive apparatus.

Duration of this Form of Treatment.—The varus can be reduced in three to six weeks, and the equinus in another month; but considerable care and the use of retentive apparatus are necessary for some years if relapse is to be prevented.

The Treatment of the Second Degree.—The deformity in this degree is of the following nature:—

The foot cannot be fully everted nor brought into a straight line with the leg. In attempting to do so the tendons of the tibialis anticus and posticus, the flexor longus pollicis, and perhaps that of the extensor proprius pollicis become tense. Contraction of the tendo Achillis exists, and the heel cannot be brought to the ground when the knee is fully extended, nor can the foot be dorsi-flexed beyond the right angle.

Cases of this kind may be cured by—

1. Tenotomy, with the after-use of shoes and apparatus; or by
2. Tenotomy, followed by wrenching on two or three occasions, and putting the foot up in plaster of Paris after each partial correction.
3. The after-use of retentive apparatus.

As this degree is usually found in children under 4 years of age, and the bones and ligaments are still elastic and partially cartilaginous, it is not necessary to resort to more serious measures. By such are meant Phelps' operation, or the various kinds of tarsectomy.

Tenotomy and Fasciotomy.—The object in congenital club-foot is to bring about an equal balance of the opposing structures. This is effected in most cases by tenotomy in two ways—the lengthening

PLATE VIII.

Fig. 1.
Congenital talipes equino-varus before treatment (Cyril S——, aged 4 years).

Fig. 2.
The same case after treatment by tenotomy, instrumental rectification, and manipulation.

of the tendons, and the rest given during healing to the contracted muscle. There can be no doubt that, according to the views now held as to the nerve mechanism of the deep reflexes, a tightly contracted tendon acts as a perpetual reflex stimulus to its muscle, provided that the nervous arc through the spinal end is intact.

Tenotomy in General.—With reference to the tenotomy knives, they may be either sharp- or blunt-pointed, the former being employed for burrowing through the more superficial structures towards the tendon, and the latter for insertion along the side of the sharp-pointed knife, which is then withdrawn. The section of the tendon is made by the blunt-pointed instrument. It should be used when there is fear of wounding a neighbouring artery, such as the posterior tibial, or a large vein, as in subcutaneous section of the sterno-mastoid. But to those practised in tenotomy one knife, the sharp-pointed one, is all that is needful except in division of the sterno-mastoid.

The point of a tenotomy knife should correspond to the centre of the blade, and the cutting edge be slightly convex. "Slender points, on account of their liability to break, are to be avoided." The cutting edge must always be keen, and not extend more than an inch from the point, and the back be strong and rounded so as to offer sufficient resistance to a tough tendon.

Tenotomy may be performed subcutaneously or by the open method (*à ciel ouvert*). Generally the subcutaneous method is to be preferred, except if the sterno-mastoid, and perhaps, the biceps and other hamstrings are to be divided, where important vessels and nerves are so near as to be liable to injury. In other cases there appears to be no object in making the open incision. It is a needless procedure, and, in my opinion, may result in adhesion of the tendon to the skin. The importance of injuring the sheath in division of tendon as little as possible may readily be understood by referring to the experimental details of the process of union. It has been abundantly shown that from the sheath the new material receives lymph at first, and later a plentiful supply of blood-vessels.

All tenotomies should be performed with full antiseptic precautions. When these have been neglected suppuration has followed, although rarely (see "Accidents after Tenotomy").

Anæsthetics in Tenotomy.—For all varieties of tenotomy nitrous oxide gas is sufficient, except for that of the sterno-mastoid, where the convulsive movements of the neck muscles from the partial asphyxia seriously embarrass the operator. The effects of nitrous oxide can be prolonged by admixture with oxygen, a proceeding most successful in the hands of my friend and colleague, Dr. Frederic Hewitt, to whom must be assigned the credit of having brought the simultaneous employment of these gases to high perfection. Ether is useful as an anæsthetic when tenotomies are combined with wrenching, or if they are performed by the open method; its administration is more pleasant if preceded by nitrous oxide gas. Some surgeons deem a general anæsthetic unnecessary for tenotomies, and indeed this is the case in young infants. As a rule chloroform, except in operations about the neck, is best avoided, since ether is practically free from risk. Local anæsthetics are of little service. The injection of cocaine is not always effectual, and is occasionally followed by alarming symptoms of collapse. If it be used at all, not more than a quarter of a grain should be given. It is stated that the injection is more successful if it be made in the direction of the arterial stream.

Accidents during and after Tenotomy, and Causes of Failure.—In the performance of tenotomy the chief risks are wounding arteries and veins, and the severing of nerve trunks. As to the arteries, it is not uncommon in dividing the tibialis posticus for a jet of arterial blood to follow the withdrawal of the tenotome, and section of the plantar fascia and short muscles of the sole, if at all deep, must involve the internal plantar vessels and nerve. Such events in the extremities are of little moment. A pad firmly applied suffices to arrest all hæmorrhage. It is better to divide a small artery completely rather than to puncture it, as the risk of aneurism is less. Operations in the neck in the neighbourhood of the internal jugular and subclavian veins demand every care, and my preference here is for the open method. In dividing the biceps tendon behind the knee the external popliteal nerve has been wounded and divided. An accident of this nature is deeply to be deplored, and if any doubt exists as to the identities of the tendon and the neighbouring vessels and nerves in important situations, the open method is safer.

Accidents after Tenotomy. 1. *Suppuration.*—This event I have not seen, but that it is a real danger is evidenced by the following remark of Messrs. Walsham and Hughes[1]: "We may say at the outset that the only troubles, we have ourselves had, have been suppuration in one case after division of the tendo Achillis, and a traumatic aneurism after division of the plantar fascia." It is much to the authors' credit that they record these accidents, as they

[1] *Op. cit.* p. 191.

FIG. 1

Double congenital talipes equino-varus (Cyril D——, aged 6 weeks).

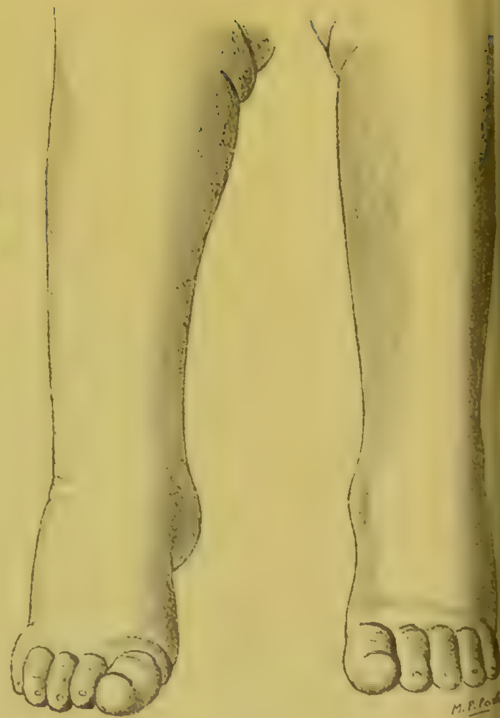


FIG. 2.

To show the completion of the first stage treatment, viz. reduction of the varus d formity, leaving the tendo Achillis intact a the feet in the equinus position.

FIG. 3.

Completion of treatment by section of tendo Achillis, and the position of the right foot at the age of 4 years.

serve to impress upon us that so slight an operation as tenotomy is not unaccompanied by danger.[1]

2. *Aneurism.*—In addition to aneurism of the internal plantar artery mentioned above, two cases of aneurism of the posterior tibial artery have come to my knowledge. They were both readily cured by the pressure of a pad and bandage.

3. Teno-synovitis may result from septic infection of the wound, and cause extensive adhesion of the uniting material and tendon to its sheath, with considerable risk of sloughing of the tendon.

4. General infective diseases, such as erysipelas, septicæmia, and pyæmia, may complicate tenotomy, as after any simple wound not accompanied by full antiseptic precautions.

5. *Hæmorrhage.*—After wounding the anterior or the posterior tibial artery free hæmorrhage occurs for some time, if firm pressure is not maintained; but if this ordinary precaution is taken, little blood will be lost. Volkmann and Owen record instances of wounding of the internal jugular vein when dividing the sterno-mastoid subcutaneously. Both patients, however, recovered.

6. Non-union of tendon results from suppuration or from an interval of too great an extent being maintained between the tendon stumps, especially if a patient be allowed to walk within a month[2]; after section of the tendo Achillis non-union may occur, especially in a case of infantile paralysis, where the tendon is often small and badly supplied with blood. Such an unfortunate event has come within my knowledge.

Causes of Failure in Tenotomy.—1. Imperfect division of a tendon. This event occurs occasionally in the case of the tendo Achillis, which may be either transfixed, leaving the deeper part intact, or a small portion of the superficial part may remain undivided for fear of "coming through" the skin.

2. Missing the tendon, as, for instance, in the case of the tibialis posticus in a fat infant. This mistake has been verified by subsequent dissection.

3. Clumsy division with extensive laceration of the sheath and

[1] It has been pointed out that during the recent prevalence of influenza suppuration has occurred after tenotomy to an unusual degree.

[2] It is well known that Syme allowed his patients to walk on the third day after section of the tendo Achillis. The weight of modern opinion is strongly against this plan. It has been shown that in the experiments on rabbits, if the foot be left entirely uncontrolled, the tendon ends separate gradually as much as 2½ inches, and the stretching goes on for several weeks.

soft parts, causing matting and firm adhesion of the tendon and neighbouring structures.

The Question of Immediate and Gradual Reposition of the Part after Tenotomy.—There are several factors to be considered. The first is the position of the tendon. On the attachments of the sheath, its elasticity, and its capability of retraction, when divided more or less completely, much must depend. In some instances, as described on p. 370 under the title of "Functional Prognosis of Tendon Suture," the tendon stumps retracted 2½ inches, in other cases not more than half an inch. Again, an interval of 1 inch in the tendo Achillis will not interfere with firm union, while the same amount in the flexor tendons of the hand will seriously impair the functions of the part if the extensors are not efficiently controlled. Then again, it is advisable before deciding the question to consider the strength and tension of the affected muscles and their opponents. In a spastic or congenital case, the interval after division will be greater than in a paralytic case, since the tendons of the affected muscles are in a state of greater tension than normal, and the ends fly apart more on division. Their opponents, too, having a normal amount of contracting power, act vigorously through the neighbouring articulation, and so pull the ends farther apart. Some tendons, again, "fly" more than others. This is especially the case in the extensor longus digitorum of the foot, and the extensors of the first and second phalanges of the thumb, if divided just below the wrist.

Then, too, if an artery has been pricked, hæmorrhage is less likely to occur if the limb be returned to the deformed position temporarily until a firm clot has formed in the artery.

There are some cases, then, in which immediate rectification as far as possible is admissible, and there are many others in which it is not advisable. But inasmuch as gradual reposition is in all cases safer, and the same end is gained, I fail to see any reason for strongly advocating the immediate reposition. Above all, the gradual method has the advantage that the length of the band of new material can be regulated to a nicety, as the uniting substance is during the first three or four weeks capable of considerable extension without in any way affecting either the subsequent thickness or strength of the band. Another point is this. If the tendon be immediately lengthened to its full extent, and the case pass rapidly from observation from some cause or another, so that the union is not kept under full control, the band becomes unduly long and weak, and in the case of the tendo Achillis, talipes calcaneus has followed.

Structures requiring Division in the Second Degree of Congenital Club-Foot.—They are portions of the plantar fascia, the tibialis anticus and posticus, the flexor longus digitorum, perhaps the extensor proprius pollicis, and certainly the tendo Achillis.

Now in a compound deformity such as equino-varus it is evident that the obstacles to complete reduction are situated in two centres of movement, the medio-tarsal and the ankle-joint. In operating on such cases we must recognise this fact. To reduce the varus there must be some fixed point to take purchase from. Such a point already exists at the os calcis and astragalus, owing to the contracted tendo Achillis fixing those bones firmly in the mortice of the tibia and fibula. If the position of this fixed point be prematurely disturbed by section of the tendo Achillis, much of the leverage which can be exerted from that part on the front of the foot is lost; and further, the foot can be rotated at the ankle and sub-astragaloid joint in such a way as to give an appearance of reduction of the varus long before it is complete.

It is therefore most strongly advocated that the treatment of equino-varus should be conducted in two stages.

I. *Complete reduction of the varus portion, leaving the tendo Achillis untouched.*

II. *When the varus is overcome, division of the tendo Achillis to reduce the equinus.*

The importance of preserving the integrity of the heel cord until this second stage is begun cannot be over-estimated. I am fully aware that some surgeons divide all resistant structures at the same time, but with much deference I cannot help thinking that in such cases there are two risks, the one of incomplete reduction of the varus, and the other of an unduly long tendo Achillis, resulting in a pernicious form of talipes calcaneus. In support of these remarks, it is well to add that such ill results have come under my notice. The varus part can usually be overcome after division of the tibialis anticus and posticus and sometimes of the extensor proprius pollicis, flexor longus digitorum, plantar fascia, and anterior fasciculus of the internal lateral ligament.

Section of the Plantar Fascia.—In slight cases this is not necessary, but if in attempting to reduce the concavity of the sole any tight bands be felt,[1] then fasciotomy should be done. The bands to be divided are on the inner side of the sole and on the

[1] The best way to feel and to localise these accurately is to use the edge of the fore-finger nail. It is more efficient than roughly palpating them with the tip of the finger.

inner border of the foot itself. The latter band is often missed, and gives rise to delay in reducing the deformity, especially of that peculiar appearance which we have mentioned, the adduction of the great toe. A practical point is that after division of the superficial bands deeper ones come into prominence, and necessitate wider section than at first seemed necessary. Frequently the short muscles of the great toe will require attention.

Division of the plantar fascia is sufficiently simple. The parts having been antisepticised, the patient is put under nitrous oxide gas, after being placed in the lateral or semi-prone position. If the division is to be made on the right side, the right leg is extended, and the foot turned as much on the dorsum as possible; the left leg is flexed at the knee, and the left foot is thus out of the way. The assistant, by fixing the heel with one hand, and carefully making upward pressure on the ball of the great toe, renders the fascia prominent,[1] so that the bands are clearly felt. If necessary, the surgeon may define them with his finger-nail. The assistant now relaxes the tension on the bands, and a knife is passed in. The spot to select is one-third nearer the attachment to the os calcis than to the roots of the toes. Posteriorly the fascia has not split into several divisions, and it is more completely divided. Again, if section is required a second time, more elongation will be obtained by bisecting the anterior two-thirds of the space between the toes and heel, than by quartering the whole space, as must occur if the first section has been made in the middle of the fascia.

The classical method is to pass the knife—a strong-backed fascia-knife—on the flat deeply to the band. The fascia, previously lax, is then made tense by the assistant, and by careful sawing movements of the knife, the edge of which has been turned upwards, the bands are severed. It is the practice at the National Orthopædic Hospital to enter the knife between the skin and fascia, and cut towards the bones. The attachment of skin and fascia is so close that, if the latter is divided in the classical way, considerable difficulty will be experienced in completely severing all the strands without cutting through the skin. Section from the skin downwards has another advantage, in that the deeper bands and short muscles can be divided

[1] An inexperienced assistant will sometimes hold the ball of the toe so clumsily that the bands are not well defined, nor are they rendered tense at the moment of division. His thumb and fingers should firmly but lightly hold the head of the metatarsal bone of the great toe in such a way as by slight movements downwards, inwards, or outwards, to render those bands prominent which need division.

PLATE X.

FIG. 1.
Congenital talipes equino-varus before treatment. Foreshortened view (Ivy H——, aged 2 years).

FIG. 2.
Side view of the same foot as in Fig. 1 before treatment.

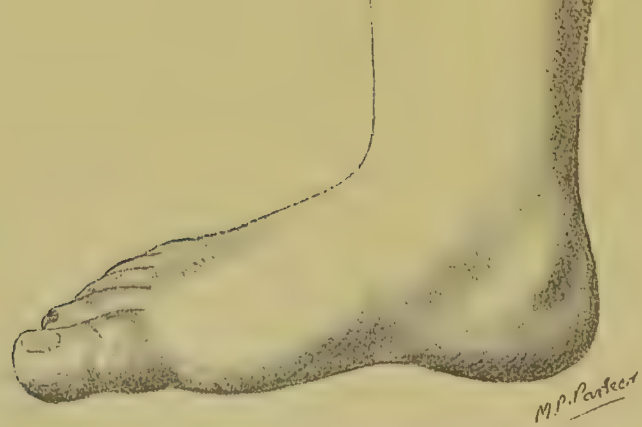


FIG. 3.
The same foot after completion of treatment.

without altering the direction of the knife's edge. If any contracted fascia is present on the inner border of the foot, it can be relieved by a section made from the same skin puncture. The small wound is then dressed with gauze and a bandage; as a rule no splint is necessary. Immediately after the operation some surgeons stretch the sole of the foot either with the hand or the wrench. But it is better to wait for two weeks until the blood effusion has disappeared, and then to stretch. It seems that less cicatricial tissue is formed, and consequently less matting of the parts ensues. At any rate the resulting cicatrix is always less painful. It is advisable to inform patients that after this operation some pain may persist at the site of operation for several weeks, and is liable to recur on walking, but this inconvenience does not last more than two or three months, and its disappearance may be hastened by careful friction to the sole. The less the foot is stretched for the first fourteen days, the less is the after-pain.

Careful dissection out of the contracted fascia in the sole, as for Dupuytren's contraction of the palmar fascia, has been suggested and practised, but in ordinary cases it is not needed, and sufficient elongation can usually be secured by subcutaneous section and the use of the wrench.

Mr. Arbuthnot Lane[1] has introduced an extension of this operation, viz. wholesale subcutaneous division of all the structures in the sole of the foot, without respect to arteries and nerves. This is practically a subcutaneous Phelps', and for the degree of deformity now under consideration is not necessary.

Tenotomy of the Tibialis Anticus.—This presents no difficulty. It is well to remember that the tendon is often displaced somewhat internally, but it can usually be felt. The patient lying supine, the tendon is accurately defined on the dorsum of the foot, and the tenotome, held flat, is passed underneath it, and from without inwards, so as to avoid the dorsalis pedis artery. The tendon is made tense by the assistant abducting the foot and rotating the sole inwards, and the edge of the knife being turned towards the tendon, a slight movement severs it. The knife is withdrawn on the flat. If the tendon cannot be readily felt, owing to the amount of fat present, a point just below the middle of the ankle-joint and slightly to the inner side localises it. Successful division is evidenced by a

[1] *Lancet*, 1893, vol. ii. 19th Aug. In addition to subcutaneous section of all the soft tissues in the sole of the foot, Mr. Lane divides all the resistant structures behind the internal malleolus.

sudden loss of resistance to the knife and a diminution of the inversion of the foot.[1]

Tenotomy of the Extensor Longus Pollicis.—This is usually done on the dorsum of the foot midway between the ankle and the first interdigital cleft, the knife being passed from without inwards. Immediately on section the great toe becomes flexed.

Tenotomy of the Tibialis Posticus is performed either above the internal annular ligament, *i.e.* above and behind the internal malleolus, or below the internal annular ligament.

As a guide to the tendon, text-books speak of a small, prominent spine, the posterior tibial tubercle, on the posterior edge of the internal malleolus, and at the junction of this process with the shaft. It is suggested that the knife should be entered immediately behind this point, and that the tendon be there divided. There are several objections. Firstly, the tendon is entering the synovial sheath in the annular ligament, and complete division is difficult; secondly, this point of bone is absent in children; thirdly, the leg is sometimes too fat for the tubercle to be felt. The best method is the following, especially in operating on infants.

If, for instance, the right foot is the affected one, the child is turned to the right lateral position, so that the outer aspect of the leg lies as flat as possible on the table. The left knee is flexed, and the left foot is thus out of the way. The operator stands on the left side of the patient (if for the left tibialis posticus, on the right side), and the assistant faces him, holding the foot extended, inverted, and adducted, so that the tibialis posticus and flexor longus digitorum are relaxed. The surgeon now marks a point with his eye, 1 to 2 inches above the tip of the internal malleolus, and exactly midway between the anterior and posterior margins of the leg. Holding the knife vertically and with the flat of the blade parallel with the long axis of the tibia, the point is passed in perpendicularly to the skin, and is carried on steadily until the inner edge of the tibia is met. This is the guide to the tendon. If the edge is not felt, the knife must be used as a probe until it is. The edge of the knife is turned backwards toward the tendon. The assistant now dorsiflexes, everts, and abducts the foot, thus rendering the tendon tight. This movement is in infants often sufficient to make the section,

[1] In many cases I turn the edge of the blade away from the skin, and sink the point until it is just in front of the tip of the internal malleolus, and then cut firmly down to bone, thus dividing all bands and fascia and the anterior fasciculus of the internal lateral ligament, as in Parker's syndesmotomy.

without any effort on the part of the operator. In older children a gentle sawing movement is made, and the tendon gives with a sudden jerk, which is felt by both assistant and operator. If the flexor longus digitorum [1] is divided at the same time a double jerk is felt in the foot. No doubt should exist as to the section of the tendons; if properly performed the foot at the time will immediately be found to be capable of more eversion. In thin legs, too, a gap may be felt between the ends of the tendon. If on withdrawal of the knife a jet of bright blood follows, with sudden blanching of the foot, the posterior tibial artery has been wounded. Oozing of dark blood indicates puncture or division of the internal saphenous vein, but neither of these events is of much importance. Those who are anxious on these points, however, or who are not practised in the operation, should use the sharp tenotome to open the tendon sheath, and then substitute the blunt knife for the tenotomy. But if one frequently performs the operation, there is little or no risk of wounding the artery with the sharp tenotome.

A pad of gauze is placed over the wound, and kept in place by two pieces of American-rubber plaster fixed crosswise, but not passing entirely round the leg. A second pad is placed over the site of the wound, and a turn or two of bandage lightly applied keeps all in place. A flexible iron splint adapted to the deformed position is then fixed along the inner side of the leg and foot.

Division of the tibialis posticus, flexor longus digitorum, and flexor longus pollicis simultaneously may be accomplished thus. The astragalo-scaphoid joint and the tibialis anticus tendon are defined. The knife is entered flat just external to the tibialis anticus tendon, and passed beneath the skin. The edge is turned towards the bone, and the foot being everted and flexed, the tendons are divided by cutting firmly towards the bone.

Division of the Peroneus Longus and Brevis can be readily effected about $1\frac{1}{2}$ inch above the external malleolus. The patient is placed on the opposite side, and the foot held somewhat everted so that the tendons are relaxed. The knife is then passed from behind forwards beneath them at a distance of $1\frac{1}{2}$ inch above the external malleolus, where they are prominent and close to the fibula. The foot is then forcibly inverted and the tendons are severed.

In the case of hyper-extended toes due to contraction of the extensors, it is often best to sever the tendons at the root of the toes.

Section of the Tendo Achillis.—This section should, in my opinion,

[1] To include the tendon the knife should be buried a little deeper in the leg.

in cases of congenital equino-varus, be done at a later period than those of the tibiales anticus and posticus, for the reasons given on p. 409.

The method is as follows: The parts are rendered aseptic, and the patient, after the administration of the anæsthetic, is turned into the prone position.

The spot selected for division is at the narrow part of the tendon, a short distance above its insertion. If the knife be entered higher up, there is risk of wounding the posterior tibial artery, greater thickness of tendons to divide, and the possibility of not including the plantaris in the section. The foot is held by the assistant so that the tendon is relaxed, and the knife is passed through the skin with the blade flat from the outer[1] side, and close beneath the tendon. The tendon is then made tense by the assistant, and by gentle sawing movements section is accomplished. At that moment a snap is perceptible, and a gap between the ends can be felt beneath the skin. The assistant should now extend the foot so as to prevent the knife coming through the skin. Section of the tendon must be complete. When I have watched novices perform this small operation, I have noticed that the division has been sometimes incomplete, arising, I believe, from two causes: (*a*) want of boldness in dipping beneath the tendon, so that it is transfixed, and only the superficial part divided; (*b*) a small band, possibly part of the plantaris tendon on the inner side, escapes section.

After the operation a pad of gauze is fixed with strapping over the puncture, and further kept in place by a bandage.[2] A flexible iron splint is put on the front of the leg and dorsum, so that the foot remains extended.

Syndesmotomy: Division of the Ligaments—Subcutaneous Section of the Astragalo-Scaphoid Capsule (R. W. Parker).—This operation is called for when there is very considerable obliquity of the neck of the astragalus, but is very rarely necessary in cases of club-foot of the degree we are now considering. It is convenient, however, to

[1] It is generally recommended that the knife be entered from the inner side. In equino-varus the posterior tibial artery is displaced towards the tendon, and the latter is frequently deviated inwards. It appears that there is a risk of puncturing the artery if the dip with the knife is made from the inner side. Should there be any doubt, both the sharp and blunt tenotomes may be employed. It is better to divide the artery than to puncture it. In the latter event, there is more likelihood of aneurism.

[2] Both strapping and bandage should be loosely applied in order that the skin may not be pressed between the tendon ends, and partially block the sheath. For perfect union the sheath must be well distended with blood.

give the steps here amongst the slighter operative measures for club-foot. The operation presents this advantage that with the ligaments the tendons of the tibialis anticus and posticus can be divided at one stroke on the inner side of the foot.

The astragalo-scaphoid capsule[1] is, according to Parker, "an unyielding capsule of great strength made up above and internally of the superior astragalo-scaphoid ligament with fibres from the anterior ligament, the anterior portion of the deltoid ligament of the ankle-joint, and below with fibres from the inferior calcaneo-scaphoid ligament. To these are united fibrous expansions of the tendons of the anterior and posterior tibial muscles." Mr. Parker's directions for division of the capsule are as follows[2]: "The tenotome, being held vertically with the edge forwards, should be entered immediately in front of the anterior border of the internal malleolus, the blade being kept as far as possible between the structures to be divided and the superjacent skin. In the next stage the blade is turned towards the surface of the ligaments, and by means of a gently sawing motion, is made to divide them. As the superficial fibres are divided, deeper ones come into play, and must in their turn also be cut until the bones are reached. By keeping the knife close to the bones and directing its point to the plantar aspect of the foot, the calcaneo-scaphoid part of the ligament can be easily divided." During section the ligaments should be made tense by forcibly abducting and everting the foot. Division of the internal lateral ligament of the ankle may be performed subcutaneously from the small wound made in dividing the tibialis anticus tendon. Care should be taken to keep close to the tip of the internal malleolus, and not to wound the posterior tibial artery.

Subcutaneous Section of the Posterior Ligament of the Ankle.—This is not a successful operation. In the first place, it is difficult to make sure that all the fibres are divided; and secondly, contraction of this ligament is rarely the sole factor in the persistence of the equinus. The two causes of intractable equinus are, downward deflection of the neck of the astragalus and tilting forwards of that bone, so that its superior articular part cannot be replaced in the mortice of the tibia and fibula.

One other operative measure, applicable to this degree of club-foot, remains to be mentioned. This is *wrenching,* which may be effected more especially in this degree by manual force, and in the severer degrees by special apparatus. If rapidity of treatment

[1] *Congenital Club-Foot,* p. 63. [2] *Op. cit.* p. 83.

in the second degree of club-foot is aimed at, there is no method so quick and so safe as that of wrenching, combined with tenotomy. When wrenching is carried out with the hands, the movements are the same as those practised in manipulation (p. 401), but they are made under anæsthetics and with more force, plaster of Paris being

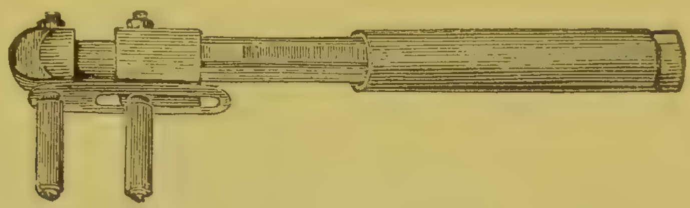


Fig. 219.—The Thomas wrench (Robert Jones).

afterwards applied. After a fortnight the plaster of Paris should be removed, and the foot again forcibly manipulated, the opportunity being taken to massage the foot and leg thoroughly.

Fig. 220.—Reduction of the varus part of the deformity by the Thomas wrench (Robert Jones).

Wrenches and their Use.—Some wrenches are formidable and powerful instruments. Others are simple and handy. The best form for the treatment of club-foot is the Thomas wrench (Fig. 219). Other useful forms are Vincent's modification of Robin-Mollière's tarsoclast, which I have seen in use at the Hôpital de la Charité at Lyons, and Bradford's lever. Phelps' apparatus and Grattan's osteoclast are complicated.[1]

My friend Mr. Robert Jones of Liverpool, who has had great

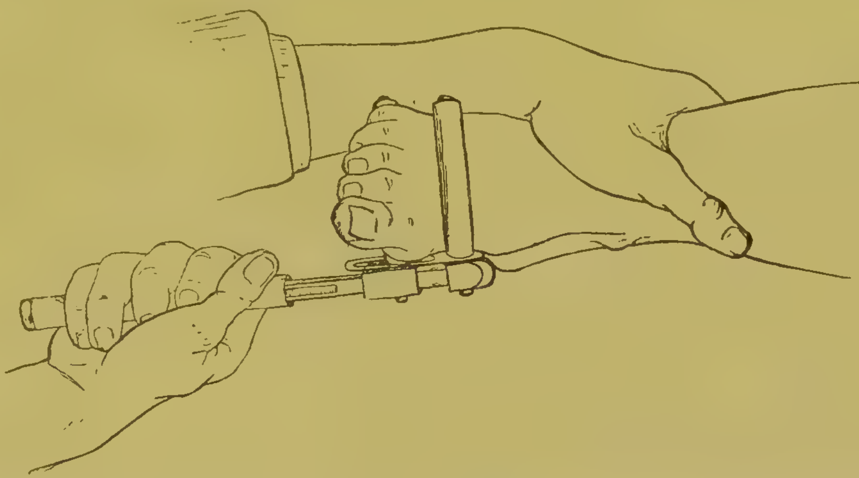


FIG. 221.—Reduction of the equinus portion of the deformity by the Thomas wrench (Robert Jones).

experience in the use of the Thomas wrench, has, at my request, most kindly described his mode of using it, and allowed me to insert the accompanying figures. After preliminary tenotomy and syndesmotomy, Mr. Robert Jones writes: "In the inversion-deformity of varus the pins of the wrench should grasp the foot on the inner side, and should be sufficiently tightened to prevent all danger of slipping. The upper pin should be against the astragalus (Fig. 220) and the foot forcibly rotated outwards, counter pressure being supplied by the operator's hand, which is placed against the lower end of the fibula. For the equinus deformity the position of the wrench is the same, but the handle should be

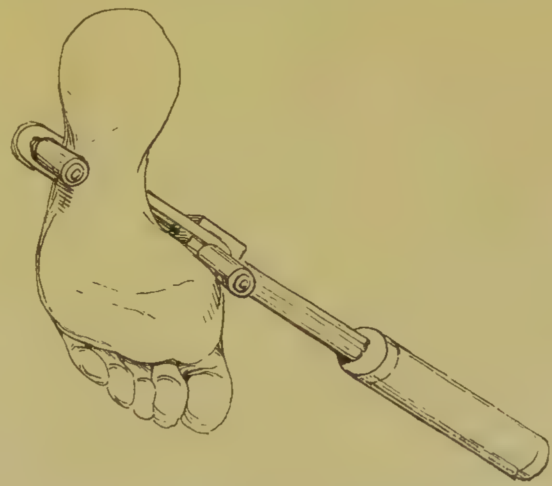


FIG. 222.—Overcoming the adduction deformity at the medio-tarsal joint by the Thomas wrench (Robert Jones).

[1] Full descriptions, with figures of the various forms of tarsoclasts, are to be found in the *Traité de Chirurgie Orthopédique* (Rédard), and in the *Deformities of the Human Foot* (Walsham and Hughes).

made to work in the flexion axis of the ankle-joint (Fig. 221). To correct the adduction deformity at the mid-tarsal joint, the upper pin should be placed against the cuboid, and the lower behind the first metatarso-phalangeal joint (Fig. 222); the structures on the inner side should then be stretched. The twisting and bending is done quickly and forcibly, and the foot immediately released. Holding the foot in the bite of the wrench too long may result in a pressure sore.[1] The key-note of treatment consists in the extent to which the stretching is carried. It should be to such a degree that the foot is temporarily paralysed, and lies limp in the hand. A retentive splint is then applied. After two or more days, depending upon the degree of the deformity and the severity of the wrenching, the resiliency of the foot begins to return, and the wrenching is repeated. To anticipate the inward rotation of the tibia and fibula, one hand grasps the leg below the knee and fixes it, while the other grasps above the ankle and attempts by a twisting movement to overcome the rotation of the tibia. This manœuvre should be practised frequently. The foot must be over-corrected."

Dangers of Wrenching.—These remarks apply not to the Thomas, but to the more formidable varieties of wrench.

1. *Tearing of the Skin.*—When the concavity on the inner side is considerable, and the foot is resistant, the skin, being much shortened and bound firmly to the plantar fascia, may give way in an oblique direction from near the tip of the internal malleolus to the middle of the sole more or less. This event should be anticipated by rendering the foot aseptic before the operation, and met by suitable dressings when it occurs. It is, according to many ardent advocates of the wrench, of no great importance—in fact it is only an involuntary Phelps' operation. Sloughing of the skin from pressure must be guarded against (see note 1 below).

2. *Gangrene.*—This arises not from the wrenching, but from the plaster bandages, which may be put on tightly, allowance not being made for the subsequent swelling of the foot.[2]

3. *Separation of the Epiphysis* is a lamentable accident, and may seriously impair the efficiency of the limb. Every care should be taken to avoid it.

4. *Fracture of the Bones of the Leg.*—This event is not so serious.

[1] This can be obviated by placing a strip of rubber or a thickness of wet cloth between the pins and the foot.

[2] Vincent (of Lyons) states that "he has had to deplore one case of gangrene from this cause" (Private Pamphlet).

In some cases, if excessive inward rotation of the leg is present, a fracture is sometimes made of set purpose to overcome the inversion.

In the less degrees of club-foot so vigorous a treatment cannot be necessary, but in severer cases, and those which have relapsed, wrenching is of great value.

The Treatment of the Limb and Foot after Operation.—The methods in use are—

A. Immediate Rectification of the Deformity.—The foot is over-corrected by tenotomy, followed by manipulation and wrenching, and is at once put up in plaster of Paris, with a good padding of cotton wool or thick flannel bandage beneath. The bandage is best applied from without inwards, and must be carried from the roots of the toes well up the leg. Care should be taken not to indent the plaster with the finger while it is hardening. This may be obviated by using a T-shaped piece of wood after Hahn's pattern (Fig. 223). The advantage of this method of immediate rectification consists in economy of time. The *disadvantages* are—

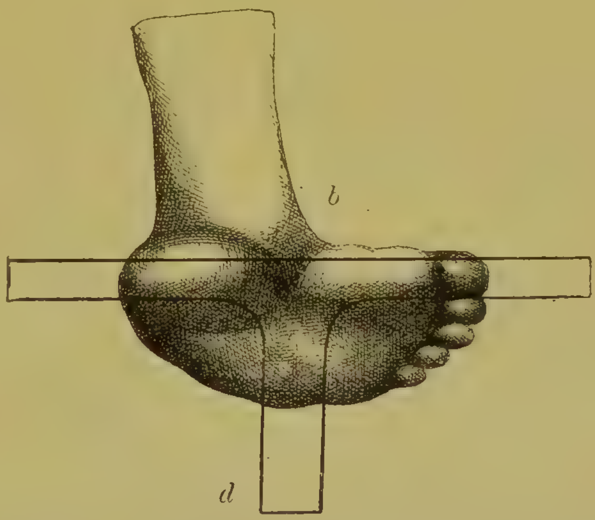


Fig. 223.—T-shaped piece of wood as used by Hahn to secure good position of foot after plaster of Paris has been applied.

1. While suitable for slight cases, in severer cases it involves risk of bruising of the parts, on account of the force required at the time of operation.

2. Extreme care and watchfulness after the operation must be observed, in order that the pressure of the plaster or other fixation apparatus may not cause sloughing, and this care necessitates retention of the patient in a hospital for one or two weeks.

3. Interference with the circulation has occurred, and gangrene followed.

4. Pain is often extreme, partly from the violence to which the foot is subjected, and partly from the pressure of the retentive apparatus. So that the foot must be "taken down," some of the

deformity allowed to return to relieve the pressure, and the hope of immediate rectification foregone. As a compromise the next method is much in vogue.

5. Relapse occurs from time to time.

B. Rapid Rectification of the Foot.—After the operation the foot is placed nearly in its corrected position, and plaster applied. This is renewed at intervals of three days, and the foot is corrected a little more each time until it is in good position. The wrench may be used once or twice afterwards, but to a less degree than at the first sitting. Before each re-application of the plaster the foot and leg should be well rubbed.

C. Gradual Rectification of the Foot.—In the opinion of many the ideal result, except in two points, viz. the length of treatment and the expense involved, is gained by the slower methods, especially in severe cases. There is less tendency to relapse, the foot is more elastic, no pain results, and there is an absence of the risks involved in imperfect supervision. In the case of the poorer patients especially, when the parents see the foot put straight in a short time by the rapid methods, they are apt to imagine that no further care is needed, and the case is promptly allowed to relapse. In illustration, I quote the following letter I received from a friend who consulted me about a case: "I tenotomised as you advised, and did a good deal of good temporarily; however, the plaster of Paris was not kept on, and when the child began to walk it got much worse again, and is now as bad as ever. The child is over 2 years of age, and walks on the external malleolus. What further to do I don't quite know, and write to ask whether you cannot take the boy in somewhere and help him. His parents are very helpless, and if it can go wrong after his return, it will." Desirable as rapidity of treatment is, and ideal as it may be to the surgeon, yet if ultimate success is thus to be discounted by relapses, it seems that after all the slower may be the surer way. In place of plaster, silicate of potash, gum and chalk, or dextrin and starch may be used, but are not so easy to apply.

The restoration of a deformed foot is not merely a question of dividing easily accessible tendons and fasciæ. It is more. The bones must be brought into position, and moulded till they assume a normal shape, and the ligaments on the concave side stretched, and on the convex side allowed time to shorten. Thus the whole foot is gradually brought into good position. Short of wide-cutting operations, which are unjustifiable in this degree, there is no method so certain and sure, but tedious withal, as that which I mention, viz. the *unfolding* of the foot at first in its anterior part, using the posterior as a fulcrum, and then reducing the deformity in the latter. Doubtless much time may be saved by wrenching, and during the first stage of treatment it should be employed; but the foot needs time to adapt itself to the new position induced by tenotomy and the wrench, and for this purpose mechanical aids, especially some form of Scarpa's shoe, seem to me to be the best.

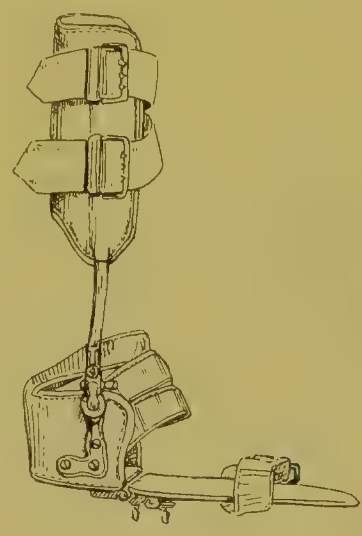


FIG. 224.—Mr. Adams' shoe with divided sole-plate for the after-treatment of talipes equino-varus.

The Gradual Method.—The plantar fascia, the tibialis anticus and posticus are divided, and the extended foot is placed in a malleable iron splint, which is bandaged on the outer side from the toes upwards. The splint is so adjusted to the outer side that the position of the foot remains in a less deformed position than before the operation. After three to four days the foot is slowly "brought out" in infants by means of the varus splint (p. 403), and in children over one year by Adams' modification of Scarpa's shoe.

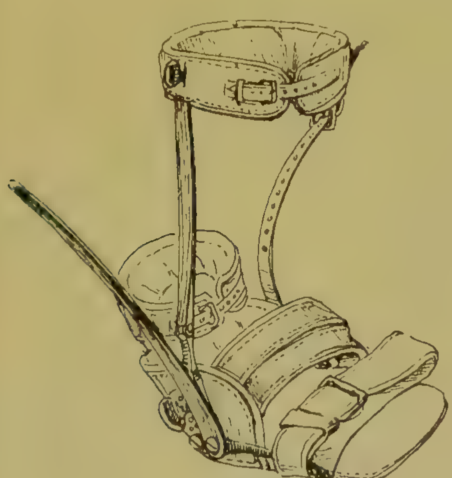


FIG. 225.—Little's double-hinge lever shoe for varus.

Adams' Modification of Scarpa's Shoe.—"The modern Scarpa's shoe, or, more strictly speaking, Adams' extension shoe (Fig. 224), is designed to meet the anatomical requirements by placing the mechanism for extension opposite to the joints where it is obtained, viz. the ankle and transverse tarsal joints. The shoe consists of a heel-piece and sole-plate, and a trough or calf portion. The heel-piece is connected to the calf-piece by a double-action rack movement, having lateral, flexion, and extension movements. This is invariably placed on the *inner* side of the shoe, for the reason that, as the outer border of the foot requires raising, the mechanical centre of movement for this should have as long a radius as possible. The heel-piece and sole-plate are connected by three rack-and-pinion movements, having lateral movement, uplifting, and rotation; these corresponding to the threefold deformity. By means of these movements the appliance can be adjusted to the severest condition, and gradually unfolded as the treatment progresses."

Dr. Little's varus shoe is nearly as efficient and not so expensive (Fig. 225).[1]

Manipulation of the foot must be most assiduously carried out once and, if possible, twice daily. It should not be done in a perfunctory manner, nor left to the care of an untrained nurse, but the surgeon must see that it is thoroughly done. No factor in this stage of treatment is more important. The movements in manipulation are described on p. 401.

Elastic Traction.—In place of and after tenotomy, efforts have been made to overcome the deformity by means of elastic traction, and it is claimed by some surgeons that cases of this degree can be thus completely reduced. The method consists in applying adhesive strapping and bandages to the leg and foot, and fixing hooks in the strapping at the upper and outer part of the leg and at the outer side of the heel and front part of the foot. The hooks are then joined by elastic tubing or accumulators such as are used for closing doors. The idea is that the india-rubber takes the place of the weaker muscles, and so acts in a physiological manner. Plausible as this is in theory, in practice it does not act well. It is difficult, in the first place, to make the plaster and bandages sufficiently firm without causing some impediment to the circulation; in the second place, much irritation of the skin is caused by the strapping; and thirdly, the force not acting through the centres of movement, cannot effectually control the deformity.

When the inversion is fully corrected the tendo Achillis is divided, and the heel is gradually brought down in the Scarpa's shoe.

Duration of Active Treatment by the Gradual Method.—The deformity in the front part of the foot can be reduced by tenotomy and the Adams' shoe in about six weeks; in less time if wrenching be employed. The reduction of the equinus takes from four to six weeks more, but occasionally this proves to be obstinate. Flexion of the foot can be effected by means of passive exercises,

[1] Details of the instruments employed in England will be found in Walsham's work, already referred to in America and on the continent in Bradford and Lovett's work.

or by using a foot-exercising apparatus. It is of especial value in rigid and relapsed cases, where adhesions frequently exist in and around the ankle-joint. While speaking of this matter of obtaining due flexion of the foot, it is well to add that when the foot can be dorsi-flexed to a little over the right angle with the knee fully extended, it is sufficiently corrected. There is no greater error in the treatment of equinus and equino-varus than excessive elongation of the tendo Achillis. As stated on a previous page (344), calcaneus of a peculiarly troublesome variety follows.

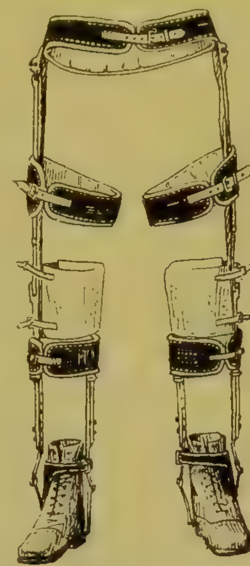


FIG. 226.—Walking apparatus for the after-treatment of congenital talipes equino-varus.

When sufficient flexion has been obtained, a walking instrument should be worn during the day, and a rectangular tin-shoe at night.

After-Treatment of Congenital Equino-Varus.—It may be certainly said that unless efforts are made to neutralise by manipulations the vicious tendencies of the affected muscles, and means be taken to control the foot during the period of active growth, relapse is certain to follow cases of any severity. For one to three years after active treatment has ceased, some form of walking apparatus is required. Slight cases and those before the child has walked are controlled by a light boot and spring (Fig. 227). "The chief merit of this instrument is a convex long spring, which is attached to the sole of the boot, and extended to the calf. The boot is first laced on and the spring then brought into position. By the convexity and position of the spring the foot is forced to assume the position of valgus, but if this be too marked, the power of the spring can be easily reduced by a controlling strap. The foot has perfect mobility, there being a free movement at the ankle." Little's concealed varus spring (Fig. 227) answers the same purpose. When the child is over 2 years of age, and begins to walk, it is desirable, taking into account the increased weight in the feet, that some firmer support should be provided. A good walking apparatus is that shown in Fig. 226, in which a noticeable

FIG. 227.—Little's concealed spring for abducting or adducting the foot in varus or valgus.

feature is the varus T-strap which is fixed to the outer part of the sole, and being buckled round the upright on the inner side, maintains the foot in a slightly inverted position. The sole-piece of the instrument must be so fixed as to evert the foot; a "stop" at the ankle is sometimes desirable to check excessive dorsi-flexion. For children of 4 years of age and older, it is advisable to have a second upright, on the outer side, so that the foot may be held under complete control.

If after one to two years the foot, being uncovered and the child standing firmly on it, remains quite straight or slightly everted, then a boot with a concealed varus spring will suffice. As to when instruments may be entirely dispensed with, it is difficult to fix a precise date. The best criterion is the steady maintenance of the foot to the front in all positions, whether standing, sitting, or lying. Then instruments may be gradually dispensed with from the thigh or knee downwards. During the after-treatment a rectangular night-shoe should be worn, and constant manipulation of the limb be carried out in all cases.

FIG. 228.—Talipes equino-varus with excessive inward rotation in the bones of the leg.

Treatment of the Complications, especially Inversion, of the whole Limb and Genu Recurvatum.—Inversion may exist (*a*) in the shaft of the tibia, *i.e.* it is unduly twisted inwards on a longitudinal axis, or, as some authors maintain, it is not sufficiently twisted outwards in development, and in that respect resembles the anthropoid apes, in which the external malleolus is normally in front of the internal; (*b*) at the knee-joint, a very frequent condition, and frequently associated with lax ligaments and genu recurvatum; (*c*) in the axis of the femur; (*d*) at the neck of the femur in such a way that the anterior margin of the great trochanter looks somewhat forwards and inwards. The existence of inversion of the leg may be ascertained by taking two points, the inner side of the great toe and the inner edge of the patella. In the normal limb these two points should be in one plane which is parallel to the median vertical plane passing through the body from front to back. Now, when the foot is put at right angles to the leg, and the great toe placed directly pointing forwards, if the inner edge of the patella is outside the vertical plane passing through the great toe, and the anterior surface of the patella looks outwards: or if, when the patella is brought to the front, the foot, though perfect in itself, remains twisted inwards, then inversion is present.

To decide as to the cause of the inversion, the following manœuvres should be employed:—As the faulty position is mostly due to relaxation of the ligaments of the knee, it is well to eliminate this cause in the first place. Therefore extend the thigh and leg, grasp the former with the left hand, the patella pointing directly forwards, and the leg with the right just below the knee-joint, and attempt to rotate the leg outwards. If the ligaments are lax at the knee, the inversion can be readily overcome. If, however, the inverted foot cannot be brought to the front by this manœuvre, then the cause is generally rotation inwards of the tibia and fibula. Inversion may, however, be due to excessive inward twisting of the femur on its longitudinal axis. In this event, the outer surface of the great trochanter will have its normal direction, but the limb below will be inverted; and the two points, the inner edge of the patella and the inner margin of the great toe, though lying in the same plane, will be inside their normal position. Should the inversion exist in the neck of the femur, the outer surface of the trochanter will look forwards, and the foot and knee may be brought to the front by rotating at the hip-joint.

While it is easy to distinguish between inversion of the tibia and fibula, and inversion at the knee-joint, yet rotation in the axis of the shaft of the femur and its neck are frequently combined in varying degrees. Fortunately, however, the treatment of the two last-mentioned causes is the same (see below).

Having thus ascertained the cause of inversion, it remains to overcome it.

1. If it be in the bones of the leg, and the child is young, it is often sufficient, as Mr. Robert Jones recommends, to grasp the leg below the knee with one hand, and above the ankle with the other, and give the leg a few firm twists outwards. In older children this procedure will not suffice, and it occurred to me that linear osteotomy of the tibia and fibula would overcome the difficulty. This idea I was able to put into practice in a case in which manipulation, free division of tendons, fascia, and the internal lateral ligament of

the ankle had failed. The foot itself was perfect in shape, but it still remained inverted in its relation to the leg.[1]

CASE 87. *Congenital Equino-Varus with marked Inversion of the Bones of the Leg—Inversion Relieved by Osteotomy.*—Agnes H——, aged 2 years, came under my care in November 1894, suffering from marked congenital equino-varus of the left foot. The varus was first reduced, and then

FIG. 229.—From a case of congenital talipes equino-varus in which the deformity in the foot had been rectified, but inversion persisted on account of the excessive inward rotation in the bones of the leg (Case 87).

FIG. 230.—The inversion of the foot remedied by osteotomy of the tibia and fibula.

The + indicates the middle point of the patella in both figures.

the equinus. Although the foot was then perfectly straight, with the heel well on the ground, yet the inner border of the foot remained at right angles with the front surface of the patella (Fig. 229). When the

[1] This case I brought to the notice of the British Orthopædic Association at Liverpool in May 1895. Almost simultaneously an article by Mr. Swan of Dublin appeared in the *British Medical Journal*, 15th June 1895. It is entitled "A Method of Treating Inversion of the Limb subsequent to the Cure of Talipes Equino-Varus." Linear osteotomy of the tibia and fibula is recommended.

PLATE XI.

Fig. 1.

Condition of the foot in Case 88 before operation.

Fig. 2.

Completion of the first stage of treatment in Case 88, viz. reduction of the varus deformity, leaving the foot in the position of equinus.

Fig. 3.

Complete restoration of the foot in Case 88.

foot was brought to the front, the anterior surface of the patella looked externally. There was no laxity of the ligaments of the knee-joint. I therefore decided to perform an osteotomy in the lower third of the tibia and fibula to remove the excessive internal rotation in these bones. This was done, and the foot came well to the front, with its inner margin and that of the patella in one right line when the child walked (Fig. 230).

In place of osteotomy, osteoclasis is preferred by some, notably Dr. Grattan of Cork.[1]

2. *Inversion due to Relaxation of the Ligaments of the Knee-Joint.*—The best means of overcoming this is the use of instruments continued up to the thigh or pelvis according to the degree of laxity of the ligaments. If but slight laxity exist, then the thigh-piece is sufficient, but it is not possible to indicate in definite figures when it is necessary for the instrument to be carried up to the pelvis. The knee-cap is very useful in preventing the free antero-posterior movement in that joint which, in addition to undue lateral movement, is so often seen in these cases. The arrangement when the instrument is carried to the pelvis is seen in Fig. 226.

3 and 4. *Inversion arising from Twisting in the Axis of the Shaft of the Femur, and at the Neck of the Femur.*—To control this the instrument to the pelvis must be used (Fig. 226). An ingenious instrument is Dr. Doyle's spring rotator, but it has very little control over the limb. Among other apparatus designed for this purpose are Bonnet's, Mathieu's, and Sayre's.

The treatment of genu recurvatum is tedious but not difficult. I am accustomed to maintain the knee slightly flexed by locking the free-joint in the instrument at the knee in such a way that an obtuse angle is formed, and the knee is kept permanently flexed at about 30°. After a few weeks of fixation of the knee, much of the tendency to recurvation disappears. A Thomas knee splint, slightly bent, or a plaster of Paris bandage applied to the flexed leg, or a bent malleable iron splint placed behind the knee, will answer the same purpose. When the patient walks, it is advisable either to have the free-joint at the knee locked, or the instrument supplied with a "ring-catch," an ingenious piece of mechanism which maintains the knee rigid in walking; while by shifting it upwards the joint is released, and the knee can be flexed, a great convenience

[1] *Vide* the discussion following on E. G. Brackett's paper, "On the Treatment of Infantile Club-Foot," *Trans. Amer. Orth. Assoc.* vol. v. p. 232. Also Grattan, "The Treatment of the more severe Forms of Club-Foot by Osteoclasis," *B.M.J.* 2nd May 1891, p. 96, etc.

in the sitting posture. To overcome the genu recurvatum will take one to two years by these means. Nevertheless, I have only seen one case in which excision of the knee could be said in any way to have been justifiable. In any case the great point in the treatment of this complication is the prevention of over-extension of the knee for a considerable time.

CASE 88. *Congenital Talipes Equino-Varus of the Second Degree—Restoration of the Shape of the Foot.*—Herbert C——, aged 6 weeks, was brought to me in 1895. The foot was inverted, adducted, and the heel raised. The deformity could not be entirely reduced by the hand, and attempts to do so caused considerable pain. The appearance of the foot is seen in Plate XI. Fig. 1. The structures which appeared to be at fault were the tibialis anticus and posticus, and the tendo Achillis. There was no history of club-foot in the family, and the birth was a normal one. The bones of the leg were of normal shape.

The treatment consisted in the first place of division of the tendons of the tibialis anticus and posticus, and the foot was put into a malleable iron splint bent to an obtuse angle, and applied to the outer aspect of the leg and foot. The angle of the splint was gradually reduced, the mother being enjoined to remove it twice daily, and manipulate the foot outwards. In four weeks the varus had disappeared, leaving the foot in a state of pure equinus (Plate XI. Fig. 2). To overcome this, the tendo Achillis was divided, and the foot placed in a rectangular tin-shoe. The deformity was thus completely reduced (Plate XI. Fig. 3). But as the child was not old enough to walk, the wearing of the tin-shoe at night was continued, and the daily manipulation carefully attended to.

CHAPTER VII

THE TREATMENT OF CONGENITAL EQUINO-VARUS

(Continued)

The Treatment of Resistant Equino-Varus by Gradual Methods, Forcible Measures, Wrenching, Phelps' Operation—Buchanan's Operation and Arbuthnot Lane's Modification—The Treatment of Inveterate Club-Foot by Forcible Rectification, Tarsotomy, and Tarsectomy—The Forms of Tarsectomy—Astragalectomy—Discussion on the Merits of Tarsectomy—The Treatment of Paralytic and Spastic Equino-Varus—Relapsed Equino-Varus, its Causes and Treatment.

The Treatment of the Third Degree, Rigid or Resistant Club-Foot.—In this variety the deformity is of the same character as in the second degree, but is more exaggerated. The adduction of the foot is more marked, the inversion of the sole is considerable, the inner border is more concave, the outer is more convex and bears traces of pressure in the skin, the heel is more raised, the internal malleolus is buried, and the external is unduly prominent. But the chief characteristic of these cases is that on manipulation in various directions the foot is very resistant. The deformity can be diminished to only a slight extent, and any attempt causes pain. The impression given to the hand of the surgeon is as if the structures of the foot were partially glued together. The same parts are involved as in the second degree, but the changes in the articulations and bones described on p. 384 are well marked and evident from external examination. Thus the tip of the internal malleolus closely approximates to the scaphoid, and the cuboid is very prominent. On trying to replace the foot, the inner and middle bands of plantar fascia are tense, the tibial tendons and that of the extensor proprius pollicis stand out, and the tendo Achillis is tight. Cases of this degree are seen from the ages of 4 to 12 years, *i.e.* after the child has walked for a considerable time.

The best form of treatment for these rigid feet is, in my opinion, a gradual one. There is no course that answers so well as the following:—Take the patient off his feet for two to three weeks and give him complete rest. By so doing time is allowed for the painful reflex spasm of the muscles to pass away, and the foot soon becomes less rigid. The disappearance of the latter condition is much assisted by soaking the feet for fifteen to thirty minutes in warm water at night. If any sores or tender places are present, they should be allowed to heal before the soaking is commenced. The degree of suppleness which returns to the foot is surprising.

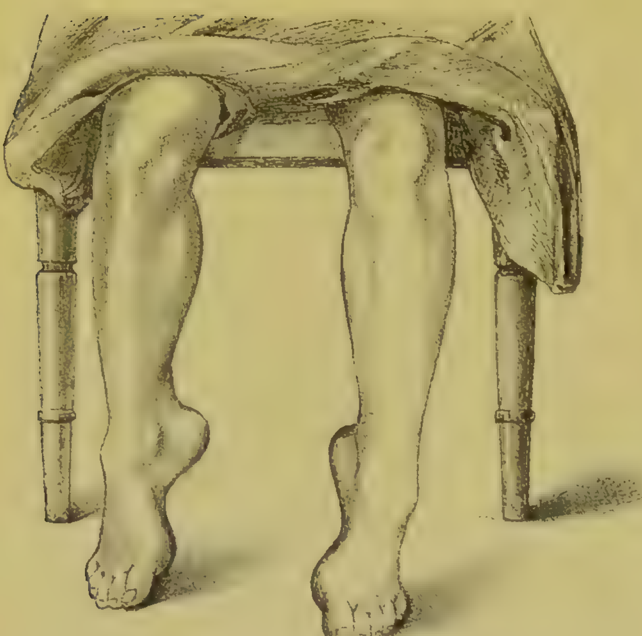


FIG. 231.—Congenital talipes equino-varus of the third degree, before treatment.

FIG. 232.—The same case after treatment.

Tenotomy of the plantar fascia and the tibial tendons is now performed, and the foot is put up for four days in a malleable iron splint. Then treatment by Scarpa's shoe is begun.

Now the essence of ultimate success by this method is to proceed gently, and on this point the writings of my colleague, Mr. Fisher, may be quoted with advantage. Speaking of the use of Scarpa's shoe in these cases, he says[1]: "It is a powerful instrument, but no attempt must be made to drag the foot into shape with the full

[1] *Lancet*, 27th May 1893, p. 1248, "The Causes of Failure in the Treatment of severe Club-Foot."

power it can give; if this is done, a source of failure will again confront us. The skin will certainly become abraded, and pressure-sores will result, which will prohibit the further use of the instrument; the mechanical treatment will thus be interrupted, and, in the meantime, the divided structures will re-unite before sufficient length of material has been obtained. The utmost gentleness must be employed, the foot being, as it were, coaxed, and not forced, into position; proceeding on these lines, it is extraordinary how rapidly a very severe distortion may be reduced. Rough handling and rude

FIG. 233.—Case 89 before treatment.

FIG. 234.—Case 89 after treatment, by tenotomy, mechanical rectification, and manipulation.

attempts to break through the resistance that the distortion may offer will cause irritation about the seat of operation, with exudation of inflammatory products, and that condition of adhesion to the surrounding structures which accompanies . . . too rapid stretching immediately after tenotomy." When the varus has been fully reduced, the tendo Achillis should be divided and the heel brought down. Some resistance at the ankle may be met with, but this can be overcome by manipulation and the use of the foot-exercising apparatus. Illustrations and notes of a case which has been treated on these lines are here presented.

CASE 89. *Double Congenital Equino-Varus of a Marked Character, the Feet being Rigid and Resistant.*—Elizabeth M——, aged 10 years, a nervous, delicate girl, the subject of this deformity (Fig. 233), was brought to me in 1894. The manner of birth was natural, and no other cases of similar deformity had occurred in the family. On examination, both feet were equally affected, the child being obliged to get about on crutches, and propelling herself partly by these, and partly by bearing the body-weight on the outer borders of the feet. The feet were adducted, inverted, and rotated, so that the outer borders could alone come into contact with the ground. The heels were much raised. The striking point about the case was the extreme rigidity of the parts. No temporary replacement by manual force was possible. The plantar fasciæ and the tibial tendons in both feet were divided, and the varus gradually overcome by the use of Mr. Adams' varus shoe. Subsequently the tendines Achillis were divided. As there was considerable rotation at the knee-joints, she left wearing a walking-instrument to the thighs, but was able to put both feet squarely on the ground, and to walk with comfort (Fig. 234). The length of treatment was six months.

Happily successful as treatment on these lines is, the length of time occupied, often twelve months, has induced surgeons to devise other means of overcoming the difficulties in restoring the foot.

The means adopted are radical in their nature, and require operative interference. They are—

1. Forcible Rectification or Wrenching.
2. Phelps' Operation.
3. Free Subcutaneous Division of all Resistant Structures.
4. Tarsal Osteotomy.
5. Tarsectomy.

Forcible Rectification or Wrenching.—This is a most valuable resource in rigid and inveterate club-foot. When the deformity has reached this stage all the tissues of the foot are implicated, and many of the structures are out of easy reach of the knife, so that forcible rectification, which affects all the tissues, is the one method which is eminently successful, and is therefore coming more into general use.

In "A Report on the Treatment of Club-Foot by Means of the Thomas Wrench," by V. P. Gibney,[1] the author describes his procedure, and gives the result of twenty cases treated by this method. He says: "The object of wrenching is, in the first place, to convert an equino-varus into an equino-valgus by the wrench, and then to reduce the equinus by tenotomy and manual force, and leave the foot in position in plaster long enough for the bones on the outer side to become atrophied, and to hope for some hypertrophy of the

[1] *Annals of Surgery*, vol. ix. p. 101; and *Trans. Amer. Orth. Assoc.* vol. i. p. 74.

inner side when pressure is removed." Dr. Gibney succeeded in the majority of his cases in getting the feet into excellent position, but the date of publication of the paper was so soon after the operations that its author regrets that he is unable to report final results. In the discussion which followed, Dr. Bradford of Boston thought that the instrument was not powerful enough for the severest cases, particularly in correcting the equinus deformity. The question of sloughing subsequently to the operation was raised, and Dr. Ridlon stated that there had been none in his cases, the thick rubber tubing on the arms of the wrench protecting the soft tissues completely. He thought that the skin would bear a great deal of pressure if it were but momentary, and therefore it was of importance that apparatus of the kind and osteoclasts should be so constructed that the grip could be instantly released when the work was done. Rédard of Paris has used several thicknesses of wet cloth as padding to obviate sloughing.

Professor König of Gottingen,[1] in speaking of forcible reduction, states that he has treated during the past five or six years all cases of club-foot by this method. He has, on account of his bad experience, abandoned the bloody operations, which have for their object the removal of a part of the bony skeleton. In only very exceptional instances have heavy instruments for reduction, which grasp the foot, been used. These have been abandoned in favour of the hand of the operator with the aid of a point of support. He does not accomplish everything at one sitting, but three or four are necessary. The most favourable cases for his mode of treatment are in patients from 5 to 20 years of age. The procedure consists of two acts; firstly, the adduction is overcome, and secondly, the foot is brought into dorsal flexion and abduction. In the intervals of forcible rectification a plaster bandage is applied.

Bradford and Lovett figure an instrument termed a club-foot stretcher,[2] the object of which is to exert pressure under control of the operator in three directions, and to enable him to twist and raise the front of the foot. Tenotomy and manual correction are first employed, and if not sufficient the instrument is then used, and the foot wrenched into an over-corrected position. An anæsthetic is, of course, required, and correction will be done gradually rather

[1] *Beilage z. Centrbl. f. Chir.* 25th November 1890.

[2] *Op. cit.* Figs. 470 and 471. Dr. Morton, the inventor of the club-foot stretcher figured by Bradford and Lovett, has now discarded its use. In severe cases he prefers astragalectomy.

than by any sudden tear. The extent to which the force can be applied is with difficulty defined; it may be said, however, that experience shows that a much greater pressure can be used than would at first be thought feasible—in a majority of cases enough force can be used to convert the foot from the position of varus to valgus, and to correct the equinus position. Bradford and Lovett further state that the risk of sloughing is not so great as would be thought. Afterwards a plaster of Paris bandage is applied by them. The authors give as their opinion that forcible rectification is able to correct and cure the severest forms of club-foot. Morton's club-

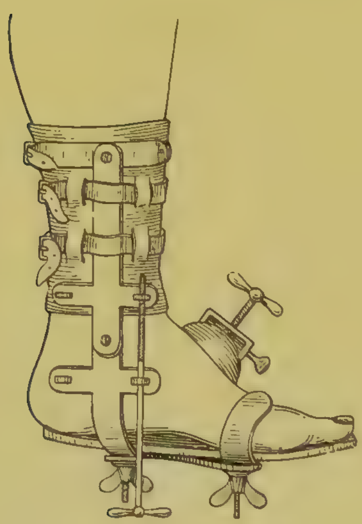


Fig. 235.

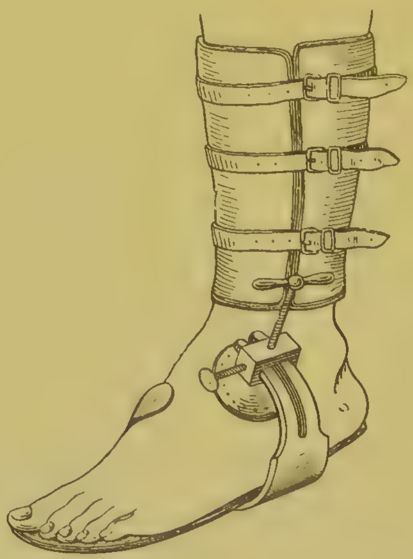


Fig. 236.

Two views of a club-foot stretcher.

foot stretcher (Figs. 235 and 236) has the disadvantage that traction is applied through straps, and these are yielding, so that the exact amount of force cannot be accurately estimated. Dr. Morton's "Remarks on Instruments for the Forcible Correction of Club-Foot"[1] are worthy of attention.

To return to the Thomas wrench. The most prominent advocate of its use in England is, perhaps, Mr. Robert Jones, of Liverpool, who has kindly furnished me with the account on p. 417 of the manner of its employment. In my opinion it is a very valuable instrument, and I have used it with success at the Westminster Hospital. Opinions still differ widely as to the best method of treat-

[1] *Trans. Amer. Orth. Assoc.* vol. i. p. 31.

ing resistant club-foot, but it would appear that the time is not far distant when the severer varieties of the deformity will be submitted to forcible rectification in all cases.

Phelps' Operation, or Treatment by Open Incision.—This operation was brought to the notice of surgeons in 1881, and has therefore had a fair trial. The details are as follows:—

An Esmarch's bandage is first put on, and the foot having been previously rendered aseptic is placed on its outer side. An incision is then made from the mid-point of a line drawn from the top of the internal malleolus to the tuberosity of the scaphoid. The incision extends downwards and outwards into the sole until the inner two-thirds have been cut across. The superficial and deep fascia and the abductor hallucis are divided. The internal plantar nerve and artery are spared if possible. The tendons of the tibialis anticus and posticus are then cut through, together with the internal lateral ligament and the calcaneo-scaphoid ligament (Parker's astragalo-scaphoid capsule). The head of the astragalus is thus exposed, and the foot is forcibly redressed. In Phelps' original operation the tendo Achillis was divided subcutaneously at the same time. Many operators prefer, however, to leave that to a subsequent sitting. The result of the open incision is a deep wound, which must heal by granulation. In the meantime the foot is kept in its new position by plaster of Paris, or it may be fixed in a Scarpa's shoe until the wound is healed. It is stated that one dressing is sufficient, and no further application is necessary. This has not, however, been my experience. One difficulty which arises after the operation is a tendency for the edges of the skin to become inverted, and to form the shelving sides of a deep depression. This I have obviated by dissecting up the skin for $\frac{1}{2}$ to 1 inch on either side of the incision from the deeper structures. To overcome the inconvenience arising from the cicatrisation of a wide and deep granulating surface, Mr. Arbuthnot Lane[1] applies a large skin-graft over the wound on the second day. The graft should be of such a size as to allow for its subsequent shrinkage. T. H. Kellock[2] transplants a flap of the whole thickness of the skin in the following manner:—The usual operation having been carried out, "A flap of the whole thickness of the skin about an inch wide is then cut on the outer side of the foot by two parallel incisions reaching from the upper end of the operation wound to the sole, and dissected off the underlying structures, the skin being brought together under-

[1] *Lancet*, 19th Aug. 1893. [2] *Ibid.* 30th March 1895.

neath it by sutures. Five or six days later, the flap appearing to be well nourished, the lower end is divided and, leaving the upper end still attached, is turned across and secured by one or two horse-hair stitches into the deep wound on the inner side of the foot, which is by this time mostly covered with granulation tissue, and the foot and leg fixed in plaster of Paris." I believe I am right in saying that a similar idea occurred independently to my colleague, Mr. Muirhead Little, and was carried out by him with success.

My friend, Dr. William Gardner[1] of Melbourne, has modified Phelps' operation with promising results. "A wedge-shaped plate of decalcified bone is inserted into the gap between the astragalus and scaphoid, to which bones it is wired, and by this the lengthening of the inner side is maintained until the plate is replaced by fibrous tissue. There is thus a minimum of interference with the tarsal articulations, and the arch of the foot is not destroyed." Dr. Gardner mentions a suggestion of Dr. Cherry, which is that the scaphoid should be divided vertically, and a plate of decalcified bone inserted between the parts, thus preserving the astragalo-scaphoid joint, although adding a false joint to the foot.

FIG. 237.—Congenital talipes equino-varus with well-marked rigidity of the foot, in which Phelps' operation was subsequently performed with success.

Phelps' operation is not necessary in the less severe degrees of club-foot, since they can be cured by tenotomy and suitable manipulation, and the question arises as to the extent of its usefulness in resistant and inveterate club-foot. In dealing with the anatomy of the advanced degrees of club-foot, it has been shown that very extensive alterations of shape and position are present in the bones, joints, and ligaments. Now Phelps' incision leaves the bones untouched. It is confined to the soft parts, and although for a time the inner border of the foot may be lengthened, yet the deformity will very

[1] *Australian Medical Journal*, 15th Sept. 1893.

probably recur later.[1] It has been claimed that after the operation it is possible to slide the scaphoid and cuboid outwards on the calcis. Walsham and Hughes[2] remark that "as regards the cuboid and os calcis it appears to us, inasmuch as the plane on the cuboidal facet on the latter bone looks in the talipedic foot forwards and inwards, that, if the cuboid is carried into a line with the leg, it must be at the expense of the separation of the contiguous articular facets on their inner side. . . . We have found that rectification in the dissected foot after division of the short ligaments and tendons on the inner side was here only accomplished by the actual separation of the articular surfaces." So that in the severer cases of club-foot, especially with old-standing displacement of the bones, Phelps' operation is likely to be followed by relapse, as, unless the ligaments on the inner side are very freely divided, the essential part remains untouched, and, further, the scar is very likely to contract. It appears, however, that Phelps' operation is useful in relapsed cases not of a severe degree, in which the bony distortion is not much marked, but where the soft parts on the inner side are matted together by previous tenotomies and syndesmotomies.[3]

Free Subcutaneous Division of all Resistant Structures.— This procedure was initiated by Professor Buchanan. Mr. Arbuthnot

[1] I have seen three cases of relapse of the foot after Phelps' operation. I think it fair to add the relapse was due to ignorance and want of perseverance on the part of the patient in the after-treatment.

[2] *Op. cit.* p. 216.

[3] A few references on the subject of Phelps' operation are the following:—"The Phelps' Method of Treating Club-Foot," by A. Phillipson, *Archiv f. klin. Chir.* Bd. xxxii. s. 989, and *Annals of Surg.* vol. viii. p. 459. "Results of Orthopædic Surgery in Pes Varus," by G. Krauss, *Deutsche Zeitschr. f. klin. Chir.* Bd. xxvii. Hefte 3 and 4, and *Annals of Surg.* vol. ix. p. 306. The author concludes that the weight of opinion tends to hold in an unfavourable light the operation of cuneiform resection of the tarsus. The talus extirpation is also unsatisfactory. The operation of Phelps is too young to command any positive opinion as to its true position. "The Treatment of Severe Cases of Club-Foot," by Noble Smith, *Lancet*, 17th Dec. 1892. He says: "Before we can accept Phelps' treatment we ought to compare it very carefully as regards the permanent results with other methods, and especially with forced reduction." Also, "Thirteen Cases treated by Phelps' Operation for Talipes Equino-Varus," by B. E. Mackenzie, *Trans. Amer. Orth. Assoc.* vol. iv. p. 48. Also, "A Comparison of the Operative Methods in the Treatment of Club-Foot," by De F. Willard, *Trans. Amer. Orth. Assoc.* vol. v. p. 225. He does not advocate Phelps' operation, since the same amount of division can be done subcutaneously. The disadvantages of Phelps' operation are that—(1) The wound must close by granulations. (2) The time of healing is long. (3) The resultant scar makes a furrow in the foot more ill-looking than that of mere subcutaneous division. Also Phelps' remarks, *Trans. Amer. Orth. Assoc.* vol. v. p. 232. He states that in 90 per cent of cases it is possible to straighten club-feet without operating on the tissues.

Lane has extended the operation, and has advocated it with vigour.[1] Speaking of the open method, Mr. Lane remarks: "The result which is obtained by this operation is apparently most satisfactory, but when the patient begins to walk on it the result, in my experience, is very unsatisfactory, since there is an absolute loss of continuity of all the soft parts in the sole of the foot. I have never obtained by this method a result with which I was satisfied, nor have I yet seen one. The other operation, or that of complete subcutaneous section, is the one that recommends itself most strongly to me." The mode of operation is as follows: "An india-rubber bandage is applied above the knee to control the circulation, and by means of a strong-bladed, sharp-pointed tenotomy knife everything beneath the skin that opposes the placing of the foot in a position of moderate abduction upon the astragalus is divided. This includes the several divisions of the plantar fascia, part of the internal lateral and annular ligaments, the superior internal calcaneo-scaphoid ligament,[2] the inferior calcaneo-scaphoid, and the long and short plantar ligaments, together with the tibialis anticus and all the tendons, vessels, and nerves in the sole of the foot. I do not hesitate to make many punctures, only taking care that the knife is entered in such a direction that the forcible fixation of the foot in a position of abduction does not cause the wound made by it to gape, a point of considerable importance. By spending some time, and by exercising a moderate amount of skill it is possible to divide all the soft parts opposing the abduction on the astragalus, and to leave the skin intact except for the punctures produced by the tenotomy knife. After this has been done, I pass a knife between the skin and tendo Achillis and divide it. If the foot does not become square, I cut all the soft parts except the peronei, carefully dividing the posterior ligament of the ankle-joint. The disadvantage of the operation is that in bad cases the skin for a time affords an obstacle to the foot being returned to a good position, and necessitates an application of a plaster of Paris bandage about every three or four weeks, the foot and leg being fastened to a back splint and foot-piece, the inner margin of which forms an angle of 25° with the vertical. Its great advantage is that the foot which results is a useful one, and one on which the patient can walk gracefully."

1 "The Treatment of Severe Cases of Congenital Talipes Varus in Infancy," *Lancet*, 19th Aug. 1893, p. 432. Although described as an operation suitable for infantile cases, I have ventured to place it among those which might be considered suitable to maturer years, on account of its very radical nature.

2 Cf. Mr. Lane's description, *Guy's Hospital Reports*, 1886, p. 250.

For infantile cases it must seem that such a procedure is unnecessarily severe, and for older cases it is difficult to see wherein the special merit of the operation consists as compared with Phelps' operation. Mr. Lane admits that the skin which is left more or less intact is a disadvantage, and it is on this point that his procedure differs chiefly from Phelps'. It is to be wished that Mr. Lane had appended a table of cases treated by his and other methods for comparison. Personally I should hesitate before performing so drastic an operation—a veritable "panotomy" (if I may coin a word)—at one sitting. No mention is made of any ill results from after-hæmorrhage, yet it seems a very possible event. Walsham and Hughes[1] mention that relapsed cases of free subcutaneous division have come for further treatment to St. Bartholomew's Hospital.

Those operations which attack the bones are more suitable for the severest degrees of club-foot, and under the heading of inveterate club-foot I propose to discuss them.

But to sum up the three forms of operation, forcible rectification, Phelps' open incision, and the free subcutaneous division of all resistant structures, it must, I think, be admitted the forcible rectification alone answers all the demands, inasmuch as it is rapid, comparatively safe, bloodless, and reaches all the affected structures, both bones and soft tissues. The after-care of these cases is all-important. There is the same choice of retentive and walking apparatus, but the need of constant supervision is still more imperative. Particularly so is this the case after Phelps' operation, as its designer pointed out when he introduced the operation to the notice of surgeons.

The Treatment of the Fourth Degree, or Inveterate Club-Foot.—Here the distortion is exaggerated to its utmost limit, and the foot is fixed, feeling as if it were set in plaster of Paris. The heel is much raised; the toes point forwards and upwards, and are almost in contact with the inner side of the leg; progression is either on the outer side or partially on the dorsum, on which are seen false bursæ lying over the prominent cuboid and fifth metatarsal bones. The plantar surface shows the longitudinal and transverse creases in a very marked degree. The affected leg and foot are smaller than the other, and the foot is boat-shaped, the outer border bearing the whole weight of the body. Such a case is that of Annie E———, aged 39 (Plate XII.), who came to me at the hospital in 1891, but who refused to go under treatment of any kind, saying that

[1] *Op. cit.* p. 214.

she could hobble about well enough in a boot of a peculiar make and shape she was wearing.

Treatment.—This resolves itself into the following methods:—

1. Forcible rectification.
2. Tarsotomy and tarsectomy.
3. The older orthopædic methods of tenotomy and gradual rectification by means of Scarpa's shoes. With reference to this it may be said that the certainty of curing the feet by these means has been proved many times, but the extreme length of time is a great disadvantage.

As to forcible rectification (p. 432), it is the measure which, combined with tenotomy and free fasciotomy, should be tried; and, failing that, in these exceptional cases tarsotomy or tarsectomy may be resorted to. For the reasons stated above, it does not seem that Phelps' operation will effect a cure. The illustration (Fig. 202) is from a case of mine in which Phelps' operation failed to cure the trouble. A slight improvement only was made.

According to Bradford and Lovett,[1] the various forms of tarsotomy and tarsectomy are—

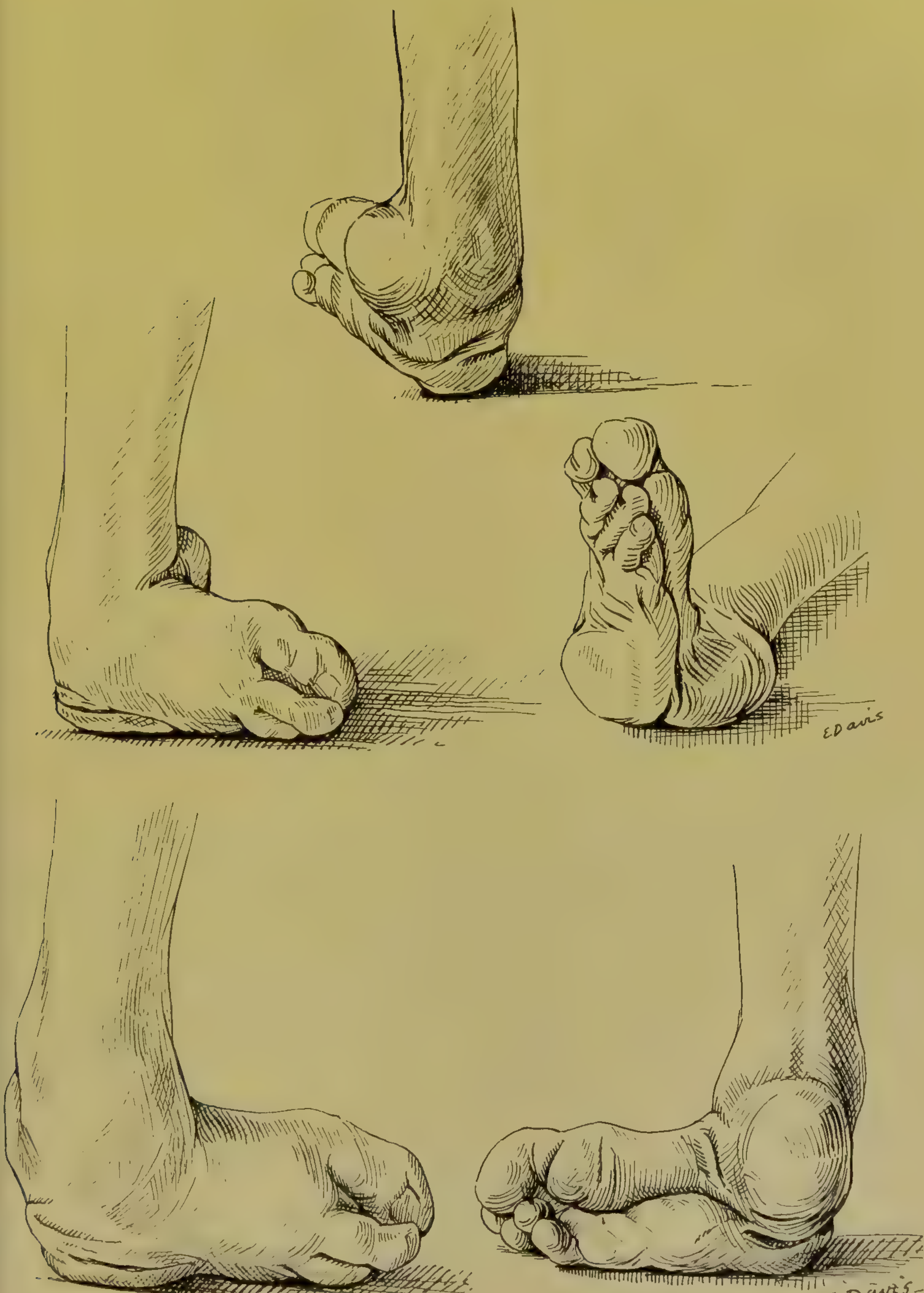
1. Removal of the cuboid.
2. Removal of the astragalus.
3. Removal of the astragalus, cuboid, and scaphoid.
4. Section of the neck of the astragalus.
5. Removal of the astragalus and external malleolus.
6. Osteotomy of the lower ends of the tibia and fibula.
7. Wedge-shaped resection of the tarsus.

Speaking of these the authors say: "The results from the first method have not been altogether satisfactory, and the fourth may be said to be insufficient, and against the third and sixth it may be urged that too much mutilation is required. Authorities differ in advocacy of the second and seventh methods." To the list should be added Fitzgerald's operation,[2] in which some of the bones are crushed and others divided. Also complete tarsotomy with a chain-saw is advocated by Mr. H. P. Symonds of Oxford. With reference to the last procedure I may quote the remarks of Mr. Walsham, in a paper on "The Treatment of Severe Club-Foot," read in the Section of Diseases of Children at the meeting of the British Medical Association, 1892: "Tarsotomy or transverse division of the tarsus is of

[1] *Op. cit.* p. 492.

[2] *A New Procedure for the Cure of Congenital Talipes Varus and Equino-Varus*, Melbourne; Stilwell and Co. 1889.

PLATE XII.



Inveterate form of congenital club-foot. The longitudinal and transverse grooves in the sole of the foot are well seen.

service where the varus is the chief defect. In extreme cases simple transverse division of the tarsus has not, in my hands, been sufficient for thoroughly dealing with the deformity, and a second or oblique section has had generally to be made, thus removing a wedge of bone. In short, the tarsotomy has had to be completed as a tarsectomy. My tarsotomies have been done with a chain-saw passed beneath the extensor tendons through a small incision on the outer and inner side of the foot. The line of section has been planned to divide the neck of the astragalus on the inner side of the tarsus, and the anterior end of the os calcis on the outer side. The ultimate results have not been so uniformly good as in the cases where the astragalus has been removed." Indeed, when the multiple nature of the deformity in inveterate club-foot is considered, it is not likely that a mere sliding outwards of the anterior on the posterior part of the foot will correct displacements consisting of adduction, inversion, and excessive plantar flexion. The twist in the axis of the os calcis, the displacement downwards and forwards of the astragalus, the insufficient adaptation of this bone to the space between the malleoli, the atrophy of the scaphoid, and the overgrowth of the cuboid all remain untouched by the operation.

Astragaloid Osteotomy.—After the structures on the inner side have been divided and stretched, the deformity of the astragalus in inveterate cases remains. Bradford and Lovett[1] say that in a great majority of cases, if the deformity is rectified and the foot held for a sufficient time in good position, and a proper walking shoe used for a year, a new facet will be formed for the scaphoid on the anterior aspect of the astragalus in place of that on the inner side, by means of which the bones articulate in long-standing club-foot, and a cure will be effected.

The method of doing astragaloid osteotomy is this. Fasciotomy, tenotomy, and division of the ligaments should be done, and the foot brought by forcible manipulation into as good a position as possible. An incision from the tip of the internal malleolus to the base of the first metatarsal bone, and parallel with the tibialis anticus tendon, is then made; and by stretching the inner margin of the foot, the scaphoid is drawn away from the internal malleolus, and the neck of the astragalus exposed. With an osteotome the neck is divided, and, if necessary, that portion of the os calcis near the calcaneo-cuboid articulation may be divided. The foot should be put up at once in the corrected position. Drs.

[1] *Op. cit.* p. 494.

Bradford and Lovett have had four cases. In one case the result was "most excellent, curing at one operation an inveterate case in a boy of ten." In three other cases "the result was not so good." But it is pointed out that the operation is too young to form a definite opinion of its merits. They do not claim it to be "a substitute for tarsal resection, but it will be found useful in cases where the astragalus is prominent and the twisting of its neck evident." It will be asked, In what respect is this operation superior to tarsotomy? I take it that with an open incision it is possible to divide the neck of the astragalus and the os calcis in such a plane that the equinus deformity may be fully rectified. That is to say, astragaloid osteotomy is valuable when equinus is a greater feature than varus.

Astragalectomy (*Lund's*[1] *Operation*).—An incision is made on to the bone from the tip of the external malleolus downwards and forwards, passing between the peroneus tertius and brevis. After raising the soft tissues with an elevator, the ankle and astragalo-scaphoid joints are opened. The astragalus is then freed from its ligamentous attachments, and is removed. Mr. Walsham[2] states: "The only difficult part of the operation is the division of the internal lateral ligament, but this can be overcome without much delay by cutting freely round the inner side of the astragalus with the curved bone scissors." It is advisable that "the astragalus be seized with lion-forceps, and drawn now this way and now that as the remaining fibres are divided." If any difficulty arise in bringing the foot to the right angle, the anterior extremity of the os calcis or a piece of the external malleolus must be removed. The wound should be closed entirely, and the foot put up in plaster of Paris for a month, and then passive movement employed so as to obtain mobility at the ankle. Twenty-one astragalectomies were performed at St. Bartholomew's Hospital from 1882 to 1893; all did well. In two only was there any suppuration. T. G. Morton[3] is in favour of astragalectomy, if there is much distortion of bone, on these grounds—

1. The resulting freedom of the ankle.
2. Immediate and permanent correction of the deformity follows.
3. No mechanical after-treatment is necessary.

[1] *Brit. Med. Journ.* 19th Oct. 1872. The operation was also done by Mr. Thomas and Prof. John Wood, *Lancet*, 16th March 1878, p. 359.

[2] *Brit. Med. Journ.* 18th Feb. 1893, p. 342.

[3] *Trans. Amer. Orth. Assoc.* vol. iii. p. 119.

4. There is no possibility of recurrence.
5. The operation is not difficult.

Dr. Mensel[1] of Gotha has removed the bony nucleus of the head of the astragalus, by splitting open the cartilage, in a case in which slight gangrene had followed forcible rectification and the application of plaster of Paris.

That the after-history of operations on the astragalus is not uniformly satisfactory is evidenced by a case of Dr. Mason[2] of New York, who was obliged to amputate after unsuccessfully excising the astragalus and a portion of the external malleolus.

Tarsectomy.[3]—The operation presents no difficulty. It is very tempting if a foot is too short on the inner side, and too long on the outer, to saw away a piece of bone and pull the foot straight; but it does not appear to be a very scientific proceeding. The cause of the trouble is in the inner segment of the longitudinal arch, and there the deformity should be rectified. The result of the trouble is on the outer side, and to attack the result and leave the cause does not appeal to one's judgment. But as the operation is performed frequently by some surgeons, it should be described.

The foot and leg are rendered aseptic, and an Esmarch's bandage put on above the knee. Strict antiseptic precautions are essential. An incision is made from the middle of the os calcis over the prominent outer border of the foot to about the middle of the fifth metatarsal bone. The size of the incision will vary somewhat according to the amount of deformity, but in any case it should be too large rather than too small. The knife cuts straight down to

[1] *Beilage z. Centr. f. Chir.* No. 25, 1890.

[2] *N. Y. Med. Rec.* 14th July 1877.

[3] The following references may be of interest in this matter:—Little, *Practical Observations on the Treatment of Club-Foot*, 3rd ed. p. 305. The operation was suggested by Dr. W. J. Little, and carried out by Mr. Solly. Verbelzi, "Removal of Astragalus in a Child of 5½ Years," *Centralblatt für Chir.* No. 24, 1877. Davy, *Lancet*, 14th Feb. 1888, and "On Improvements in the Treatment of Equino-Varus," *Lancet*, 14th Oct. 1893, p. 921. Davies-Colley, *Medico-Chir. Trans.* 2nd series, vol. xliii. 1877. König, *Centralblatt f. Chir.* 1880, No. 13. Rupprecht, *Ibid.* 13th March 1880. Mensel, *Ibid.* No. 11, 1880. Hartley, "Operative Treatment of Club-Foot," *Annals of Surg.* March 1894. De F. Willard, "Comparison of Operative Methods in the Treatment of Club-Foot," *Trans. Amer. Orth. Assoc.* vol. v. p. 225. Bradford, "Treatment of Congenital Club-Foot," *Trans. Amer. Orth. Assoc.* vol. i. p. 89. A. C. Ramsay, "Cuneiform Osteotomy for Congenital Talipes Varus," seventeen cases given, *Annals of Surg.* vol. xii. p. 423. V. P. Gibney, "Cases of Cuneiform Osteotomy for Relief of Double Congenital Varus," *Annals of Surg.* vol. xi. p. 334. Ewens, "Osteotomy Generally, with Special Reference to Tarsectomy in Advanced and Intractable Cases of Talipes Equino-Varus," *Brit. Med. Journ.* 17th Oct. 1891, p. 842; eleven cases are alluded to.

the bone. A second incision at right angles, and about 1 inch long, either extending upwards to the dorsum of the foot or, preferably, into the sole, is made. With an elevator the soft parts and periosteum are reflected over the bone which is to be removed. Then with either chisel or saw a wedge-shaped piece is taken from that portion of the foot which is most prominent, and of such a size that the foot can be brought into position without any undue force being used. The base of the wedge should at least equal that of the outer border of the cuboid, and be thicker above than below. In Mr. Davies-Colley's original case this was done "irrespective of the articulations." The wound is then sewn up and dressed antiseptically, and placed at once in plaster of Paris in the corrected position, and retained so for a month to six weeks. Even after tarsectomy it is necessary in most cases to use some kind of mechanical apparatus, otherwise there is danger of relapse, in spite of all that is said to the contrary. Relapsed cases after tarsectomy are not so uncommon.

Removal of the astragalus, scaphoid, and cuboid involves extensive mutilation of the foot. If the case be so severe, a doubtful matter, as to appear to require this procedure, it may well be that amputation is to be preferred. A shortened, rigid foot, although of normal shape, is of little good, and an artificial substitute will often enable the patient to walk with greater ease.

Comparison of the Efficiency in Treatment of the Older Orthopædic Measures, combined with Wrenching, and the Various Forms of Tarsectomy.—In the first place I would quote the opinion of some authorities on this subject. Bradford and Lovett, after detailing some admirable results of tarsectomy, remark: "Such results correspond with those of others, but it cannot be denied that much of the foot is sacrificed, and that the severest cases can, as a rule, be perfectly corrected without such radical proceeding. The method does, however, save time in treatment, and when time and expense are to be considered, the procedure should be regarded as efficient and without risk."[1] Mr. Walsham, whose great experience must entitle his opinion to much respect, says[2]: "What is the ultimate condition after excision of the astragalus, and, if necessary, other portions of the tarsal bones? Well, at the most, it is only making the best of a bad job. But the foot is plantigrade and respectable in shape, and if healing by the first intention is ensured, and passive

[1] *Op. cit.* p. 494 and *Trans. Amer. Orth. Assoc.* vol. i. p. 89.
[2] *Brit. Med. Journ.* 18th Feb. 1893, p. 342.

movements are subsequently kept up, a fairly movable ankle-joint is obtained. Further, the patient's walking powers are much improved, and he can, as a rule, dispense with instruments. I say as a rule, because, as all are aware, the severe deformity of the foot which calls for astragalectomy is often, after all, merely part of a general malformation of the whole limb." Krauss'[1] opinions on the points at issue are as follows:—

"1. The different methods of resection of the tarsus impair the form of the foot and the stability of its osseous arch, with a consequent impairment of mobility and usefulness.

"2. Resection as an operation is not free from risk.

"3. Resection removes all chance of future restoration by orthopædic treatment.

"4. There is no conceivable form of club-foot in which tarsal resection is justifiable, except it be in the case of one that is persistently painful in an old subject, and in which there is no prospect of a good result from orthopædic treatment.

"5. Equally good and more rapid cures can be effected by bloodless 'redressement' of the foot, this being possible not only in the deformed feet of children, but also of adults."

These then are the opinions expressed by authorities on the matter. There is, perhaps, no subject on which so many diverse opinions are held as the respective merits of tarsal resection and the bloodless methods. It seems that unless the case be one of exceptional difficulty, the solution is found in the social status of the patient. If time can be spent in the cure, many surgeons prefer the gentler methods, whereas the stress upon hospital beds is so great in large cities that the quicker method of tarsectomy is resorted to.

It may not be amiss to examine the question at issue under the headings of the risk involved, the efficiency of the operation and the utility of the foot, the time taken in the cure, the possibility of relapse, the availability of future orthopædic treatment, and the necessity of employing apparatus after active treatment has ceased.

General Considerations on Tarsectomy.—1. *The Risk Involved.*—By the bloodless methods there is practically no danger, provided that the foot be not secured too tightly in fixation apparatus. Tarsectomy is by no means uneventful in its history. Suppuration is not unknown. V. P. Gibney[2] relates two cases of cuneiform osteotomy for relief of double congenital equino-varus. One did perfectly well, but the other—a most inveterate case, aged 32 years—after

[1] *Trans. Fifteenth German Surg. Congress.* [2] *Annals of Surgery*, vol. xi. p. 334.

removal of parts of the os calcis and the neck of the astragalus, combined with Phelps' operation in the right foot, suffered from septicæmia. The left foot was subsequently operated on, and healed very nearly by first intention. "There did remain in both feet fistulous sinuses, from which bits of necrotic bone were removed from time to time." Now that tarsectomy is so widely advocated, we cannot but express our admiration at the courage shown by Dr. Gibney in relating this case. Mr. Walsham[1] records suppuration in two of twenty-three cases. Mr. Richard Davy, in a clinical lecture delivered by him in 1883, gives an analysis of twenty-two operations, all successful except one on a man aged 20 years, who died of septicæmia. Mr. Ewens[2] of Bristol says that, "Of fifteen cases performed by him and his colleagues we have no fatal case to report, but in two or three instances suppuration has taken place." So that tarsectomy is not free from risk, as these cases show. They are isolated cases, it is true, and culled from surgical literature after some search[3]; but they are none the less telling (see Dr. Wilson's statistics at the foot of the page).

2. *The Efficiency and Utility of the Foot.*—After the bloodless methods the foot, even if not always shapely—and form is not everything—is at least elastic and useful. After astragalectomy, or removal of a wedge, the member, although perfect in outline, is frequently shortened and inelastic, with imperfect or no movement at the ankle and medio-tarsal joints. At a meeting of the British Orthopædic Society in December 1894, Mr. Keetley alluded to a case of a man the subject of double congenital club-foot. One foot had been subjected to tarsectomy and the other left untreated. The patient found the untreated foot of greater use to him in progres-

[1] *Brit. Med. Journ.* 18th Feb. 1893, p. 341. [2] *Ibid.* 17th Oct. 1891, p. 844.

[3] Dr. H. A. Wilson (*Amer. Med.-Surg. Bull.* 1st Feb. 1894) has analysed 435 bone operations for the correction of club-foot performed by 108 operators. There were *seven deaths*—three from septicæmia, three from diarrhœa, and one from carbolic acid poisoning. In one case the foot had to be amputated for gangrene, and two cases are described as failures without explanation. The age of the patients ranged from 3 weeks to 47 years; 29 operations were done on patients under 2 years, 126 under 6, and 234 under 10. Simple excision of the astragalus was done 156 times, and 68 forms of bone operation were practised on the remaining cases. The results of operation are given under numerous heads, but 231 may be grouped as good or excellent, 135 as not definitely stated, and 42 as not benefitted, including two amputated for pain and seven deaths, as before stated. The author, in accord with recent experience, states his belief that cases of congenital club-foot properly treated from birth will never require tarsectomy, and that even in relapsed and neglected cases the percentage suitable for bone excision is extremely small. Twenty-nine surgeons reported that they had never done any bone operations for club-foot.

sion than the tarsectomised foot, which, though perfect in shape, was entirely inelastic.

3. *The Time occupied in Treatment.*—In inveterate cases there can be no doubt that tarsectomy carries the day. The ratio of time

FIG. 238.—Severe relapse after tarsectomy on both feet. The + marks the centre of the patella.

occupied respectively by tarsectomy and the bloodless methods may, as a general rule, be reckoned by weeks to months.

4. *The Possibility of Relapse.*—The very nature of congenital club-foot is one of relapse. It has been claimed for tarsectomy that relapses are not possible. Neither should they be if the

restored foot is retained in good position by apparatus. But I have seen sad cases of relapse after tarsectomy done some years previously. These patients have presented themselves at the National Orthopædic Hospital for further treatment (cf. Fig. 238), which in several instances has not been possible to any satisfactory extent, owing to the matted condition of the soft parts and the firm ankylosis at the joints. It is not claimed that the bloodless methods are never followed by relapses, but fortunately then there is room for further treatment.

5. *The Availability of Further Treatment.*—From what has been said it appears that a tarsectomy, which has failed, leaves no room for complete cure by future treatment. Indeed, it would seem that an artificial foot would be preferable in some cases to the rigid, distorted, useless member I have seen.

6. *The Necessity of Apparatus after Active Treatment has Ceased.*—If relapses are to be prevented both after tarsectomy and the bloodless operations some mechanical appliance is necessary. In the accounts of cases after tarsectomy it is specially noted that the patients could walk without any instrumental aid. I may be wrong, but I venture to think that if such cases had been seen, say three years afterwards, the foot would not be in perfect position.

To sum up[1]:—1. The cases in which tarsectomy is necessary are very few, and form a very small percentage.

2. Tarsectomy is entirely inadmissible in infants and children under 12 years of age. Their feet can be restored by the bloodless methods.

3. In the majority of cases of severe nature in adolescents and adults a cure may be obtained by the bloodless methods.

4. Tarsectomy should only be done when orthopædic treatment has been tried and failed, when progression is impossible owing to severe pain and the pressure of inflamed corns and bursæ and ulcerated skin; or if any marked developmental deformity is present.[2]

[1] The generalisations on the treatment of club-foot made by Bradford and Lovett (*op. cit.* p. 504) are excellent and to the point, and coincide with the author's opinion.

[2] The usual deformity exists in the astragalus and the lower ends of the tibia and fibula. The varus can be overcome, but all attempts by ordinary means to remove the equinus are futile. The upper articular surface of the astragalus refuses to fit between the malleoli. In such instances astragalectomy is practised. My colleague, Mr. Muirhead Little, writing "On the Treatment of Resistant Talipes in Adults and Adolescents" (*Brit. Med. Journ.* 19th Oct. 1895, p. 965), describes the removal of a wedge with the base upwards from the neck of the astragalus and front part of the os calcis with much success in an obstinate case. He thinks that sufficient flexion can be obtained in this way, and that astragalectomy is unnecessary.

5. Only those who are perfectly sure of their antiseptic methods should undertake tarsectomy.

Comparison of the Forms of Tarsectomy.—The favourites are astragalectomy and removal of a wedge from the outer side of the foot; and according to the statistics of Augustus Wilson,[1] who has collected 435 cases of operations on the bones of the foot, astragalectomy is preferred.

Dr. Frank Hartley has published an excellent paper on "The Operative Treatment of Club-Foot,"[2] in which details of fifteen patients, the subjects of the severer forms of congenital club-foot, are given. In all, twenty-six feet were operated on. Speaking of astragalectomy, he says: "The extirpation of the astragalus would seem to be indicated when the chief deformity in the foot is due to the astragalus, and the flexion at the ankle-joint cannot be carried beyond a right angle with the foot, on account of the prominence of this bone anteriorly." He claims that astragalectomy causes less interference with the arch of the foot than tarsectomy, and interferes less with the growth of the foot. He adds, however: "If the ankle-joint can be brought to a right angle or more, and the distortion of the foot is principally in the medio-tarsal joint, cuneiform osteotomy is the slightest and easiest method of treatment. The principal disadvantages of this method seem to be that the supination in the calcaneus remains, that the arch of the foot is broken, and that the growth of the foot is interfered with in the younger class of cases." In concluding his article, Dr. Hartley says: "I wish to state that I do not believe in any routine operative treatment for club-foot. Each case is to be studied for itself, and with the idea of restoring the function and relieving the deformity."[3] In both resistant and rigid club-foot, massage, douching, and electricity need to be used as in the less severe degrees.

Treatment of Paralytic Talipes Equino-Varus

In considering the treatment of this form of club-foot, the following special points should be borne in mind:—

1. The deformity is due to loss of power on the part of certain

[1] *Trans. Amer. Orth. Assoc.* vol. vi. 1894.

[2] *Annals of Surgery*, vol. xix. pp. 257-288.

[3] Barton Hopkins of Philadelphia has contributed to the *Annals of Surgery*, April 1895, "A Note on a New Method of correcting Inveterate Talipes Varus by the Artificial Production of Pott's Fracture Deformity," and gives three cases in which success appears to have been achieved.

muscles; they are functionally absent, and in the majority of cases cannot be restored. They can only be to a certain extent replaced by artificial apparatus.

2. Restoration of form is not so difficult, since the ligaments and bones become fixed only in inveterate cases. Generally the condition is one of absence of power on the part of muscles and groups of muscles which are over-balanced by the normal strength of their opponents, therefore over-correction is to be avoided.

3. The disease, after it has fully declared itself in the spinal cord, is not progressive. It is rather the reverse. Muscles which at first appeared to be hopelessly paralysed often show signs of partial recovery.

4. Trophic changes in the parts (*e.g.* fatty degeneration of the bones) are well marked. Thus they do not lend themselves to radical operative procedures.

5. Physiological methods such as douching, rubbing, electricity, active exercise, play a very important part in the after-treatment of these cases.

In slight cases manipulation is all that is necessary, and the use of a walking instrument with an inside steel support and a varus T-strap, with a tin-shoe for night wear, is required. In some marked cases division of the plantar fascia and tenotomy of the tibialis anticus and posticus are called for; and when the varus deformity is corrected, either by Scarpa's shoe or by plaster of Paris, the tendo Achillis is divided, if the foot cannot be dorsi-flexed to the right angle. Every care should be taken that in the after-treatment the tendo Achillis is not allowed to become too long. A walking instrument, with both inside and outside steel supports to the knees, toe-elevating spring, and varus T-strap, are necessary for some years. If there is paralysis of the thigh muscles, the instrument must be carried up and secured around the pelvis by a girdle, and a ring-catch fitted at the knee, so to fix the leg in extension while walking, and to allow flexion on sitting down. In most cases a cork-sole will be required to compensate for the shortening. A more sightly arrangement is the O'Connor extension boot.

The question of arthrodesis will be referred to in the chapter on Spinal Paralysis. An ingenious operation has been devised and carried out once by Winkelmann,[1] with the object of saving the patient the inconveniences of arthrodesis, while making it unnecessary for him to use an apparatus. The operation is designed

[1] *Deutsche Zeitschr. f. Chir.* xxxix. pp. 1, 2.

PLATE XIII.

Fig. 1.

Talipes equino-varus from infantile paralysis, in a child aged 4½ years.

Fig. 2.

The same case at the completion of treatment, viz. reduction of the varus deformity. This was effected by tenotomy, followed by mechanical and manual rectification.

Fig. 3.

The appearance of the feet on conclusion of treatment.

to throw on the paralysed peronei a portion of the extra power of the tibialis anticus and posticus and the calf muscles. The anatomical facts applied to the operation are—

(*a*) The existence of two heads and two bellies to the gastrocnemius.

(*b*) The tendon of the gastrocnemius unites with that of the soleus at the junction of the middle and lower thirds of the leg.

(*c*) At this spot, too, the tendons of the peronei commence.

An incision is made lengthwise at the external edge of the gastrocnemius to about 2 inches above the external malleolus. The external half of the tendon of the gastrocnemius is divided transversely at its junction with the soleus, and then lengthwise down the mid-line as far as the median tendon separating the two bellies. The tendon of the peroneus longus is divided obliquely from before backwards and from below upwards, after which the latter tendon is united by several silk sutures to the one which has been detached from the gastrocnemius. Lastly, the tendon of the peroneus brevis is freshened and attached laterally to that of the peroneus longus. Plaster of Paris is then applied. In the one case in which the operation was performed the result was excellent. Winkelmann proposes in future to utilise the whole tendon of the gastrocnemius, fixing its inner half to the lower end of the severed extensor communis digitorum, and its outer half to the tendon of the peroneus longus. The soleus is left intact to perform plantar flexion, while the gastrocnemius acts as its antagonist.

This operation has been quoted in full, as it seems to me to give a useful hint for the treatment of many deformities of the foot and hand; and in properly selected cases, and with a moderate amount of operative skill, successful results should be achieved. It is evidently suitable to cases only in which there is complete paralysis of the extensors. If partial paralysis be present, over-correction would probably result.

As to the prognosis of cases of paralytic equino-varus, so far as the shape of the foot is concerned, some little deformity may remain in inveterate, though not in moderate cases, but it is of little moment; while by the use of cork soles and walking apparatus a shortened, shrunken, seemingly useless limb may be made a very useful member for progression, and as exercise is persevered with, partial recovery will often follow.

The Treatment of Spastic Cases.—By many it is not considered advisable to operate in such cases. Their objection arises from the well-known tendency of spastic cases to relapse, as the contraction of the affected muscles is progressive. But there is reason to believe that the tension of the tendon reacts on the muscle, *i.e.* a tight tendon causes increased contraction of the muscle, and so on in a circle. If the tendon is divided, the circle is broken. It may be only for a time, it is true, but that is a question of years and not of months. So that by tenotomy two points are gained—the contracted tendon is lengthened, and the reflex effect of the tight tendon on the muscle ceases for a time. When, too, the spastic process has ceased, then tenotomy may be successfully performed.

FIG. 239.—Hysterical talipes equino-varus (after Walsham and Hughes).

In cases of spastic paralysis I divide the tendons, adding, however, this caution. The operation will have a good effect for some time, but, unless the process of contraction in the affected muscles ceases, owing to the subsidence of the irritation in the central nervous system, some relapse will take place as the child grows. In that event, however, the tendon may be severed again at a higher point.

Relapsed Varus and Equino-Varus, and their Treatment

That cases of club-foot relapse after treatment has long been an unjust cause of reproach to surgeons, but generally it will be found that the fault is not theirs, but should rather be laid on those who undertake the after-supervision of children the subjects of club-foot, and do it imperfectly. Still, instances occur in which it is possible to ascertain that the feet were never fully corrected. Some inversion or want of dorsi-flexion has been allowed to remain at the time of active treatment, and these deficiencies have become accentuated later. In treating of the subject of relapses, it does not appear that, following many authorities on the matter, a better classification can be adopted than to arrange the causes under two headings—imperfect cure, and want of sufficient after-treatment.

Imperfect Cure.—Very true, indeed, is Bradford's aphorism that "in club-foot half-cures are no cures." Imperfect cure may arise from the following causes:—

1. Incomplete or insufficient division of fasciæ, tendons, and ligaments; or, if wrenching has been adopted, insufficient stretching of the contracted parts.

2. Delay in commencing treatment.

3. As a part of the preceding, failure in recognising that in old-standing cases considerable bony deformity is present, especially in the astragalus.

4. Defects in other parts of the limb.

5. Too great haste in treatment.

1. *Incomplete Division of Fasciæ, Tendons, and Ligaments.*—Rigid bands of plantar fascia are divided, and it will appear that all that is necessary in this direction has been done. But a careful examination two or three weeks afterwards will reveal to the skilled touch other bands which have come into prominence. Chief among these is the innermost portion of the fascia passing along the inner margin of the foot, from the internal tuberosity of the os calcis to the head of the first metatarsal bone. This is extremely thin, but at its anterior insertion diverges considerably, and is readily overlooked. It is partly responsible for the pigeon-toed appearance of the foot. The tibialis posticus tendon is sometimes not divided by the operator.[1] Sometimes the tibialis anticus, the direction of which is almost vertical in cases of the second and third degrees, is missed entirely, and the extensor proprius pollicis divided in its stead. Severe cases require division of the latter tendon, as well as of the tibialis anticus. The tendo Achillis may be transfixed, or its inner portion left undivided for fear of wounding the artery. As to the ligaments, the important rôle of the internal lateral ligament and astragalo-scaphoid capsule is sometimes not fully appreciated. In

[1] Adams, *op. cit.* p. 290, quotes two cases of partial division of this tendon, and by the open operation; the writer has verified another.

almost all cases it is my practice to make a sweep with the knife subcutaneously round the convexity of the internal malleolus. In wrenching the foot the resistant structures should be felt to give, and not merely to stretch. Mr. Adams strongly insists upon retaining the tendo Achillis intact until the varus is completely removed, and on this point experience shows him to be correct. Walsham and Hughes say that "they are bound to confess that the order of division (that of the tendo Achillis before the plantar fascia and tibiales) has in some instances appeared to be at the bottom of the relapse or imperfect cure."

2. *Delay in commencing Treatment.*—It goes without further remark that a foot mainly cartilaginous will be more amenable to treatment and less liable to relapse than a rigid foot in which all the bones are ossified and the ligaments set.

3. *Failure in the Recognition in Old-Standing Cases of Bony Deformity.*—The neck of the astragalus is deflected downwards and inwards, and the upper articular surface cannot by any ordinary force be made to enter completely into the mortice formed by the tibia and fibula. It is in these cases that Phelps' operation fails to relieve the deformity, and relapses are ascribed to the operation rather than to want of judgment in undertaking this mode of treatment. A choice must be made between long-continued mechanical treatment and astragalectomy. By the former method absorption of the protruding part may be obtained by constant pressure, the faulty direction of the head of the astragalus rectified, and the scaphoid pushed outwards. By the latter method the deformity is rapidly and completely reduced, though at the expense of the integrity of the foot.

4. *Defects in other Parts of the Limb.*—These consist of inward rotation of the tibia and fibula, at the knee and of the femur. The measures for overcoming them have been detailed on pp. 425-428, and failure to recognise their existence is followed by a relapse.

5. *Too great Haste in Treatment.*—To illustrate this, it is permissible to remark that it is within the writer's knowledge that after simultaneous division of all the tendons, including the tendo Achillis, the patient has been allowed to walk about one week after operation without any retentive or corrective apparatus. The result was disastrous. It is necessary to recognise that a new and well-controlled mode of progression has to be acquired by the patient, and this takes time. As stated previously, if Scarpa's shoe be employed, it is better to "coax" the foot into position and not to

force it. The remarks on p. 430 which bear upon the question of hasty treatment may be consulted with advantage.

Want of Sufficiently-Extended After-Treatment.[1]—It has been thought by some that treatment by immediate or rapid rectification is more likely to be followed by relapse than if the deformity is gradually removed. This is not so, provided that in congenital club-foot over-correction is obtained and the cure is complete. By whatever means the cure is attained, if the after-treatment be not assiduous and thorough, relapse is inevitable. The application of plaster of Paris has been made responsible for relapses, and it is certain that one sees relapses after the use of this material. But it will be found that neither the surgeon nor the plaster of Paris are to blame. The parents, seeing the child getting about in the bandage, take it that the case is completed, and therefore do not attend so often as is desirable to have the foot manipulated and the plaster reapplied. The after-treatment is thus neglected from carelessness or ignorance on the part of parents who are not aware that club-foot cannot be cured in a week, nor a month.

The Treatment of Relapsed Varus and Equino-Varus.—If the inversion and extension of the foot are but slightly marked, forcible manipulation under an anæsthetic, with further moulding in Scarpa's shoe (Adams' modification), will suffice.

Should inversion be well marked, fasciotomy and tenotomy are called for in the first place, and the same retentive appliance used. A few weeks later, six to eight, the tendo Achillis should be divided.

CASE 90. *Relapsed Congenital Equino-Varus successfully Treated.*—Master E. J. W., aged 2 years, was sent to me from South Africa for further treatment. He was the subject of double congenital club-foot. The tibial tendons and the tendines Achillis had been divided in both feet, plaster of Paris being afterwards applied. Relapse, however, took place, and it was necessary to again divide the tendons, to forcibly manipulate the feet at intervals, and to ensure correct position of the feet by the use of Mr. Adams' modification of Scarpa's shoe. The results of treatment may be seen by comparing Figs. 240, 241, and 242.

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[1] On this question of relapse the remarks of E. H. Bradford (*Trans. Amer. Orth. Assoc.* vol. i. p. 111) are of interest. He points out that, "if the foot is large and the child able to walk, the act of walking, if the foot is prevented from twisting and the weight falls correctly on the sole, is sufficient to stretch those muscles in which adaptive shortening may occur after operation. But in infants in arms this correcting influence is absent, and the retentive appliance needs to be carefully watched until the child walks, and walks well. It may be said that the larger the foot, the less time after complete correction will a walking apparatus be needed."

In still severer cases subcutaneous division of the resistant structures and forcible rectification with a Thomas wrench will restore the foot. In old-standing cases the like means may be

FIG. 240.—Front view of a case of relapsed congenital talipes equino-varus (Case 90).

FIG. 241.—Back view of the same feet.

FIG. 242.—Case 90 after treatment.

employed, or one of the forms of bone-operation considered. Of these, astragalectomy is to be preferred. The prolonged use of retentive and walking apparatus is essential.

The prognosis of relapsed cases cannot be so good as that of untreated cases, because the patient is older, the bones more distorted, the soft tissues more fixed, and a second tenotomy is not so satisfactory as the first, on account of the adhesions contracted to the sheath at the time of the prior operation.

CHAPTER VIII

ACQUIRED FLAT-FOOT OF ADOLESCENTS AND ADULTS

Weak Ankles—General Description of Flat-Foot—Degrees of Flat-Foot—Etiology—Pathology—Morbid Anatomy—Symptoms—Diagnosis—Prognosis—Treatment, General and Local—Treatment by Rest, Exercises, Apparatus, and by Operation.

Synonyms—English, *Spurious Flat-Foot, Splay-Foot, False Valgus, Static Flat-Foot*; Latin, *Pes Valgus Acquisitus, Pes Staticus*; French, *Pied Plat Valgus, Tarsalgie des Adolescents* (*Gosselin*); German, *Plattfus.*

Definition.—A deformity of the feet, often painful, occurring subsequently to childhood, and characterised by abduction and eversion of the foot with loss of the arch.

In a previous section the other forms of valgus have been considered, and it is now proposed to enter more fully into the question of flat-foot, arising from occupation and often pre-determined by constitutional states. Before, however, entering on the matter it may be well to allude to the matter of

Weak Ankles or Valgus Ankles.—Weakly children, especially those suffering from rickets, are frequently brought to hospitals because the foot turns over "in walking." Associated with this condition some genu valgum from relaxation of ligaments is frequently present. The excessive movement at the ankle is due to the debility and partial lack of contractile power in the tibialis posticus and other plantar flexors of the foot and the tibialis anticus. Following these the short muscles of the sole and the ligaments of the ankle and foot yield, so that the foot has no arch and is everted slightly and abducted, and the external malleolus becomes prominent. In an extreme case of rickets I have seen the foot almost flail-like at the ankle. It could be made to assume every form of malposition, and could be dorsi-flexed so that the toes touched the shin. Bradford and Lovett state that boots tightly laced on the ankle, if worn constantly, interfere with the free play of muscles, and cause valgus ankles and flat-foot.

If such cases are left untreated, flat-foot of a particularly obstinate kind follows. But it is sufficient to apply long outside splints reaching from the upper part of the thighs to 4 inches below the soles, so as to keep the child off the feet, and to give passive exercise to the leg muscles and feet by shampooing the former and inverting the latter so as to raise the arch. When the flat condition has passed away, a boot carried well above the ankles, with plenty of stiffening but not tightly laced, and small valgus pads in the soles are advisable.

To return to the subject of flat-foot.

General Description of Flat-Foot.—All the changes in the appearance of the foot are due to sinking of the so-called arch, not only in the longitudinal, but also in the transverse direction. The depression downwards and inwards of the head of the astragalus and the outward twist of the anterior part, with extreme rotation of the foot, are the immediate results. The foot is increased in length on its inner side, and it is broadened. Flattening of the sole, best marked when the patient is standing, is present in various degrees. In all suspected cases it is advisable to take a tracing of the sole, otherwise slight examples escape recognition, and the cause of the pain in the foot and leg is not accounted for. In Figs. 249 and 251 are seen two degrees of flat-foot, shown by tracings from the sole. With the falling of the arch the instep loses its normal convexity and is often flattened. Generally one or two irregularities appear on it, due to twisting of the astragalus, scaphoid, and cuboid on their axes.

FIG. 243.—A case of static flat-foot.

On looking at the foot, the expression "canoe-shaped" conveys an idea of what has taken place, if the inner border be taken to represent the under surface of a canoe.

The inner border is convex instead of concave, and is in contact with the ground. It is also thicker than normal. Both the convexity and thickness are best marked just in front of and below the internal malleolus. Proceeding from behind forwards, the heel appears to be shortened. It is not actually so, but the explanation is that it is dwarfed, so to speak, by the large prominence on the inner border of the foot; and further, from the medio-tarsal joint the line of the inner border slopes distinctly outwards and backwards, so that the effect of perspective is to foreshorten the heel. The internal malleolus, somewhat prominent in slight cases, becomes extremely so in severe cases, and descends downwards, inwards, and backwards, so that its tip is either in a line with, or even behind that of the external malleolus, a condition which is seen in anthropoid apes. In advanced cases the swelling caused by the displacement

FIG. 244.—Flat-foot in a syphilitic patient; development of a gumma over the bony prominence on the inside of the foot (Case 91).

of the internal malleolus blends with that produced by the displacement of the bones at the medio-tarsal joint. On the inner aspect of the latter the chief deformity is found. The head of the astragalus sinks downwards, forwards, and inwards, and the scaphoid is rotated downwards so that its tubercle looks directly downwards. Sometimes the soft tissues over these bones are so hypertrophied that it is difficult to distinguish the line of Chopart's articulation. The formation of false bursæ and corns is best seen at this spot, and along the whole inner border an unnaturally thickened epidermis is present.

CASE 91. *Flat-Foot: Syphilis: Development of a Gumma over the Prominence on the Inner Side of the Foot.*—The patient, from which a drawing seen in Fig. 244 was taken, came under my notice at the Westminster Hospital, suffering from advanced flat-foot. Twenty years before he had contracted syphilis. When he came to the hospital the typical convexity about the inner aspect of the medio-tarsal joint was much in evidence, and over it there was a sloughing gumma, situated in the hypertrophied soft tissues. I took the case to be an example of the clinical observation that late syphilis is specially prone to show itself in those places which are the sites of constant irritation.

In front of the medio-tarsal joint the inner border slopes outwards, and the great toe is frequently valgoid. The outer border is concave, and shortened, and often raised from the ground; the skin beneath it is less thick than normal. There is not only abduction at the medio-tarsal joint, but eversion as well. The degree of abduction may be estimated, according to Walsham,[1] "by continuing the mid-line of the under surface of the heel forwards, and the mid-line of the under surface of the great toe backwards and observing the angle; or, if there be hallux valgus, by substituting the space between the great and second toe for the mid-line of the great toe." In many cases varicose veins co-exist, and sweating of the foot is not unusual.[2] In the absence of varicose veins considerable puffiness is often seen about the ankles, and effusion into the sheaths of the tendons occur. This is probably due to the strain on the ligaments and tendons arising from the valgoid position of the ankle.

In exceptional cases I have met with wasting of the tibialis anticus. Such an instance was the following, which came under my notice:—

CASE 92. *Flat-Foot with Wasting of Anterior Tibial Muscles.*—Leonard B———, aged 18 years, was seen in 1894 (see Fig. 245). The arches of both feet were diminished, especially the right; and the head of right astragalus and tuberosity of the scaphoid were on the ground, the foot abducted and everted, and very painful. The muscles of the right leg were much wasted, especially the tibialis anticus. A groove was seen along the outer side of the crest of the tibia, and the muscle was shrunken and flabby. By rest and the application of the constant current to the tibialis anticus, and gradually bringing the foot into good position in a Scarpa's shoe, he entirely recovered.

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[1] *Op. sup. cit.* p. 402.

[2] Cf. v. Lesser, *Deutsche med. Wochenschrift*, 1893, No. 44. p. 1070; and *Amer. Journ. Med. Sciences*, June 1894, p. 722, on "Sweating Feet and Flat-Feet."

When the feet are very painful, the peronei tendons are felt to be very tense, and may be seen to stand out in relief. At first this contraction of the peronei is reflex, and disappears with rest, but in old-standing cases these tendons and the extensor communis digitorum become actually shortened, and require division before the front part of the foot can be replaced (spasmodic flat-foot).

FIG. 245.

FIG. 246.

Two views of static flat-foot, viz. before and after treatment (Case 92). In Fig. 245 is seen a groove, externally to the crest of the tibia, and due to the wasting of the tibialis anticus.

For the purposes of description, the affection may be divided into degrees, but these distinctions are artificial at the best. A good mode of estimating the degree of deformity is described by Mr. Golding-Bird in the Guy's Hospital Reports, 1882.[1] He says: "If the inner side of a normal foot, or skeleton of the foot, be examined, it will be seen that the greater part of the span of the arch lies in the posterior half; and hence when the arch sinks, it can be proved by measurement that a greater change in shape and length occurs in the posterior than in the anterior half of the foot. The exact centre of the foot is the metatarso-cuneiform joint of

[1] *Pes Valgus Acquisitus, Pes Pronatus, Pes Cavus,* pp. 440, 441.

the great toe. . . . In those cases, where the arch has sunk, a disparity between the two measurements is at once apparent; and as in most cases the anterior half, having so little of the arch in it, retains within very small limits its normal length, the excess of the posterior measurement over the anterior very fairly represents the degree of flat-foot present. At times, however, a marked sinking of the anterior half of the arch is demonstrable by an excess of the anterior measurement over that of the healthy side, when of course the disease affects only one foot, so that the other remains for comparison." Cases are quoted by Mr. Golding-Bird in which the excess of posterior over the anterior measurement amounted to as much as $\frac{3}{4}$ of an inch. The same writer divides acquired valgus into simple acquired flat-foot, acquired flat-foot with fixation (fixed flat-foot), and acquired flat-foot with arthritic symptoms.

Since definite data are necessary before the various modes of treatment can be indicated, it is useful to divide cases into four degrees. But it should be understood that in this deformity as elsewhere there is no hard and fast line to be drawn. One class of case merges into another.

Degrees of Flat-Foot.—*First Degree, or Oncoming Flat-Foot.*—There is noticeable some sinking of the arch when the patient stands, and is told to bear the weight fully on the foot. This sinking disappears on adduction of the foot, standing on tiptoe, and on sitting. Pain is frequently present at this stage.

Second Degree or Pronounced Flat-Foot.—The arch has sunk to a considerable extent, although the head of the astragalus is not touching the ground. The deformity cannot be reduced by any effort of the patient, nor can the feet be voluntarily inverted. The peronei tendons and the extensor communis digitorum are seen in relief, and there is considerable muscular spasm and pain. By gentle and sustained efforts the surgeon is able to reduce the deformity. An instance of this is the following:—

CASE 93. *Case of Pronounced Flat-Foot.*—William A——, aged 19 years, was seen by me at the National Orthopædic Hospital in October 1893. He is a grocer's assistant, and complains of pain only in the ankles, which is always worse at night, but generally absent in the morning. When he stands, the left foot is markedly flat, and the right foot less so. With the tape the measurement from the most prominent part of the heel to the tip of the great toe on the left side is $11\frac{1}{4}$ inches, while on the right side it is 10 inches. The excess of the posterior over the anterior half of the left arch, estimated on Mr. Golding-Bird's plan, is $\frac{1}{2}$ inch. The head of the astragalus and the tubercle of the scaphoid are prominent and nearly touch the ground, and the outer border is slightly everted, while the front part of the foot is also slightly abducted. Any attempt to restore the arch by manual pressure causes considerable pain. There is considerable contraction of the peronei tendons.

He was ordered to rest entirely, and to sit tailor-fashion with the outer borders of the feet in contact with the couch. At the end of two weeks the pain and spasm of the peronei had disappeared, and the arch was less flat. He was then able to wear a boot with a valgus pad and T-strap. This he did, at first for a short time, and later all day. Finally he was able to resume his occupation.

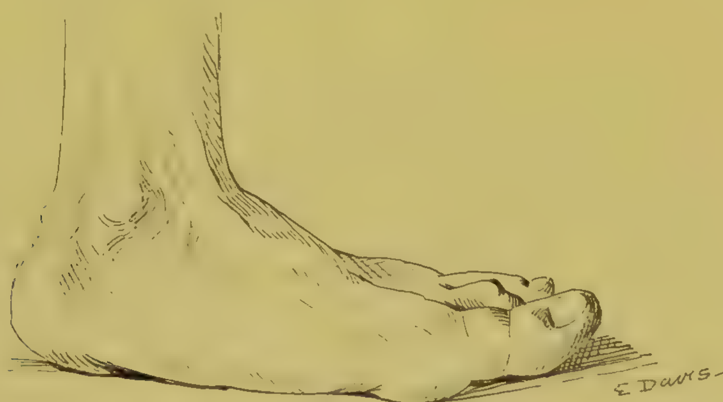

FIG. 247.

FIG. 248.

Two views of Case 93. Pronounced flat-foot.

Third Degree, Rigid or Spasmodic Flat-Foot.—In this degree the astragalus and scaphoid are touching the ground, the foot is very tender, the patient can only " hobble " about, and the deformity can be reduced neither by the patient nor by the surgeon. The peronei and extensor communis digitorum are in strong relief, and the thickening of the soft tissues on the inner side is much in evidence. The eversion and abduction of the anterior segment of the foot are very noticeable. Amongst many others, the most painful cases of this variety met with were in a waiter, aged 40 years, and in a gardener, aged 36 years. Both recovered under treatment, but it was interesting to note that in the case of the gardener, his wife subsequently became pregnant, and the child was born with double equino-varus. There had been no other cases of congenital club-foot in the family.

Fourth Degree, or Osseous Flat-Foot. — Of this degree Mr. Walsham, whose description of the different grades I have adhered to, has met with but two cases. Although, as he says, "since they

FIG. 249.

Outline of a flat-foot.

FIG. 250.

Outline of normal foot.

(cases of this degree) appear to have been met with more frequently in the practice of Professor Stokes,[1] Professor Ogston, and others, we must suppose that their occurrence is more common than our statistics would lead us to believe." Marked changes arising from arthritis occur at the medio-tarsal and other joints (Fig. 254). I have felt in severe cases distinct grating in the first metatarso-phalangeal joint, and have seen considerable hypertrophy of the base of the first metatarsal bone, but as I have not performed tarsectomy

[1] In this connection see Sir William Stokes, "Remarks on Flat-Foot," *Brit. Med. Journ.* 1st Dec. 1894, p. 1224.

2 H

in these cases, I am unable to speak as to the existence of ankylosis in the astragalo-scaphoid joint.

The Etiology of Flat-Foot.—In the majority of cases there are three factors involved, viz. adolescence, feeble health, and strain on the feet out of proportion to the muscular development.

1. *Adolescence.*—Mention has already been made of the occurrence of flat-foot in the rickets of childhood. Either owing to the persistence of post-rhachitic weakness of the ligaments, or to the occurrence of late rickets, flat-feet are sometimes seen in childhood. At the time of puberty, especially in girls, the body becomes weighty, and at the same time the general health is often impaired by the strain incidental to that period. The strength of the muscles and ligaments supporting the arch of the foot does not increase *pari passu* with the general growth of the body, and breaking down of the arch commences. Taking 100 cases under the age of 25, I find that the average age of onset was 14 years. Now at this age the foot frequently becomes unduly lengthened, and the arch is therefore extended. It is these "long" feet which are very liable to become flattened, and to assume rapidly a severe form.

But it must not be thought that acquired valgus is only likely to occur in adolescence and early adult life. Any cause which throws too much stress on a weakened arch in later years produces the like result. Thus I have notes of cases commencing at the thirty-sixth, fortieth, forty-fifth, and fiftieth years.

2. *Feeble or Impaired Health.*—Under this heading there are—

(*a*) Weakness following the exanthemata. One of my cases suffered from scarlet fever at 5, measles at 8, succeeded by pneumonia, and a second attack of pneumonia at 12 years of age, followed by flat-foot at 13.

(*b*) Acute rheumatism. After this disease two kinds of deformity of the foot are seen—flat-feet and contracted plantar fascia. It is difficult to explain the occurrence of such totally opposite conditions in different subjects, but it seems to me that subacute rheumatism is more liable to be followed by contraction, and acute rheumatism by relaxation of the fascia and tendons. Certainly, repeated attacks of subacute rheumatism are followed by limitation of movement in the larger joints, and acute rheumatism is not unfrequently a cause of a condition of excessive freedom of mobility in the same joints.

(*c*) Anæmia. This condition so common in girls may serve to explain the more frequent onset of the deformity in that sex at the age of puberty. At this time, too, scoliosis often commences, and is not seldom combined with flat-foot.

3. *Excessive Strain on the Feet.*—Occupation involving long standing on weak feet (static club-foot) is an immediate cause. Thus amongst my cases some of the occupations were grocer's assistant, gardener, butcher, errand-boy, porter, barman, waiter, domestic servant, and nursemaid.

In addition to these general factors, *local conditions* are concerned; these are—

1. Bunions and corns on the outer side of the foot.

2. Hallux valgus.

3. Genu valgum.

4. Shortness of one limb. In them progression is easier if the inner side of the foot is brought to the ground first.

5. High-heeled and Narrow Boots.—In addition to the difficulty of balance, Mr. Golding-Bird[1] says: "The height that the heel takes the ankle off the ground gives immense leverage from below upon the astragalo-calcanean joint; and this must be met by proportionately muscular development in order to preserve the equilibrium of the foot. When this is not forthcoming the joint gradually yields; and the parents, discovering a projection of the inner malleolus, bring their daughter to be treated for 'ingrowing' ankle."

FIG. 251.—Outline of the sole of a flat-foot due to static causes.

In another way, tight or stiff ungainly boots produce flat-feet by preventing sufficient play of the muscles of the leg and foot.

6. Gout.—An attack of this disease in the foot is in middle-aged persons sometimes the precursor to flat-feet. Such an instance was that of Laura W———, aged 49 years, a housekeeper. Eighteen months previously to being seen by me, she had an attack of gout in the right foot, which is now in the second degree of flatness.

7. Injury.—Excluding examples of badly-set Pott's fracture, which often become valgoid subsequently, it is a common observation that the date of onset of flat-foot coincides with a sprain or injury in itself insufficient to account for all the deformity then present. I saw in 1891 a boy, aged 8 years, whose right foot had been run

[1] *Loc. sup. cit.* p. 445.

over three months previously, and who developed a painful rigid condition of flat-foot.

Doubtless in some cases, of which the last-mentioned is an example, the effect of the injury is such as to permanently damage the ligaments and fasciæ. But in other cases it would appear that the valgus had existed some time although pain had been absent, and that when the strain of repair was thrown on weakened ligaments and muscles, they failed to respond and yielded still further, so that the pain and disability came immediately in evidence. From this time the patient will date his trouble.[1]

8. Dr. Gowers[2] states that locomotor-ataxy and flat-foot co-exist in a fair proportion of cases.

9. Gibney[3] mentions two cases of flat-feet produced by ingrowing toe-nail.

To sum up. The predisposing causes are adolescence, rapid growth, anæmia, acute febrile disorders, long standing on the foot in the abducted position (the position of rest). The exciting causes are slight injury, gout, and rheumatism.

Pathology.—Abduction of the foot is the position of weakness, and adduction of strength and activity, or the usefulness of the foot varies with the preponderance of power of the adductor muscles; when this is lost weakness and pain ensue (Royal Whitman). The same truth is expressed by Arbuthnot Lane,[4] who says: "Abduction of the foot is the position of rest in the erect posture, while that of adduction is the attitude of activity. Abduction is the position habitually assumed by people of poor muscular activity."

Hueter believed that flat-foot is simply the persistence of the normal pronated condition in infants, and that this condition is confirmed in valgoid subjects by subsequent changes in the bones.

[1] Whitman, *Trans. Amer. Orth. Assoc.* vol. iii. p. 73, "On Persistent Abduction of the Foot (Chronic Sprain of the Ankle)," thus explains the modus operandi of sprains in causing flat-foot. He says: "In a healthy foot forced dorsal flexion may be carried to 70°-80°, forced extension to 140°-180°. If the foot be extended, the patient should be able to raise the inner border of the foot until the sole forms an angle with the floor of 40°-60°, but a patient with persistent abduction of the foot cannot raise the inner border at all, and if from any cause movements at the ankle or the medio-tarsal joints are limited, the patient everts the foot to avoid flexion in walking. Such a condition arises from sprains of the ankle, especially of those kinds severer degrees of which result in Pott's fracture. As a result of the persistent abduction, subluxation of the astragalus downwards and inwards occurs, hence the adductors work at a disadvantage and the spasmodic action of the abductors is perpetuated."

[2] Quoted by Walsham and Hughes, p. 411.

[3] *Trans. Amer. Orth. Assoc.* vol. ii. p. 287.

[4] W. Arbuthnot Lane, *Guy's Hosp. Rep.* 1883, vol xi.

In opposition to this view, it may be pointed out that in most cases of flat-foot an interval occurs between infancy and the onset of valgus. In this interval the arch shows good development, and the position of supination has been assumed, *i.e.* in the majority of cases a more or less normal condition of the feet is present in childhood. Lorenz[1] has conclusively shown that the distortion is due to the new position assumed by the os calcis, astragalus, and scaphoid.

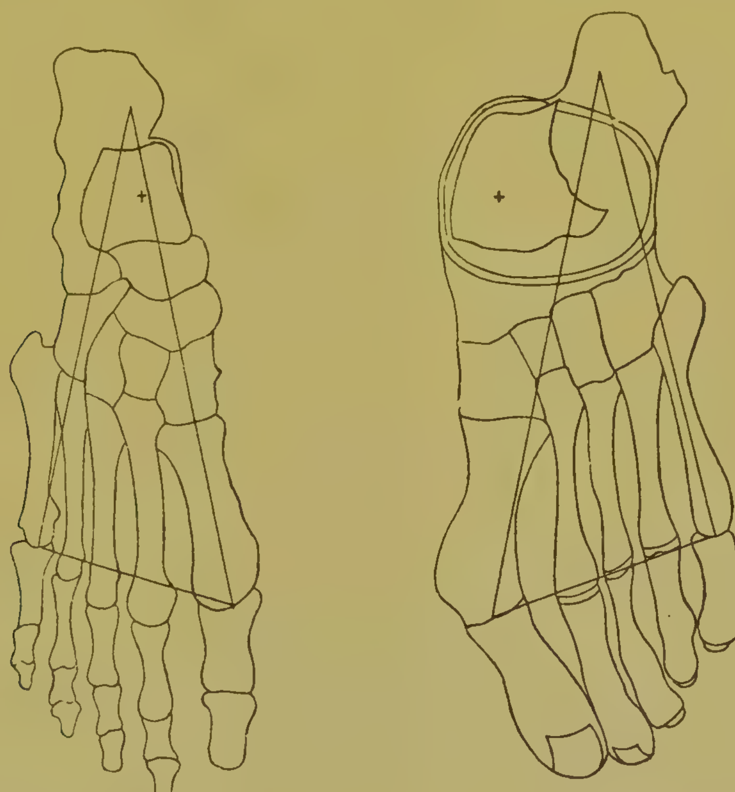

FIG. 252. FIG. 253.

Outline of von Meyer's triangle in the normal and in the flat foot.
The + indicates the position of the astragalus "point" (the centre of the trochlear surface of that bone). After Sir W. Stokes.

And as Bradford and Lovett[2] remark: "It is the result of a disproportion between the body-weight and the apparatus for sustaining it."

The pathology of spurious valgus is much assisted by a consideration of von Meyer's triangle (Figs. 252 and 253). If the patient be standing firmly on both feet a triangle may be drawn by uniting three points, the centre of the heel and the heads of the first and fifth metatarsal bones. The triangle is acute-angled, with its apex

[1] *Plattfuss*, Stuttgart, 1883. [2] *Op. sup. cit.* p. 728.

at the heel. Normally the centre of the trochlear surface of the astragalus (the "astragalus-point") is immediately above the inner line of the triangle. But in flat-foot it is altogether inside this line. The base of the triangle is also increased, the inner side lengthened, and the outer side shortened. My colleague, Mr. Horrocks Openshaw,[1] has discussed the etiology of flat-foot, and dwells upon the importance of the integrity of the transverse arch. He also shows that "as the body moves forwards and backwards the course of greatest weight may be roughly indicated by an antero-posterior line. At any single point in this line the body-weight will be distributed not only forwards and backwards, but laterally also." Mr. Openshaw then adds: "When standing upon both feet, with the body bent forwards, the body-weight will strike the centre of the internal plantar arch itself, and will thence be transmitted forwards to the great toe, backwards to the heel, and outwards to the outer arch in each foot. The inner arch is . . . prevented from collapsing solely by muscles and ligaments, and upon them, therefore, there will be the greatest strain when the body and feet are in the above position. The farther apart the feet are held, or the more turned outwards the feet are, the more will this antero-posterior line be displaced inwards, until it fails to strike the great toe, but crosses the inner border of the foot. The line described by the weight of the body when walking with the foot turned well outwards, in fact becomes a curved one, commencing at the heel, running forwards, and then turning inwards across the inner margin of the foot. From what has been said, it is not difficult to see why prolonged standing on both feet, with the body slightly bent forwards and the feet turned out, should be the attitude, of all others, which will most quickly produce a bulging of the inner portion of the arch and border of the foot." The entire article is well worthy of attentive perusal, as it puts the whole question in a concise manner.

Another view of the pathology of flat-foot must be alluded to, viz. that it is due to paralysis of the tibialis anticus muscle. The view is, I believe, held by Professor Sayre. With reference to it, I must say that although in my opinion it does not explain the majority of the flat-feet, yet I have seen at least three cases in which a distinct groove could be seen and felt along the outer side of the crest of the tibia in its whole length, and corresponding to

[1] "Some Points on the Etiology and Treatment of Acquired Flat-Foot," *Clinical Journal*, 12th Dec. 1894, pp. 106-112.

the position of the tibialis anticus. One of these cases is figured on p. 462. The muscle was not paralysed, but it had undoubtedly undergone some wasting. That the anterior tibial muscles are stretched and weakened, and have their periosteal attachments pulled on is evidenced by the pain felt on the shin.

Morbid Anatomy.—*The Ligaments.*—The most marked change is in the inferior calcaneo-scaphoid and the calcaneo-astragaloid. The former is relaxed and broadened,[1] and has resting on it more of the inferior aspect of the head of the astragalus than normally. Of the calcaneo-astragaloid ligaments the interosseous is stretched, and its fibres are separated one from another. The external ligament of this articulation is also longer than naturally. As the ankle becomes more valgoid, its ligaments suffer in proportion. The superficial part of the internal lateral ligament is elongated and thinned, while its deeper part suffers but little. The external lateral ligament shows changes chiefly in its middle fasciculus, which is thin and atrophied.

Fasciæ.—In early cases just as the arch is giving way I have felt the inner band of plantar fascia very plainly in relief. In such a case it is probable that the ligaments and muscles have given way before the fascia.

Muscles.—In advanced cases the calf loses much of its roundness, owing to gradual wasting of the muscles. Mention has already been made of the wasting of the tibialis anticus. The peronei are in a state of tension, and their tendons stand out like cords. The tibialis posticus tendon passes beneath the head of the astragalus, instead of internal to it.

Bones.[2]—The os calcis is rotated on a horizontal antero-posterior axis, so that the outer border of the inferior surface is raised, its inner lowered, and the outer tuberosity cannot come in contact with the ground. Its anterior extremity looks forwards and outwards. Its outer side in severe cases articulates with the fibula, and a new joint is formed here.[3] The astragalus is displaced downwards, forwards, and inwards with reference to the bones it articulates with, although, as Walsham and Hughes are very careful to point out, it is displaced downwards and outwards with reference to the bones of

[1] Von Meyer states, however, that it is not elongated, *Jahresbericht der Med.* 1883, p. 15. Symington controverts this, *Journal of Anat. and Phys.* 1884-85.

[2] A very exhaustive account of the alterations in the direction and shape of the bones is to be found in Walsham and Hughes' work on *Deformities of the Foot*, on pp. 412-423, and 424-427.

[3] John Wood, *Path. Soc. Trans.* 1857.

the leg. The head of the bone is twisted inwards. On it at its upper and outer part is seen a growth of new bone—an attempt of Nature to arrest the deformity. The extent of surface resting on the inferior calcaneo-scaphoid ligament is much increased, while the scaphoidal facet is diminished. The scaphoid is displaced outwards and upwards, and is rotated externally. Its tuberosity drops downwards and inwards. This bone is also much altered in shape. The cuboid and cuneiform bones undergo a similar rotation, but are otherwise little altered.

The metatarsal bones are stated by Rédard to be adducted. His opinion is supported by Lorenz. The writer's impression is that they are abducted.

The Malleoli.—The external malleolus in severe cases is in the same transverse plane as the internal or even in front of it, while the position of the internal is but little altered.

Symptoms.—They are—(1) pain; (2) swelling; (3) flattening of the sole; (4) alteration in gait; (5) loss of shapeliness of the foot; and (6) congestion and sweating of the feet.

1. *Pain.*—In many instances this is present from the first. Occasionally it is complained of only after a twist or sprain of the foot. It would then appear that although the ligaments and muscles were relaxed previously to the injury, and some valgus was present, yet it was not of such a degree as to be painful. The sprain probably has been just sufficient to cause a sudden giving way of weakened ligaments, and many, if not all, the causes of pain come suddenly into action. In most instances of flat-foot of severe grade, pain is a prominent symptom. But occasionally it happens not to be the case; whereas slight cases may be attended with much suffering.

The character of the pain is not uniform. In the early stages there is first a feeling of fatigue, succeeded after a few days or weeks by a dull aching, which is noticed first in the feet and then extends to the legs, and even to the thighs. On resting in the evening, with the feet raised, the aching passes away. But as the daily occupation is persisted in, the aching comes on earlier in the day, and towards evening assumes a sharp and intense form, shooting up into the legs and thighs. In the early stages of this sharp pain the night's rest is followed by freedom in the morning; but after a time there is often a considerable loss of sleep from it, and when the patient wakes he finds the feet stiff. On rising and placing the feet on the ground, the aching at once recommences.

Finally, the patient is unable to stand for any length of time, and can only hobble with considerable difficulty.

The *tender points* in the feet are well defined and very sensitive to pressure. They are found beneath the head of the astragalus and tuberosity of the scaphoid, below and in front of the internal malleolus, on the dorsum of the foot just in front of the ankle, and about the bases of the first and fifth metatarsal bones. Less often the pain is felt about the external malleolus, and on the outer side of the shin and up the thigh.

FIG. 254.—Flat-foot with arthritic changes (after Sir W. Stokes).

The causation of the pain is not difficult to understand. The feeling of fatigue first complained of arises from overwork and stretching of the muscles. They have not sufficient vigour to repair the metabolic changes of ordinary daily wear and tear. The dull pain is due to stretching of ligaments and fasciæ, and the pull upon the enfeebled muscles. The sharp pain has its origin partly in the continued strain on the soft tissues, but more often is referable to surfaces of bone not normally in contact being brought into relationship with one another at points which are not accustomed to pressure. I have heard it taught that the persistence of pain beneath the head of the astragalus is due to the weight of the body compressing the internal plantar nerve between the bone and the ground. But this is unlikely. The extreme stretching of the ligaments of this articulation is sufficient to account for much. If the pain must be assigned to the nerve trunk, the explanation would probably be found in the longitudinal stretching it undergoes. Over the tender spots the skin is extremely sensitive.

Arthritic changes (Fig. 254) explain some of the worst degrees of pain, especially when it is situated at the base of the first metatarsal bone. Here distinct hypertrophy is present. Allusion has already been made on p. 472 to the formation of new bone at the upper and outer part of the head of the astragalus—an evidence of increased vascularity at least, and in bone this is usually accompanied by pain.

2. *Swelling of the Feet.*—Local puffiness is frequently seen over the tender points, and redness from time to time, dependent in degree on the amount of standing and walking. When redness is present, the mere touch of the finger increases the pain. If the case be of rheumatic origin, the pain is worse at night, and effusion into the tendon-sheaths occurs. In old-standing cases, especially if varicose veins are co-existent, a general œdema of the foot occurs. In cases of the third degree, corns and false bursæ or bunions form over the prominent portions of the bone. Inflammation of these adventitious structures is attended with exquisite pain.

3. *Flattening of the Sole.*—The existence of this is best ascertained by taking a tracing or outline of the tread. Thereby the slightest cases ought not to escape recognition, and the degree of improvement or the reverse can be noted from time to time.

4. *Alteration in the Gait.*—In cases of some severity the gait is lumbering and awkward; the patient is splay-footed. He walks with considerable difficulty, and cannot move quickly. The foot is no longer elastic, and walking is further impeded by the attendent pain. The loss of elasticity is due to stretching of the ligaments, and alteration in the position and direction of the bones, especially of those entering into the medio-tarsal joint, and to a less extent of those at the ankle-joint. The foot is involuntarily kept stiff and rigid, and hence the patient appears "wooden-footed." If, as not seldom occurs, there is ingrowing toe-nail, the awkwardness of progression is still more marked.

Loss of Shape of the Foot.—The change in appearance has been fully described on p. 459, but the relative position of the bones and malleoli should be noted, and the shape of the inner and outer borders, with the amount of falling of the arch.

6. *Sweating of the Feet.*—By many flat-feet and sweating are said to frequently co-exist. The explanation may be that both are due to feeble local innervation of the vessels and other structures, and consequently to poor nutrition, but this is rather a speculation than a fact confirmed by research.

Prognosis.—Flat-feet do not become cured without treatment. As a rule, the pain and disability become steadily worse, and the patient has to seek relief from the inconvenience. Occasionally, however, after several years, when the breaking down of the arch has ceased, the pain disappears, but the foot is permanently damaged, and has lost nearly all its usefulness.

Diagnosis.—Probably there is no deformity so easily and so often overlooked as slight acquired valgus. But a careful examination of the foot, especially if a tracing of the sole be taken, will often reveal the true cause of the pain and swelling. I have known cases to be treated for rheumatism, gout, and for ostitis of the bones of the tarsus. But, as Bradford and Lovett justly remark: "There is no need of entering upon any elaborate differential diagnosis, for mistakes are oftenest the result of carelessness. It is a wise precaution to investigate the condition of the arch in all painful feet."

Treatment of Acquired Flat-Foot.—The treatment of flat-foot in many cases must be both general and local.

General Treatment.—If anæmia be present, iron should be given for a considerable period. The best forms are probably Blaud's pills and Mistura ferri composita. Objections to the latter are its uninviting appearance and nauseous taste. A good mode of giving the carbonate of iron is in the form of "jelloids." Change of air and rest are often urgently called for. When the rheumatic diathesis is present, salicylate of soda in acute and sub-acute cases, and in the chronic, iodide of potassium and tincture of guiaiacum will be found serviceable. Gonorrheal rheumatism is very intractable. Iodide of potassium and cod-liver are said to do good. When gout is associated with flat-foot, citrate of lithia, citrate of potassium, and piperazin associated with suitable dietetic treatment will ameliorate the general condition. In rhachitic flat-foot, cod-liver oil, the phosphate of iron, the hypophosphites of calcium, and plenty of fresh milk and pure air will go far to effect a cure.

The relief of pain is often a pressing necessity. The surest therapeutic measure is rest, *entire and absolute.* But unfortunately patients rarely understand the full value of complete rest, and indeed are often unable, from force of circumstances and surroundings, to obtain it. At the most, the rest is only partial. If the feet are acutely sensitive, the application of extract of belladonna and glycerine, or warm opium lotion or poppy fomentations gives temporary relief. Rédard suggests the injection of cocaine near the painful joint. But surely it is not advisable to habituate a patient to the use of this drug in so chronic an affection as flat-foot.

Local Treatment.—The means we have are—

Rest.

Exercises—passive and active.

Mechanical support.

Operative measures, including forcible manipulation.

But the exact line of treatment must depend upon the degree, severity, and duration of the deformity. Briefly, it may be said that in the first and second degrees of flat-foot rest, passive and active exercises, and mechanical supports will all be employed, but each to an amount varying with the special cause at work, and the condition of the muscles and ligaments. To illustrate my meaning I would instance the case of flat-foot of the first and second degree in an anæmic overgrown girl. It is useless to trust to tiptoe exercises as an immediate remedy. The patient is physically incapable of raising herself often on tiptoe, and if she do so, the strain on the muscles and ligaments is so great as to cause further breaking down of the arch. This class of case requires rest and support as the prime factors in treatment, and when the parts have regained their positions the muscles may be actively exercised, so that the best means may thereby be taken to prevent a return of the trouble.

Prophylactic Treatment in Children.—Royal Whitman,[1] in a most interesting article, has pointed out that the attitude of muscular weakness, as shown in infancy and old age, is with the feet wide apart and the toes widely separated to increase the base of support. On the contrary, the attitude of muscular strength and activity is with the feet well under the body, and the toes pointing straight ahead. The walk of muscular weakness and inactivity is the walk of flat-foot, the step is short and inelastic, the toes widely divergent, the weight borne almost entirely on the inside of

[1] *Trans. Amer. Orth. Assoc.* vol. i. pp. 122-134.

the heels. The foot, resting flat on the ground, is lifted by an exaggerated bend of the knee, the final strain falling entirely on its "weakest part" (the arch). He goes on to say that "the walk of civilisation is a direct approximation to the walk of weakness," because, firstly, the ordinary boots are so made that corns and bunions result, and the muscles are at the same time weakened from disuse by the pressure of the tight unyielding boot; and, secondly, children are often allowed, and even taught, to stand by drill-masters with the feet abducted, and their inner borders separated at an angle of 60°. Thus the best preventive of flat-foot is a proper walk in shoes not too thick, and approximating in the sole "the shape of the Greek sandal," so that the foot points directly forwards and is not cramped. All games which fully employ the muscles of the feet and legs should be encouraged.

Treatment of the First and Second Degrees.—Mr. Golding-Bird [1] pithily remarks: "The principle of all successful treatment in acquired valgus is to relieve the overstrained adductors, that they may again recover; offer due opposition to the abductors (peronei) as nearly like that they have lost as possible; relieve the pronation and eversion and the sunken arch by giving elastic support upwards and inwards. Before this can be done all active spasm on the part of the peronei must have ceased." In static and rhachitic cases of this degree the first essential is *absolute rest*, and with this may be combined the relief of the abduction. The patient should be told to sit on a comfortable sofa or bed, tailor-fashion, *i.e.* with the legs crossed and the weight of the limbs bearing on the outer edge of the foot. By making use of this posture, which is maintained for two to four weeks, the foot rapidly regains its normal appearance, the pain ceases, the arch rises, and the deformity is temporarily relieved. I have now, however, under my care a butcher who is suffering from acquired valgus in the left foot, and unable to lie up on account of his business. He has successfully adopted the plan of walking on a wooden pin-leg, with the leg and foot carried at right angles behind.

But rest merely allows the foot to return partially to its normal position, and gives the exhausted muscles and weakened ligaments breathing time, so to speak. Then two other methods should be employed in addition, viz. exercises and an elastic support to the arch of the foot, the exact proportion of each being dependent on the general and local conditions.

Exercises.—Those most to be recommended are the tiptoe move-

[1] *Loc. sup. cit.*

ments. The object is to strengthen the flexors of the toes, especially the long and short flexors of the great toe. At the same time the tibialis posticus should be called into vigorous action, and with the extension of the foot the tibialis anticus come into play. The exercises should be carefully regulated. The patient stands erect with the arms by the side. The feet are placed on the ground somewhat adducted and inverted, the toes being nearer together than the heels and the knees fully extended. He then raises himself on tiptoe and immediately resumes the position of rest. It is best to do this in rhythm to the swing of a pendulum, or to the beat of a metronome, which can be set to the required rate. At first two to three minutes' exercise, twice a day, followed by complete rest in the tailor-position is all that can be borne, the patient ceasing the exercise before fatigue is felt. But as the muscles acquire strength and vigour, the duration and the number of times a day may be increased. The same idea is carried out by going upstairs, first bringing the toes into contact with the stair and then the whole foot. Another form of exercise is to place the feet nearly touching, and to invert the sole so as to bear the body-weight on the outer edge. Then to resume the original position. This may be done as often as the tip-toe exercise and in place of it.

Passive exercises may be carried out as follows:—The nurse takes the foot and performs a combination of extension movements at the ankle with rotation at the medio-tarsal joint, at first inwards and then outwards. Later the patient should be able to perform them for himself.

Supports.—In very slight cases it is sufficient after resting to have the heel prolonged forwards on the inner side and thickened at the inner edge, after Thomas' plan. In the first and second degrees of flat-foot, it is worthy of notice that the pain is immediately relieved by temporarily wedging up the inner border of the foot with a thin book or a piece of paper suitably folded. In fact this is a good means of diagnosis in doubtful cases.

Bandages.—In early cases the application of a wedge-shaped pad of cotton-wool, the feet being strapped with diachylon plaster and bandaged, is much resorted to at some hospitals as a means of relief, especially when the patients are too poor to pay for any kind of pads in the boots. The strapping is put on in figure-of-8 fashion from within outwards, each figure-of-8 being made up of a separate piece, and the bandage is applied from within outwards, so that each turn passing beneath the arch and over the dorsum of the foot pulls the arch upwards and draws the outer border downwards. But this plan has many disadvantages. By the strapping and bandage the foot is cramped and confined, and the cotton-wool pad shifts, and becomes useless and uncomfortable. In accordance with the idea of elastic traction a Martin's rubber bandage has been used. This, however, has disadvantages similar to an ordinary bandage, and may, further, cause eczema from the confinement of that free perspiration so common in flat-foot.

Pads and Surgical Soles.—Pads are made of various materials, viz. felt, wool, leather, steel, rubber, or hollow and filled with glycerine after Mr. Walsham's pattern. Of these the vulcanised rubber are the most useful and in the end least expensive, since felt, wool, and leather become sodden with perspiration and hard to the foot, while rubber becomes softer and more elastic with wear.

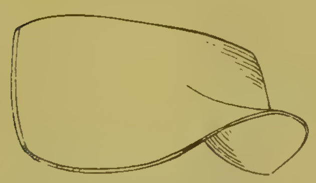

FIG. 255.—Whitman's valgus sole plate for the right foot.

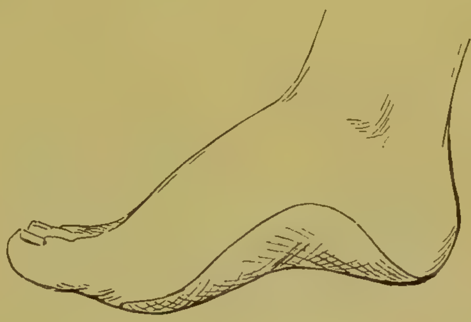

FIG. 256.—The same applied.

To be of any value the valgus pad must be made a part of the boot. A good combination for the first and second degrees of valgus is Ernst's boot with the vulcanised valgus pad and concealed spring. The boot is made on the same pattern as that for varus, with the exception that the spring is on the outer side of the boot. In marked cases a boot with valgus pad and outside support to the knee with valgus T-strap is indicated. At first pads and surgical boots can be worn for half to one hour, and this time should be gradually increased until the apparatus is worn all day.

The surgical sole, which resembles a cork-sole with a steel-piece shaped to the concavity of the arch, is of little or no value. It does not keep its proper position, and often does more harm than good.

A most excellent contrivance is Whitman's brace,[1] made of steel, or preferably, since this may rust, of aluminium, which is light and comfortable and does not interfere with the movements of the foot

[1] *Trans. Amer. Orth. Assoc.* vol. i. pp. 130-132.

or muscles. At the same time the brace fits so perfectly that there is no tendency for the foot to slide from the brace when the body-weight bears on it. The brace is made as follows: "The flat-foot is by manipulation replaced as far as possible in the normal position. In an acute case, accompanied by pain, redness, and swelling, the foot should be placed in a plaster bandage in an adducted and inverted position for a time; afterwards rubbing and bandaging will bring it into condition for the plate. In old cases a forcible breaking up of adhesions and reposition under ether is sometimes necessary. The foot being at right angles to the leg and slightly flexed at the medio-tarsal joint, a plaster-cast is taken, on which the lines for the plate are drawn. The point A is made beneath the ball of the great toe, just short of its bearing centre; a point B, just short of the bearing centre of the heel bone, beneath its inner

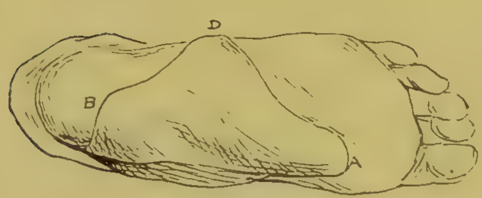

FIG. 257.

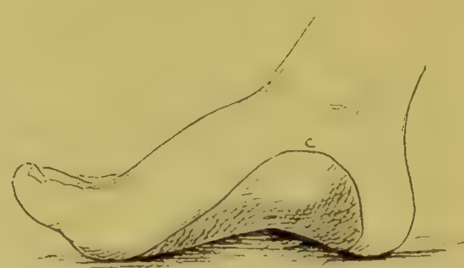

FIG. 258.

Whitman's valgus plates.

tuberosity, so that the foot may rest on its natural supports; C, just above the head of the astragalus, a little in front and below the internal malleolus. These three points are now connected by a gradually ascending line from A, rising above the inner border of the foot, a little in front of the internal cuneiform bone, curving upward above the scaphoid, meeting at C the line drawn upward from B. A curved line is drawn, three-quarters of an inch in length, whose centre corresponds to a point D on the outer aspect of the foot, just above and behind the tuberosity of the fifth metatarsal. The extremities of this line are now connected with A and B, and the pattern is completed. The brace should be accurately moulded in the cast, and the outer third of the arm D must be perfectly flat, so that when pressed down it may lie smoothly against the sole of the shoe." Two objections have been urged against this brace. (1) That it prevents the natural movements of the foot. This is not correct in practice. (2) That it causes painful pressure. This objection is disproved also in practice. So that when the arch of

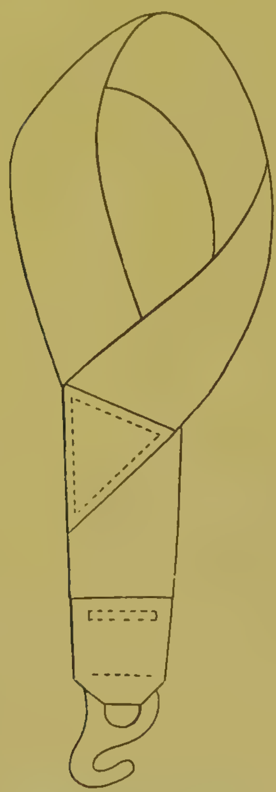

FIG. 259.—A sling of soft webbing for supporting the arch of the foot

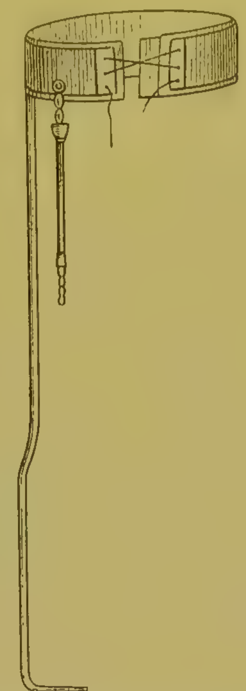

FIG. 260.—An outside steel support, fitting into the boot, with a steel garter-piece carrying an elastic spring to which the hook in Fig. 259 is attached.

FIG. 261.—The sling in position.
Mr. Golding-Bird's sling with elastic traction for the treatment of flat-foot.

the foot is nearly restored, the brace acts as a most efficient support. It is also mechanically correct.[1]

Personally, I have been content to use the boots with the valgus

[1] On this point see Dr. Whitman's remarks, *loc. sup. cit.* p. 132.

pad and spring in cases of the first degree, the boot with the outside iron and valgus pad and T-strap in the second degree, but lately I have used the Whitman's brace, and find it very efficient. With the idea of applying continuous upward tension to the sunken arch, various forms of elastic supports have been arranged.

Elastic Tension.—Barwell's method is the oldest, and Walsham and Hughes[1] describe a method of their own, "which is a combination of elastic tension with a boot and leg-iron for severe degrees of flat-foot, especially where patients are unable to sufficiently carry out exercises, and where their occupation necessitates the continuance of long hours of standing." Mr. Golding-Bird uses a modification of Barwell's apparatus in which, by an arrangement of an outside leg-iron, an elastic band and a sling of soft webbing, the strapping in Barwell's apparatus is done away with. The arrangement can be understood from Figs. 259-261, which Mr. Golding-Bird has kindly allowed me to use.

To sum up the treatment of the first and second degrees of flat-foot. First, rest till the pain has disappeared and the arch is rising; then the use of passive exercises, if the muscles continue weakly, but when these become stronger, of active exercises. When the patient stands, a suitable support to the arch is required. Of the latter the valgus boot with pad and spring, or T-piece, Whitman's brace, and Golding-Bird's modification of Barwell's plan are all suitable.

Treatment of the Third Degree—Rigid or Spasmodic Flat-Foot.—The causes of the rigidity are two, viz. the altered position of the bones, and the pain and tenderness incidental to this stage, which set up reflex contraction of the peronei and extensor longus digitorum. These muscles may be permanently shortened or contractured, and the peronei tendons are sometimes dislocated forwards. But it is not always possible to be sure how much of the tightness of the peronei is reflex and how much is permanent. Before any division of these tendons is decided on, it is well to take the patient completely off the feet for a fortnight. So much of the peroneal contraction may disappear that it is not necessary to perform tenotomy of these muscles. In the event of the peronei remaining contracted after a few weeks' rest, tenotomy should be done. In addition to the peroneal tendons, the tendo Achillis may need division. Now cases of this degree may be treated in two ways, either by—

[1] *Op. sup. cit.* p. 459.

(*a*) Forcible rectification under an anaesthetic, and then retention of the foot in plaster.

(*b*) The gradual method, by tenotomy, passive exercises, and the employment of a modified Scarpa's shoe.

Forcible Rectification, either by the hand or Thomas' wrench. If the hand be employed, the method of Mr. Willett,[1] the patient must

FIG. 262.

FIG. 263.

FIG. 264.

Three views of a case of spasmodic valgus, with rigidity of the peronei and extensor communis digitorum.

be fully under ether. The surgeon stands in front of the patient, and grasping the anterior part of the foot with both hands, with the thenar eminence of his right hand, if it be the patient's left foot, and the reverse if it be the right foot, and pressing firmly on the head of the astragalus, steadily adducts and inverts the foot at the medio-tarsal and sub-astragaloid joints until the adhesions are felt

[1] *St. Bartholomew's Hosp. Rep.* vol. xviii. 1882.

to yield. Then rotation and circumduction movements are made at these joints, and finally the ankle-joint is forcibly moved in all directions. The effects noticed are that the foot has come into better position at once, the peronei tendons are no longer tense, and the arch is partially or entirely restored. A thick flannel or cotton-wool bandage is applied nearly to the knee, and then a plaster bandage put on from within outwards in figure-of-8 fashion. Anæsthesia is maintained until the plaster is dried, so that the foot remains fully adducted and inverted and lightly flexed. Afterwards the patient may be allowed to walk, if extra strips of plaster bandage are applied to the inner side and to the heel. The bandage should be worn for a month. If at the end of this time the foot is not in good position, the process must be repeated. When the plaster is finally removed the patient is ready for exercise and a suitable walking apparatus.

The same measures can be carried out with Thomas' wrench in the place of the hand.

The Gradual Method.—This has been carried out for some years past at the National Orthopædic Hospital. In the first place, unless the spasm subside by rest, the peronei and extensor longus digitorum and, in some cases, the Achillis tendons are divided, and an external malleable iron splint put on until the punctures are healed. The affected foot is then placed in Mr. Adams' modification of Scarpa's shoe, designed for these cases, and the foot gradually adducted and rotated inwards. Due attention can also be paid to the eversion at the ankle during the use of this apparatus. Care is taken that finally as much adduction as possible at the ankle and medio-tarsal joints is obtained. At least once a day, but better twice a day, the shoe is removed, and passive exercises resorted to. The leg muscles are at the same time vigorously shampooed. In cases of this degree supports for walking are called for after this treatment. The double upright walking instrument is generally needed at first, and as the foot increases in strength, the inner support may be removed, and still later the valgus boot with pad and spring substituted.

Treatment of the Fourth Degree.—It is in this degree, and when wrenching under an anæsthetic has failed, that operative interference on the bones is alone justifiable.

The operative measures are :—

1. Resection of the Astragalo-Scaphoid Joint (Ogston's Operation).

2. Hare's[1] Modification of Ogston's Operation.
3. Extirpation of the Astragalus (Vogt's Operation).

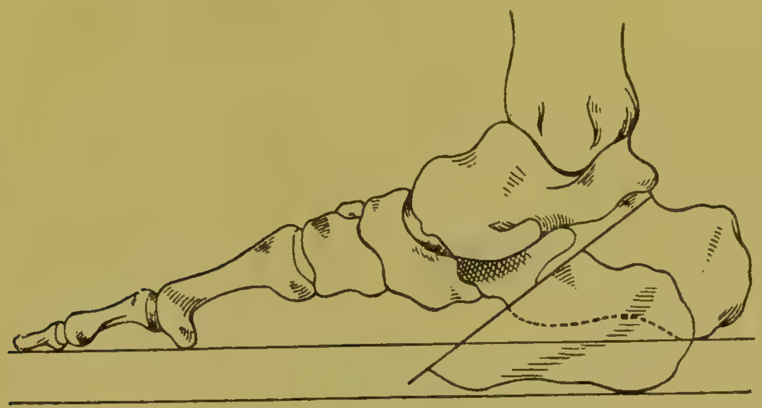

FIG. 265.

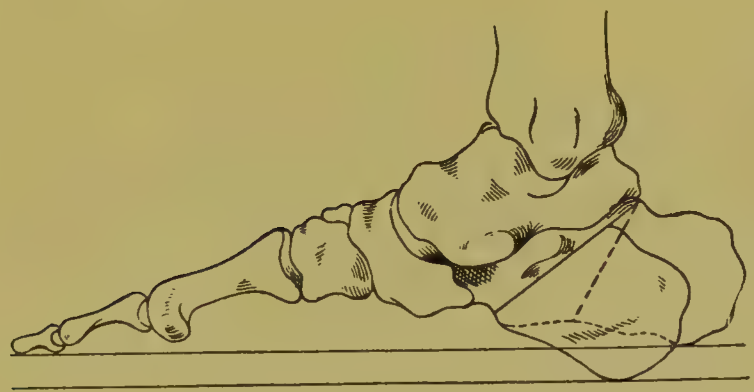

FIG. 266.

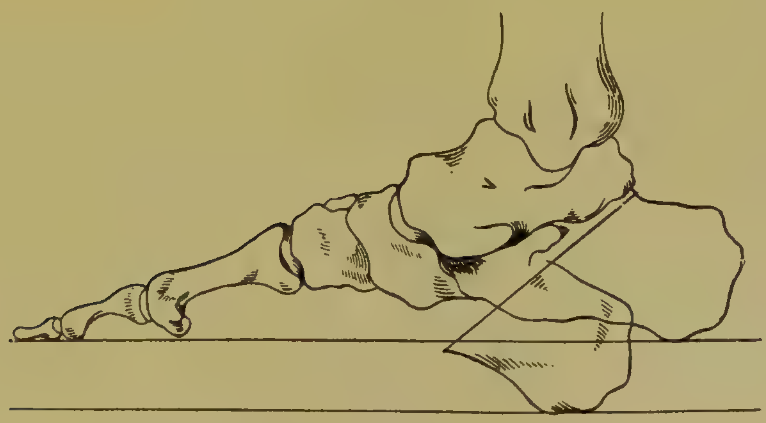

FIG. 267.

Three figures to illustrate Gleich's operation of transplantation of the posterior part of the os calcis, with removal, as in Fig. 266, of a wedge-shaped piece of this bone (after Sir W. Stokes).

4. Extirpation of the Scaphoid (Golding-Bird and Davy).

[1] *Lancet*, 9th Nov. 1895.

5. Transplantation of the Posterior Part of the Os Calcis (Gleich's Operation, Figs. 265, 266, and 267).

6. Excision of a Wedge from the Head and Neck of the Astragalus (Stokes' Operation,[1] Figs. 268, 269, and 270).

Of these six, the first and last are in vogue.

Ogston's Operation.—An Esmarch's bandage is applied, and the foot, having been rendered aseptic, is laid on its outer side. A horizontal incision $1\frac{1}{2}$ inch long is made down to bone over the astragalo-scaphoid joint. The ligaments and periosteum are then dissected off the bones for about $\frac{1}{2}$ inch on either side of the incision, and the joint freely opened. With a chisel the cartilage and a thin layer of bone is removed from the astragalus, and similar structures from the scaphoid in such a way as to leave on the latter bone a concave surface. The bones are then pegged together with ivory, the wound closed, and the foot put up in a plaster case. At the end of three months the patient is allowed to walk.

The result[2] is an improved and, in a few cases, complete arch, bony ankylosis, and relief from pain. Walsham and Hughes state that they have only once had occasion to perform the operation themselves, and in this case the result was disappointing. I have not yet met with a case which could not be relieved by other measures.

Hare's Modification of Ogston's Operation consists in so treating the astragalus and scaphoid that the bones can be dovetailed together.

Stokes' Operation.—An incision, $1\frac{1}{2}$ inch in length, is made below and parallel with the tendon of the tibialis posticus over the most prominent part of the astragalus. A second incision joins this at right angles, and the small flaps thus made are turned back.

[1] *Trans. Acad. Med. Ireland*, 1885; and *Brit. Med. Journ.* 1st Dec. 1894, p. 1224, "Remarks on Flat-Foot."

[2] My colleague, Mr. Openshaw, has modified the operation. He removes the bone and cartilage, but does not insert ivory pegs. A week after the operation, when the wound is healed, the sutures are removed; and under an anæsthetic the foot is brought into perfect position, and put into plaster for about a month. Mr. Openshaw at that time of writing had operated on nine cases, in three of whom both feet were affected, with the best results. In two of the three bilateral cases he had operated upon one foot, and wrenched and applied a plaster case to the other simultaneously. Both patients, however, subsequently begged to have the other foot operated upon. In two only of the twelve operations did the wounds fail to heal by first intention. . . . The results were excellent, the arch in all being firm, and, as far as could be ascertained, bony. Needless to say, these patients presented aggravated forms of flat-foot, and had undergone other treatment in some cases for years (*Clinical Journ.* 12th Dec. 1894).

From the neck and head of the astragalus a wedge of bone is taken away, and the wound is closed and put up, according to the inventor

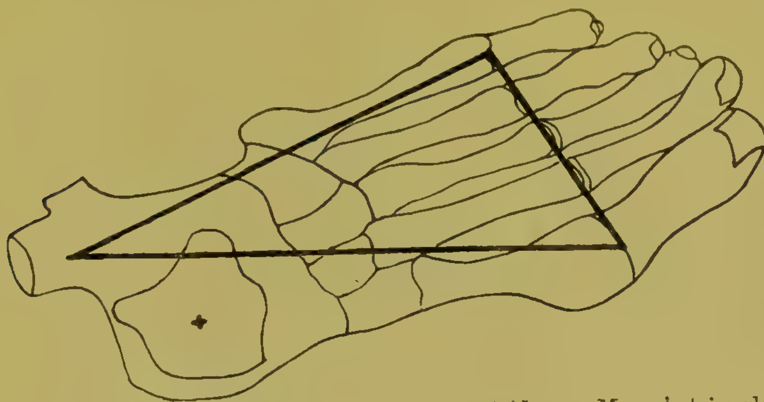

FIG. 268.—The astragalus point (+) lying outside von Meyer's triangle.

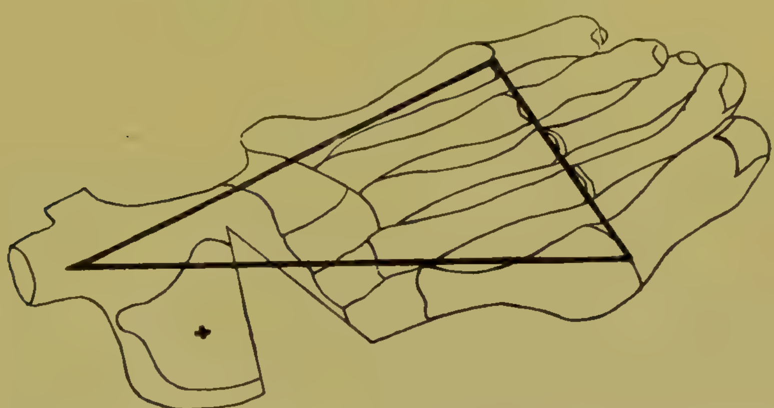

FIG. 269.—The foot after removal of the wedge-shaped portion of bone.

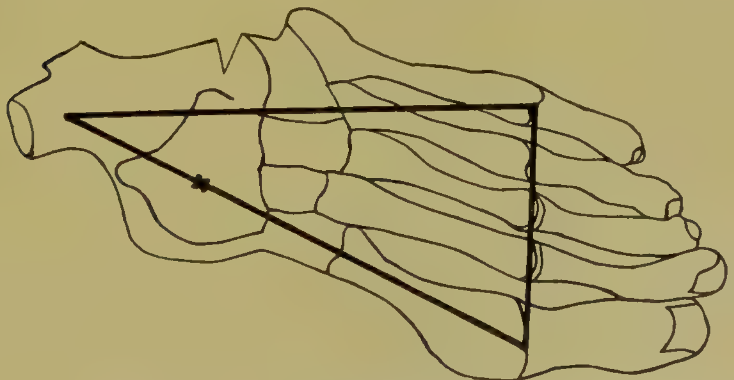

FIG. 270.—The foot adducted, and the astragalus point on the inner side of von Meyer's triangle.

These figures illustrate Sir W. Stokes' operation of removal of a wedge-shaped portion of bone from the neck and head of the astragalus.

of the operation, in a Dupuytren's splint. Plaster answers equally well.

It appears that Sir William Stokes' operation[1] is the more scientific operation, for the following reasons:—

1. The medio-tarsal joint is left intact.

2. By prolonging the apex of the wedge well into the body of the astragalus, the centre of gravity at the "astragalus point"[2] is made to approximate to the inner side of von Meyer's triangle.

[1] Sir William Stokes, "Flat-Foot," *Brit. Med. Journ.* 1st Dec. 1894.

[2] This is a point which represents the centre of gravity of the astragalus, and is the highest point in the axis of the trochlear surface.

CHAPTER IX

OTHER ACQUIRED AND CONGENITAL DEFORMITIES OF THE FOOT

Metatarsalgia, Symptoms, Etiology, Diagnosis, Prognosis, and Treatment—Hallux Valgus or Bunion—Hallux Varus—Hallux Rigidus—Hammer-Toe—Congenital Deformities of the Toes.

Metatarsalgia (Morton's Disease)

Definition.—This condition is a neuralgia chiefly situated in the anterior part of the foot. In some cases the pain is intensely acute, but in others it is a dull ache.

Authors[1] agree that the immediate cause is pressure on the digital nerves at the heads of the metatarsal bones. According to Morton, the pain is located at the interspace between the fourth and fifth metatarsal bones, but in four of the cases I have seen it has been present in the second and third interspaces, and starting about the head of the third metatarsal bone.

With reference to the causation, there can be no doubt that the rheumatic or gouty diathesis play an important share in the production of the disease; but its incidence is determined by a blow[2] or strain, or a fall in which the weight comes mainly on the front

[1] Morton, "Peculiar Painful Affection of the Fourth Metatarso-Phalangeal Articulation," *Amer. Journ. of Med. Sciences*, 1876; Bradford, "Metatarsal Neuralgia, or Morton's Affection of the Foot," *Boston Med. and Surg. Journ.* 1891, vol. ii. p. 52; Gibney, "The Non-Operative Treatment of Metatarsalgia," *Amer. Journ. of Nervous and Mental Diseases*, Sept. 1894, p. 589; C. E. Woodruff, "Incomplete Luxations of the Metatarso-Phalangeal Articulation," *N. Y. Med. Record*, 18th Jan. 1890; Goldthwait, *Boston Med. and Surg. Journ.* cxxxi. No. 10, p. 233, on "Obliteration of the Anterior Transverse Arch of the Foot as a Cause of Metatarsalgia"; Box, on "Morton's Disease," *Archiv Gen. de Med.* July 1894. See also papers by T. S. K. Morton in the *Trans. Philadel. Acad. of Surg.* 1893; Edmund Roughton, *Lancet*, March 1889; and Dana, *Med. Rec.* (*N. Y.*) July 1895.

[2] In one of my cases the patient, who was no mean cricketer, stated that on stepping out to a ball he had frequently been hit on the dorsum of the right foot.

part of the foot. In other instances it comes on after long standing and walking, especially in narrow boots, and the disease frequently follows a long illness. In many cases some degree of flat-foot is present.

Symptoms.—1. The attention of the surgeon is called to a patient's foot on account of the pain suffered. Frequently it is intense and paroxysmal, and renders movement impossible. Nor is it confined to the foot, but starting about the head of the third and fourth metatarsal bone, is reflected up the limb. As a rule no redness is present, but I have seen very considerable congestion in one case. In that instance, while at rest the patient would suffer little or no inconvenience, and started on a walk feeling no discomfort. Shortly afterwards the pain would commence, and become worse on going into a warm room, the feet feel hot, and he was unable to move. His one desire was to remove the boot, and hold the front part of the foot firmly. On two occasions, during a severe attack of paroxysmal pain, I found redness present over the first and second interspaces. Pain, however, is not always of this acute character, but is occasionally of a chronic nature.

Fig. 271.—Tracing of the sole from a case of Morton's disease. A bulging instead of a re-entering angle is seen behind the ball of the great toe.

2. Deep tenderness is present about the heads of the third and fourth metatarsal bone.

3. The affected foot is broader across the heads of the metatarsal bones than is normal, and, as stated above, some degree of flat-foot may exist.

4. On examining the sole, a large corn may be seen over the heads of either the second, third, or fourth metatarsal bone, which are felt to be prominent in this situation. This prominence of the head of one of the metatarsal bones, taken in conjunction with the character and starting-point of the pain, is diagnostic of the disease.

5. A peculiar twist is present in the foot. The portion in front of the tarso-metatarsal articulation is twisted inwards, so that the base of the fifth metatarsal bone is exposed to the pressure of the boot, and the patient complains of constant pain at that spot. In fact, in some instances, and these are early cases, the patient seeks relief from this alone.

6. The impression of the foot is typical. There is a bulging instead of a re-entering angle behind the ball of the great toe. Fig. 271 is from a case of Morton's disease.[1]

In illustration of these points I may quote three cases :—

CASE 93. *Case of Morton's Disease.*—Mr. C——, aged 39, a bank-cashier, and standing most of the day, consulted me for pain on the outer side of the foot, which became so bad as to necessitate his giving up his position at his desk in the latter part of the day. His father had suffered from gout, but he himself had not at any time had an acute attack. On examination of the right foot I noticed at once the peculiar inward twist, and the base of the fifth metatarsal bone was prominent, very painful, with a false bursa over it. He complained also of dull aching pain about the head of the third metatarsal, but it had never been paroxysmal. The arch of the foot was somewhat lowered, and on examining the sole, a corn was found over the head of the third metatarsal bone, which seemed to have dropped away from the others. The boots he had been wearing were narrow in the tread and very pointed. I advised that he should rest the foot entirely for a fortnight, and meanwhile a pair of low-heeled boots should be made, with a valgus pad beneath the instep, and so arranged as to fit tightly across that part, and to leave ample room across the heads of the metatarsal bones in treading. It seemed to be highly probable that the displacement of the head of the third metatarsal bone arose from the pressure of narrow boots on that part of the transverse arch. To relieve the pain over the base of the fifth metatarsal bone, I suggested that the leather of the boot should be blocked out over that spot. A month afterwards he expressed himself as much relieved.

CASE 94.—Mr. N——, aged 32, consulted me for paroxysmal pain in the front part of the right foot, which became so severe at times as to entirely prevent him moving about. He played much cricket, and had frequently been struck with the ball on the dorsum of the foot. The boots he was wearing were fashionable, and no doubt contributed to the perpetuation of the pain. The latter was always worse in the evening, and occasionally became agonising in a warm room, and was accompanied by considerable redness and extreme tenderness in the first interspace. Relief was temporarily obtained by removing the boot.

On examination I noted that the arch of the foot had given, the base of the fifth metatarsal bone was prominent, the anterior part of the foot twisted inwards, and there was depression and enlargement of the head of the second metatarsal bone. Relief was obtained by boots constructed on the same plan as in Case 92. He was also advised to soak the feet in hot water containing a drachm of bicarbonate of soda to the pint, and citrate of potash was given internally. After some weeks the pain

[1] Taken from Goldthwait's article, *Brit. Med. and Surg. Journal*, cxxxi. No. 10, p. 253.

lessened and disappeared. I should state that I have subsequently seen one of Mr. N——'s sisters on account of osteo-arthritis.

CASE 95.—Mr. J. D——, aged 25, consulted me in July 1895 with reference to pain and difficulty in walking. He could only hobble, on account of the pain, and had tried all sorts of boots. The history of gout was well marked in the family. Pain was complained of in both feet, about the head of the third metatarsal bones and over the base of the fifth metatarsals. In the soles of both feet the head of the third metatarsal was very prominent with a large corn on it, and in the right foot smaller ones were present over the heads of the second and fourth. The arch of the foot was much *increased*, and the toes of both feet were hyper-extended. At times acute attacks of pain, lasting on and off for a fortnight, occurred, and completely laid him up. The inward twist of the foot was well marked. So extreme was the displacement of the head of the third metatarsal bone on the right side that I advised its removal. As he objected to this, and was anxious to try other treatment, I advised bathing in hot water every night, and boots closely fitting over the instep and very broad in the tread. In November 1895 I heard that a considerable improvement had occurred.

Pathology of this Affection.—The explanation given by Morton is the following:—The heads of the first three metatarsal bones are nearly on a line and less movable than the remaining ones. The head of the fourth is $\frac{1}{4}$ inch behind that of the third, while that of the fifth is nearly $\frac{1}{2}$ inch behind the head of the fourth. Between the heads of the fourth and fifth branches of the external plantar nerve pass; while the anterior extremity of the fifth metatarsal, and to a less degree the fourth, is very mobile. When the transverse arch is compressed the head of the fifth metatarsal bone and its proximal phalanx come directly into contact with the head and neck of the fourth metatarsal, and consequently the nerves are compressed.

While this anatomical explanation suffices in the case of the fourth and fifth metatarsal, it does not explain instances of metatarsalgia beginning between the second and third, and third and fourth bones. In such instances the explanation appears to be this. When the transverse arch gives way at the heads of the metatarsal bones, and tight boots continue to be worn, the heads of the metatarsal bones are rubbed together, and pressure on the nerves with pain ensues. One head is pushed out of place at the spot where pressure is greatest, and the nerve is compressed between the adjacent heads and the depressed one, and pain is most marked there. In other cases of an osteo-arthritic nature the digital nerves are compressed by osteophytic projections. This hypothesis is supported by the co-existing enlargement of the base of the first phalanx of the great toe, which is notably affected in osteo-arthritic cases.

The Diagnosis.—It has to be made from flat-foot chiefly on account of the pain. I have already said that in many cases of Morton's disease flat-foot of a minor degree is present, but it is rarely so marked as to explain the acute and agonising pain of metatarsalgia. The cases may be considered to partake more of Morton's disease than flat-foot when the pain begins about the heads of the metatarsal bones, and is of the paroxysmal nature already alluded to. In other instances not a trace of flat-foot exists, but the arch of the foot is exaggerated (cf. Case 95). So that no confusion ought to arise in the latter class of case.

The *Prognosis* should be guarded in all cases. Even with complete rest, the acute pain diminishes slowly for a few days, and for weeks afterwards exacerbations may take place when the patient walks. The effects of treatment are displayed slowly, and the patient should therefore be warned that the trouble is likely to be a tedious one.

Treatment.—In all instances evidences of rheumatism, rheumatoid arthritis, and gout should be sought for, and treated with the usual, but frequently inefficacious, constitutional remedies.

The acute attacks of pain are relieved by removing the boot and soaking the foot in hot water. Bradford and Lovett suggest the alternate use of hot water and ice. But these applications I have not tried, and as far as ice is concerned, I should hesitate to use it in a gouty case. The application of the oleates of morphia and atropin temporarily relieve the pain. In most cases relief may for a time be obtained by grasping the instep and sole, or by tightly compressing the bases of the metatarsal bones with a flannel bandage.[1]

The first thing is complete rest of the foot for two or three weeks. Then some walking may be allowed. But no boot should be worn for a time, merely a canvas or rubber shoe with a bandage around the proximal ends of the metatarsal bones. When all pain has subsided the following description of boot should be

[1] There may appear to be a contradiction here. One of the causes given is narrowness of the boots, and yet relief is gained by grasping the instep and the sole. But the discrepancy is only apparent. Gibney, *Journ. of Nervous and Mental Diseases*, Sept. 1894, p. 592, has observed that if the bases of the metatarsal bones be tightly grasped the distal ends are separated and the nerves are no longer compressed, hence the relief obtained.

worn, viz. one with a high instep and valgus pad, if flat-foot is present, with a heel coming well forward beneath the instep and of moderate height. The boot should also be made to fit closely over the instep, and be broad in the "tread" so as to give plenty of room to the heads of the metatarsal bones, and the soles must be thick.[1] In severe and long-continued cases not relieved by the above treatment, Morton advised excision of the head of the fourth metatarsal bone. But when there is undue prominence of the distal extremity of either the second or third, rather than of the fourth, I should certainly excise that one which could be most plainly felt from the sole, and had the largest corn over it; and this I have done in the case of the head of the third metatarsal bone with complete relief.

Deformities of the Toes

Synonym—*Hallux Extrorsus, Bunion.*

Hallux Valgus.—The proper direction of the great toe is the subject of a paper contributed to the Paris Société de Biologie by M. F. Regnault.[2] He agrees with the observations of anthropologists and surgeons that, in persons who go barefooted and use their feet only for walking, the great toe and inner border of the foot form a right line. In some cases the great toe is even slightly adducted, and this is more marked among savage races, who use their feet as prehensile organs. Abduction of the toes is an artificial condition, and arises from wearing boots, and is exaggerated by the demands of fashion.

Hallux valgus is largely due to the use of improper boots, not necessarily of tight ones, but of those which are pointed and often too short. In some cases it may be traced to osteo-arthritis and gout.[3] These diseases, however, merely give a faulty direction to the great toe, which is accentuated by narrow-pointed boots.

The feature of the deformity is displacement of the great toe outwards, with prominence of the base of the proximal phalanx and the head of the first metatarsal bone. Both these portions of bone are often enlarged and covered by a bunion or false bursa. The

[1] For this idea of the construction of a suitable boot in these cases I am indebted to Dr. Gibney. The boot is fully described in the article referred to in the preceding note.

[2] An abstract of his observations appeared in the *New York Med. Journ.* 19th May 1894, p. 638.

[3] Anderson, *Lancet*, vol. ii. 1891.

enlargement is specially noticeable in cases of osteo-arthritis, and I have on several occasions felt grating in the first metatarsal-phalangeal joint.

The *Anatomy* of the affection is as follows:—The great toe is

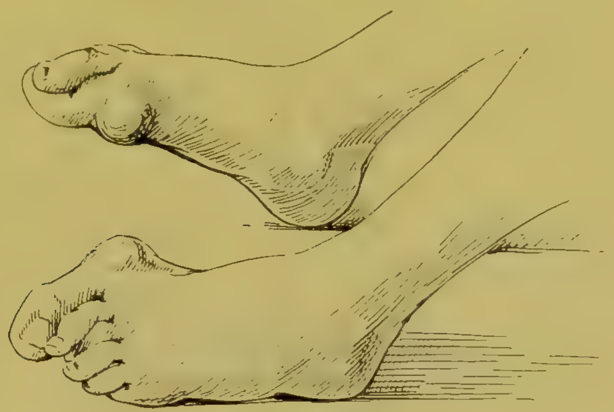

FIG. 272.

FIG. 273.

Two views of case of hallux valgus.

displaced outwards so as to leave part of the head of the metatarsal bone uncovered. A subluxation occurs, with the result that the internal lateral ligament is stretched, and is in some cases thinned, but more often thickened. According to Rédard,[1] it is

[1] *Traité Pratique de Chir. Orth.* p. 850.

occasionally perforated. The external lateral ligament is shorter and thicker than normally. Those muscles the tendons of which are inserted into the inner side of the base of the first phalanx are stretched, and those which are inserted into the outer side are contracted. On the dorsum the tendon of the extensor proprius pollicis is displaced externally, and by its new position takes an important part in maintaining and increasing the deformity. The skin on the inner side, beneath the ball of the great toe, is in early cases reddened, and later becomes thickened. Beneath it, in the subcutaneous tissue, a false bursa or bunion forms, which, according to Walsham and Hughes, is sometimes multilocular. It is very liable to inflammation, and suppuration may cause cellulitis. If pus make its way into the joint, disorganisation occurs.

Corns situated in and on the bunion are extremely painful, and often of large size. In one patient, from whose foot I dissected out a large painful bunion with a painful corn on top of it, I found, on subsequent section of the part removed, that the corn extended through the whole thickness of the bunion, nearly an inch.

Where the head of the metatarsal bone is not covered by the base of the phalanx, the cartilage is thinned or has entirely disappeared, and much osteophytic enlargement of the head of the metatarsal bone is present, while lipping of the base of the proximal phalanx can frequently be felt through the skin.

The *Symptoms* are sufficiently plain. In most people some displacement outwards of the great toe is present, but not enough to cause pain. It is for this symptom that the surgeon's attention is called to the part, which is seen to be inflamed and prominent. In old-standing cases the altered direction of the great toe, the presence of a fluctuating swelling and corns over the inner side of the head of the metatarsal bone suffice for the diagnosis. Occasionally the affection is mistaken for gout, but a little care will distinguish an inflamed bunion from an acute attack of podagra. As the great toe is being displaced, it rides over the second toe, and depresses the second and third phalanx, so that hammer-toe complicates the deformity. In cases of hallux valgus or extrorsus, flat-foot is often present as well.

Women suffer more frequently than men,—three times as frequently,—and both feet are often simultaneously affected, though not in the same degree.

Treatment—Prophylactic.—Pointed boots must be absolutely forbidden. It is not of much avail to discuss with the patient whether the boots he is wearing are pointed or not. An outline of the sole of the boot he should wear must be given to him, and he should be directed to go to a rational bootmaker who will carry out instructions. The sole of the boot should be as broad as the sole of the foot when it is placed on the ground and the weight of the body is being borne on it. If any displacement exist, the inner side of the upper leather should be blocked out, so as to give ample room to the great toe and to the prominence of the metatarso-phalangeal joint.

Curative treatment in slight cases consists in wearing the boots made on the lines just suggested, the application of cold and soothing lotions to the inflamed and thickened skin, and in the use of some arrangement whereby the great toe is kept away from the second toe. In early stages nothing answers so well as a divided (digitated) sock, with a separate stall for the great toe. Some advise the use of a "post" between the first and second toes, but I have not found this answer well in practice, as it is difficult to bring the great toe into the proper place for it. Pulling inwards of the great toe night and morning, if persevered with, soon brings the toe into better position.

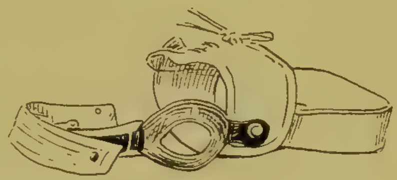

FIG. 274.—Spring for the treatment of bunion.

An excellent arrangement is made by Ernst for these cases, viz. a leather cap or thimble fitting over the great toe, secured by a tape which passes along the inner border of the foot and around the heel by an elastic insertion which is fastened at the outer border of the foot. A more elaborate apparatus consists of a metal plate adjusted to the foot at the instep (Fig. 274). At the lower part of the plate a spring is jointed and curved convexly towards the toe, having a division of the spring over the bunion to obviate pressure. When the patient is unable to afford a special apparatus, a wedge-shaped pad of lint fixed between the toes is of service, and the first toe may be further separated from the second by drawing it away by strapping secured round it, and passing back towards the heel. Or a splint of rubber or pasteboard may be fixed to the inner margin of the foot and toe, thus pulling the latter inwards.

When the deformity is severe, the bursa large and painful, and subject to recurring attacks of inflammation, operative procedures are necessary. I may here detail my proceeding in the following case:—

Case 96. *Bunion, Removal of Bursa, Chiselling off Bony Prominences around the Joint, Complete Relief.*—Maria B———, aged 42, with a gouty history, had suffered for some years from a large bunion and hallux valgus on the right side. When seen by me in 1891 the bursa was much inflamed. I cut down on it and dissected it out, but as she then objected to any interference with the joint and bone, I was obliged to content myself with dividing the extensor proprius pollicis and the external part of the capsular ligament, and forcibly manipulating the great toe inwards. After the wound healed she wore one of Ernst's bunion springs. In 1894 this patient again came to me with the great toe more abducted than when I first saw her, and a new and much-inflamed bursa was present. So great was the pain that she was anxious to have whatever I thought necessary done. I therefore made a longitudinal incision down to the bone, cutting through the bursa, which contained pus. The bursa was removed, and the cavity so left was well washed out with carbolic lotion. The joint was opened freely, the capsular and other ligaments being divided as completely as possible. With a chisel a large slice was taken away from the inner and under surfaces of the head of the metatarsal bone and base of the phalanx, and the extensor proprius pollicis divided. With a little force the great toe was brought into position, and, after closing the wound, it was firmly held in position by a malleable iron splint applied along the inner side of the foot. The wound healed rapidly, and the patient left the hospital with a movable joint of normal size and shape, and walking very comfortably.

Another ready way of curing these severe cases is to excise the head of the metatarsal bone. Mr. Davies-Colley prefers removal of the base of the first phalanx. The latter procedure does not, however, get rid of the enlarged head of the metatarsal bone. Mr. Barker excises a wedge-shaped portion from the neck of the metatarsal bone. Other surgeons perform a linear osteotomy of the bone. Amputation of the great toe is necessary in few cases, viz. if much suppuration is present, if the skin is riddled with sinuses, and the joint destroyed.

In the treatment of simple bunion, the wearing of suitable boots and the application of Scott's ointment, or of unguentum ammoniaci cum hydrargyro, give relief. If acutely inflamed, hot boracic fomentations may be applied, and if suppuration follow, the bursa should be freely opened and dissected out.

Hallux Varus or Pigeon-Toe

This deformity is met with frequently in congenital equino-varus. After the treatment of varus, it may remain as an obstinate feature of the deformity. It varies in extent, and the angle of inward displacement may be 45° or more.[1]

The treatment consists of manipulation and the use of a light splint to press the toe outwards.

Hallux Rigidus

Synonyms—*Hallux Dolorosus, Hallux Flexus, Painful Great Toe.*

As described by Mr. Davies-Colley, the deformity consists of a forced flexion of the proximal phalanx of the great toe through 30° to 60°, and some extension of the second phalanx with the toe held rigidly in that position. Other writers differ in some respects. Thus Walsham and Hughes[2] state: "In many cases we have met with, beyond the pain in movement, there has been little or no flexion, and practically no rigidity." Bradford and Lovett[3] agree with Mr. Davies-Colley's description. Mayo Collier[4] gives the following account of it founded on nine cases, seven males and two females: "The affected foot presents a peculiar characteristic appearance. In the first place it is a long foot; it is an abnormally long foot for the size of its owner. Next the foot is nearly always cold, damp, and blue. The distortion of the foot is characteristic and peculiar, and is due to the fact that any pressure between the head of the metatarsal bone and the sesamoid bones on the tendons of the short flexor cannot be tolerated. The metatarsal bone is flexed on the tarsus, and is adducted to the mid-line from its fellows. With this the proximal phalanx is slightly flexed. . . . The head of the metatarsal bone appears through the skin to be enlarged, and there is found sometimes some lipping of the cartilage of this bone at its under and lower aspect in the neighbourhood of the sesamoid cartilages. In early cases pain is not usually complained of until the end of the day, and then mostly after long standing or much walking, but as the disease progresses the pain is continuous. The joint is never red, painful, or tender to the touch, except on manipulation. . . . Flexion of the joint is generally readily permitted, but any attempt at extension elicits opposition and evidence of acute pain on the part of the patient." It seems to me that the discrepancy as to the position of the parts is explic-

[1] Anderson, "Contraction of Fingers and Toes," *Lancet*, vol. ii. 1891, mentions a case in which the angle was nearly 90°.

[2] *Op. cit.* p. 512.

[3] *Op. cit.* p. 756.

[4] *Lancet*, 1894, vol. i. p. 1614.

able on the supposition that the cases recorded are various stages of one affection.

The disease is more commonly seen in males than females, and in young males under 20 years of age. It is generally associated with flat-foot; and, according to Cotterell, its origin is to be sought in a combination of flat-feet and short boots. The great toe is thus cramped, the proximal phalanx becomes flexed, and the head of the metacarpal bone depressed. Pressure then follows between the last-named structure and the sesamoid bones.

As to the anatomy of the affection, Mr. Davies-Colley found the plantar fibres of the lateral ligament and the tendinous tissue connecting the sesamoid bones to be contracted, so that extension of the toe was limited. Mayo Collier found "caries with marked absorption from pressure existing on the under aspect of the head of the metatarsal bone at the points of contact with the sesamoid bones. The cartilage was almost completely worn off the points of contact, leaving the subjacent bone bare and congested. There was also some lipping of the adjacent margin of cartilage, and at spots invasions of granulations passing in from the synovial membrane. The cartilage of the rest of the bone, as well as of the proximal phalanx, was healthy.

The treatment is to remove the causes, viz. flat-foot and too short boots. In the majority of cases this is successful. But in inveterate cases excision of the head of the metatarsal bone is the surest means of relief.

Hammer-Toe

Synonyms—French, *Orteil en marteau, Orteil en Z, Orteil en cou de cygne, Orteil en griffe;* German, *Hammerzehe.*

Definition.—A deformity usually affecting the second toe, and consisting of dorsi-flexion of the first phalanx, plantar flexion of the second, and extension of the third phalanx.[1]

Etiology.—1. *Congenital.*—A small proportion of the cases are

[1] Hammer-toe must not be confused with the contracted and claw-like toes met with in various forms of talipes. In the latter cases *all* the toes are affected, and the following forms of contraction are present:—

(*a*) In talipes equinus all the toes may be dorsi-flexed at the metatarso-phalangeal joint, and plantar-flexed at the first interphalangeal joint. A condition similar to this is met with in talipes arcuatus and plantaris.

(*b*) The toes may all be plantar-flexed from the metatarso-phalangeal joint, so that the dorsal surface of the toes is in direct contact with the ground.

distinctly congenital. In these instances the second toe is usually affected, and in both feet. In the same patient congenital contraction of the fingers, especially of the fourth and fifth, may be seen.

2. *Heredity.*—Of all the deformities to which the foot is liable, this is the one in which heredity is most marked. Mr. William Anderson has traced this in at least a fourth of the cases which have come under his notice, and in the *Lectures on the Contraction of the Fingers and Toes*[1] he alludes to an instance in which the deformity had occurred in four generations.[2] I have met with two

FIG. 275.

FIG. 276.

Two views of a case of hammer-toe.

examples in private practice of its perpetuation through three generations.

3. *Acquired Causes.*—In many people the second toe is longer than the first, and by some this is believed to be the normal state. Whether the first or second be the longer matters little, if tight and pointed boots be worn, so far as the production of hammer-toe

[1] *Lancet*, vol. ii. 1891, p. 213.

[2] Mr. Warrington Haward showed six dissected specimens at the Pathological Society in 1893. These toes had been amputated on account of the pain they caused. Mr. Haward was unable to accept the theory of ill-fitting boots to explain all the cases. "Many were distinctly hereditary, and occurred in neurotic people" (*Lancet*, 6th May 1893).

is concerned. In either case, the great toe, not having sufficient room, is subluxated outwards and the other toes become clawed. As the displacement of the great toe persists, it rides over the second toe, and the second and third phalanges of the latter being maintained in constant plantar flexion, adaptive shortening of the long tendons and the lateral and glenoid ligaments follows, with hyper-extension of the first phalanx.

The Appearances of Hammer-Toe.—On the dorsal aspect of the first interphalangeal joint a painful corn is frequently present. Beneath this is a bunion, which from time to time inflames and suppurates. On the under surface of the joint a deep groove is noticeable. The skin is contracted, and at the bottom of the groove the long flexor tendon can be felt. The first phalanx is in a state of extreme dorsal flexion, so that the head of the metatarsal bone is uncovered below to about half its extent. The second phalanx is always plantar-flexed, while the third may be either plantar-flexed, dorsi-flexed, or in a line with the second. As a result of the squeezing of the tip of the affected toe downwards, its tip is often broad and flat, hence the term "hammer-toe."

Fig. 277.—Hammer-toe.

The second toe is in the majority of cases affected, and in both feet, but to a variable degree. I am inclined to think that the deformity is more common in women than in men.

Morbid Anatomy.—To Shattock and Adams must be ascribed the credit of first having correctly described the anatomical conditions in an advanced case. Whatever may have been the original cause, the great obstacle to reduction is found to be in the shortened lateral ligaments and the contracted glenoid ligament. The flexor and extensor tendons are undoubtedly contracted, but division of them is not sufficient to remove the deformity. The lateral ligaments must be severed. As a result of the displacement neither the lower part of the head of the metatarsal bone nor the upper half of the head of the first phalanx is covered by the bone articulating with it, and the cartilage of the uncovered portion of bone is thin and atrophied. On account of inflammation extending from the bursa, ankylosis between the first and second phalanx has been met with.

Treatment.—In slight cases attention to the boots, and the various measures for remedying outward displacement of the great toe detailed on p. 497 are of value, especially if care be taken to straighten the affected toe several times night and morning. By fixing at night a malleable iron splint suitably bent to the sole and to the affected toe, the condition will often be improved. Ernst makes a useful T-spring for slight cases (Fig. 278). This is also of service after operation.

Operative.—In cases of medium severity, forcible reposition with the fingers under an anæsthetic is often successful. A distinct snap or crack is felt indicating rupture of the lateral ligaments. If the shortened skin prevent complete restitution of the toe, the skin may be divided by a V-shaped incision.

FIG. 278.—T-spring for hammer-toe. The spring is applied to the sole of the foot and the under surface of the affected toe, which is extended on it.

Division of the Ligaments.—Mr. Adams has performed this operation subcutaneously for several years with much success. I have treated a very large number of cases on this plan with good results in every case except one. In this instance there was free hæmorrhage from the digital artery, and I applied a strip of gauze firmly around the toe. By a misunderstanding this was left on too long and the skin of the toe remained in a sloughy condition for some weeks. The patient's general condition was unhealthy, and as the toe was exceedingly painful, I thought it better to remove it.

Subcutaneous Section is performed under all aseptic precautions in the following manner:—An assistant holds aside the first and third toes, and the surgeon, steadying the second toe with his left hand, enters a fine, narrow-pointed, strong-backed knife into the mid-point of the groove on the under aspect of the first interphalangeal joint. Passing the knife upwards, beneath the skin, and avoiding the digital arteries and nerves, the edge of the knife is turned toward the bone, and the lateral ligaments severed. By continuing the division on the under aspect of the joint, the long tendon and the glenoid ligament are divided. Without removing the knife from the skin puncture, it is passed down to bone through the remaining lateral ligament. Mr. Adams is of opinion that the joint is not usually opened. I venture to think that it is and must be. After free division of the ligaments and tendon, the toe can be brought into good position. If not, a little force suffices to rupture any of the ligamentous fibres which may have escaped division. In some cases it is as well to sever the contracted extensor tendon as well. Should the toe, however, not come into good position, the puncture on the under surface may be enlarged to

FIG. 279.—The cure of hammer-toe by subcutaneous section of the flexor tendons and of the ligaments. This is the same foot represented in Figs. 275, 276, and 277.

a transverse incision, the head of the first phalanx protruded and removed with bone forceps.

After the operation and dressing, the toe is placed in the corrected position in a malleable iron splint, until the wound is healed. A T-splint is then worn for some time until the toe shows no disposition to return to its former state.

Complete excision [1] of the joint by a lateral incision is practised, and cures the patient, saving, too, a considerable amount of time in

[1] Acting on the suggestion contained in Mr. Anderson's Lectures, Surgeon-Captain Rowan successfully removed the heads of the first phalanges in a bilateral case in which tenotomy had been tried and failed (*Brit. Med. Journ.* 10th June 1893).

FIG. 280.

FIG. 281.

FIG. 282.

From three photographs taken by Mr. L. C. Burrell to illustrate the author's "Cases of Lobster-Claw Deformity of the Feet and Partial Suppression of the Fingers, with a Remarkable Hereditary History."

treatment. Amputation is rendered unnecessary if the foregoing plans be efficiently carried out, and, indeed, it is an unnecessary mutilation.

Abnormal conditions of the toes other than those described above are met with. They are, syndactylism, polydactylism,

FIG. 283.—Partial suppression of the fingers (from a photograph by Mr. L. C. Burrell). The woman in the illustration is the aunt of the children seen in Figs. 280, 281, and 282.

suppression of the toes, or wide departures from the normal condition.[1] Syndactylism is treated on the same lines as in the hand.

[1] *Vide* "A Case of Lobster-Claw Deformity of the Feet and Partial Suppression of the Fingers, with a Remarkable Hereditary History," with photographs, by the author. *Lancet*, 17th Feb. 1894. This case is that of a boy, aged 3 years, who was seen by me at the Evelina Hospital. I must express my thanks to Mr. L. C. Burrell, late of Guy's Hospital, for the great trouble he took in tracing the genealogical history of the deformities, and for his kindness in taking photographs. The patient was one of a family all of whom presented abnormalities of the hands and feet. In his case the abnormalities may thus be described. The feet, which were nearly symmetrical in appearance and size, gave one the idea of a lobster's claw. The second, third, and fourth toes were entirely suppressed ; the great toe was much lengthened, there being two phalanges, but no nail. The fifth toe was also overgrown, and seemed to have three phalanges, while a well-grown nail was found on it. Between these digits a wide sulcus was present, closely similar to that found between the forefinger and the thumb in a normal hand ; but the most remarkable point was that the well-developed first toe presented, in addition to the ordinary movements of flexion and extension, the power of opposing itself to the remaining toe, so that in its action and grasping movements it

Polydactylism, often persistently hereditary, may call for amputation of one of the supernumerary toes, preferably one of the outer ones.

Lateral deviation of the toes, the result of bad boots, may be

resembled the thumb of man and the opposing toe of the quadrumana (see Figs. 280 and 281). With this severe deformity the feet were, however, perfectly useful for walking, and in so doing there was no sign of lameness. The hands had but one finger, corresponding in position to the fifth finger, the thumb, first, second, and ring fingers being entirely suppressed, while the metacarpus was normal. In the case of the younger child, a girl, the feet presented the same appearances as in this patient's case, while there were two fingers on each hand webbed together (see Fig. 282). Two other children, who were males, were deformed similarly to my patient. An aunt, who brought the child to the hospital, was another example of precisely similar deformity. Her hands are shown in Fig. 283. The table of family relationship is very interesting. The deformity has persisted nearly constantly through four generations, and in the later generations is more marked than in the earlier. The ancestors, J. G. and his wife, were perfectly formed in the hands and feet, while the abnormalities were transmitted indiscriminately through males and females, although in no instance was there any relationship between husband and wife in any one generation. It was not possible to trace any cousinship. The curious shape of the feet is much more persistent than the suppression of the fingers; of twenty-two descendants of J. G., thirteen had but two toes on each foot, with the prehensile movements of the great toe; one had but one toe on each foot, and one had one toe on the left foot and two on the right foot. The family table is given below.

James G——— Married; both normal; not cousins.

- James. Two fingers each hand and two toes each foot. Married Mary; normal.
  - James. One finger each hand; two toes each foot. Married Harriet; normal.
    - Edward. Married; wife normal; two fingers each hand; two toes each foot.
      - Henry. One finger each hand; one toe each foot.
      - Harriet. Normal.
      - Lucy. Three fingers left hand; four fingers right hand; stump in place of thumb projecting into palm; two toes each foot.
      - Thomas. Normal.
      - Joseph. One finger each hand; one toe left foot; two toes right foot.
      - Harriet. Two fingers each hand; two toes each foot.
    - Maria. Married; Edward normal; one finger each hand; two toes each foot. Female patient in Fig. 283.
      - Edward. One finger each hand; two toes each foot.
      - Richard (patient). Absence of all fingers, except the last on both hands; two toes on each foot; nail on last toes; no nail on first, which in its movements resembles a thumb. Figs. 280 and 281.
      - Mary. Two fingers each hand — these are webbed together; two toes each foot. Fig. 282.
      - James. Exactly same deformity as Richard.
    - Male. Normal.
    - Male. Normal.
    - Isaac. One finger each hand; two toes each foot.
  - Thomas (normal). Married; wife normal.
    - Two sons; normal.
  - Mary. Married; hands normal; two toes each foot.
    - Male. One finger each hand; two toes each foot.

remedied by manipulation and wearing a digitated sock, or by the use of a sole-plate with slots in it. In extreme cases amputation is necessary.

Hypertrophy of the toes, generally of the hallux, is seen from time to time. The hypertrophied toe is frequently displaced inwards or outwards. It may attain an immense size. The hypertrophy may affect the skin, subcutaneous and fatty tissues, or these and the bones may be uniformly enlarged. In most cases partial or complete amputation is required eventually.

SECTION V

ANKYLOSIS, CONGENITAL DISPLACEMENTS, DEFORMITIES RESULTING FROM CEREBRAL AND SPINAL PARALYSES, ARTHRODESIS

CHAPTER I

CONTRACTURES AND ANKYLOSIS

Definitions — Spurious Ankylosis and its Treatment — Ankylosis, Fibrous and Osseous; Causes, Prognosis, and Treatment—Osteotomy for Bony Ankylosis—Adams' and Gant's Operations for Ankylosis of the Hip.

Synonyms—English, *Stiff-Joint, Fixed Joint*; French, *Raideur articulaire, Ankylose*; German, *Gelenkverwachsung*. Derivation—Greek, *ἀγκύλος, crooked or hooked; ἀγκύλη, bent.*

Definitions.—Ankylosis is a permanent pathological condition of the articulations characterised by the interposition of new tissue between the articular extremities, diminishing or abolishing the movements natural to the part (Rédard). Contracture is a condition of structural shortening of the soft parts, especially of the muscles and ligaments. It is distinct from contraction, which is simply functional shortening. For example, in the early stages of tubercular knee-joint disease the hamstring muscles are in a state of contraction, due to reflex irritation; they are functionally shortened or *contracted*. But in the late stage, when the ligaments have given way and partial dislocation has taken place, the hamstrings are permanently shortened; they are *contractured*, and the shortening does not disappear under an anæsthetic.

Contracture.—Many forms of contracture have been spoken of already, viz. congenital torticollis, congenital club-foot, and club-hand. There is a rarer variety of congenital contracture which merits a passing notice. Congenital contracture of the knee has been seen by Adams, Lonsdale, Bouvier, Nissen, B. Schmidt, and J. Wolff. In Bouvier's case the knee was in the position of extension, and of flexion in Adams', Lonsdale's, Bernard Schmidt's, Nissen's, and J. Wolff's cases.

But there are more common examples of contracture than this. The condition known as spurious ankylosis includes that of contracture. Contracture arises from many causes, viz. after ulcerations, wounds, and burns, involving the skin and subcutaneous tissue with retraction of the scar; after acute or chronic inflammation of fasciæ and aponeuroses, arising from gout and syphilis or rheumatism; following affections of the muscles, either rheumatic, traumatic, inflammatory, or from suppuration about and in them, and from gonorrheal arthritis; as the result of long retention of a vicious position, as in scoliosis; periarticular inflammations resulting from injury and rheumatism, with adhesions outside the joint, are responsible for spurious ankylosis; and, finally, lesions of the central nervous system, as in spastic paralysis.

To distinguish between spurious ankylosis or contracture and true ankylosis, Mr. Howard Marsh[1] says: "If care be taken the distinction between true ankylosis and mere stiffness depending on conditions external to a joint can seldom be difficult. The patient's history is different in the two cases. In instances of ankylosis there is generally an account of either acute or prolonged inflammation of the joint itself; while if stiffness depends on conditions external to the joint, there is a history either of some accident, of a slight inflammatory attack, or of merely incipient disease of the joint. . . . If the patient be examined under an anæsthetic, any stiffness that is due to muscular spasm will disappear; while, should rigidity depend on external adhesions, a very slight amount of force tentatively applied will often suffice to rupture some of them, and the nature of the case will become clear, not only from the fact that the adhesions as they give way are felt to be outside the joint, but from the immediate restoration of considerable movement."

The Treatment of Contractures and Spurious Ankylosis consists either in gradual or operative measures. By gradual measures are meant friction, douching, and frequently repeated passive movements. Much value has been claimed for the employment of the hot air bath to the limb. This is the principle of the Tallerman-Sheffield arrangement.[2] Dry air is heated to a temperature of 250° to 300° F. in a suitable cylinder, and in this the affected limb is placed for an hour or so. Mr. Willett came to the conclusion that this form of treatment was useful for extra-articular adhesions,

[1] *Diseases of the Joints and Spine*, 2nd ed. 1895, p. 302.

[2] *Vide* a clinical lecture on the "Therapeutic Action and Uses of the Localised Application of Dry Air heated to High Temperature in certain Classes of Surgical Affections," Alfred Willett, F.R.C.S., *Clinical Journal*, 30th May, 1894.

but not for cases in which intra-articular fibrous ankylosis existed. The result of soaking contractured limbs continuously in hot water is often good; and in gouty cases it seems that if the water be made alkaline with bicarbonate of soda, the parts become supple at an earlier date than if water alone is used. If such means fail, and there has not been at any time serious joint disease, forcible manipulation may be tried. When a joint has suffered severely, it is very unwise to attempt to break down adhesions, as attempts almost invariably fail; and still worse, if the disease have been tubercular in character, there is a very appreciable risk of re-lighting it up. To quote Mr. Howard Marsh again. He suggests that for forcible manipulation an anæsthetic should be employed; preferably gas. He says: "Indeed it may be regarded as an axiom that the good to be obtained is, in the great majority of cases, inversely proportionate to the amount of force required. . . . Only very slight force is necessary. It is well to observe that a single manipulation is frequently useless. If left to itself, the joint will soon be as stiff as ever. Manipulation must be followed by hot douching and daily massage."

The conditions in which manipulation is of value are, according to that surgeon:—

1. After sprains in which extra-articular adhesions have formed, but the joint is uninjured.

2. After subacute rheumatism with stiffness and severe pain, in which gentle movement shows that the joint-surfaces glide smoothly on one another.

3. In cases in which acute or subacute rheumatism has left *slight* intra-articular adhesions.

4. In those cases in which a joint becomes stiff and painful after fracture in its neighbourhood, those in which a dislocation has left a partially stiff joint, and in those stiff after a lengthened application of a splint.[1]

5. After old unreduced dislocations forcible manipulation often relieves the pain and improves the position of the limb. To the foregoing may be added—

[1] Cf. on this subject Paget, *Clinical Lectures*, 2nd ed. 1879, p. 213; Butlin, *Path. Soc. Trans.* vol. xxv.; Menzel, *Archiv f. klin. Chir.* Bd. xii.; Reyher, *Deutsche Zeitschr. f. Chir.* Bd. iii.; Teissier, *Gaz. Med.* 1841; Jacobson, *Hiltons' Lectures on Rest and Pain*, 3rd ed. p. 321. "A fallacy must not be overlooked in considering this question of fixation of a joint after prolonged rest, viz. that the joint itself may have sustained an injury at the time of fracture, and this injury not having been noticed, the fixation of the joint may therefore be due to true fibrous ankylosis."

6. In the cases of bruised deltoid in which any attempt to raise the arm is painful. As pointed out by Mr. Golding-Bird, the pain and stiffness are due to exudation of inflammatory material into the loose cellular tissue beneath the deltoid. Through this tissue the circumflex nerve passes, and at each movement of the deltoid the inflammatory effusion and the nerve are dragged on. It is therefore better to break down the adhesions.

Ankylosis.—This, in the correct surgical sense, is always intra-articular. The varieties are fibrous and osseous, or partial and complete.[1] In some instances of fixed joint the fibrous and osseous forms are combined. In the centre is a variable amount of fibrous tissue, and externally is fully formed bone. For practical purposes these are cases of bony ankylosis, and no suspicion of the presence of fibrous tissue is entertained until an occasion arises for making a longitudinal section through the joint.

Causes of Ankylosis.—Generally it has been said that acute non-purulent forms of arthritis are more likely to produce fibrous ankylosis than bony. But there are numerous exceptions. To take the first part of the statement, the sequence of fibrous ankylosis after non-purulent inflammation. Many forms of non-purulent arthritis end, not in fibrous, but in osseous ankylosis. For example, some cases of Pott's disease of the spine, in which no suppuration has occurred, result in bony ankylosis, and the last stages of scoliosis and osteo-arthritis of spine are similar in their morbid anatomy. The same event of formation of intra-articular bone is seen sometimes after gout and gonorrheal rheumatism and acute rheumatism, entirely apart from suppuration.[2] Osteitis deformans is another case in point.

Nor is suppurative inflammation necessarily followed by bony ankylosis. Take, for example, many cases of suppurative tubercular arthritis of the knee-joint in which the ankylosis is almost always fibrous. Even in some cases of prolonged suppuration in a joint, recovery has followed with the preservation of considerable movement. Mr. Marsh, speaking of suppuration in the hip-joint, says: "Indeed I have met with several instances in which movement was quite perfect, and I have been led to the

[1] Cf. "On the Classification of the Non-suppurative Forms," a paper read by Mr. W. Anderson at the Pathological Society, 18th Feb. 1896.

[2] Cf. a valuable lecture by Mr. Howard Marsh, entitled, "On the Pathology and Clinical History of some Rare Forms of Bony Ankylosis," *Brit. Med. Journ.* vol ii. 1895, p. 1087. Also W. Anderson, *Path. Soc. Trans.* 1896.

conclusion that instead of being the almost constant rule, it is the exception that suppurative hip disease is followed by bony ankylosis."

The immediate causes of ankylosis, then, are all forms of acute, subacute, and chronic arthritis, and I take it to be unnecessary to enumerate them in this place. To these may be added occasional instances of Charcot's disease,[1] osteitis deformans, and Volkmann's "cartilaginous ankylosis."

It will happen sometimes that in fibrous ankylosis the bands passing between the joint surfaces are so short, numerous, and strong, that no movement can be obtained even under an anæsthetic.

Symptoms and Diagnosis.—It is important to recognise, in the first place, if the contraction and malposition be extra-articular or intra-articular (see p. 512). Then the degree of movement should be ascertained. For this purpose an anæsthetic is usually necessary, but no force should be used, and the range of movement in the affected joint should be compared with that in the corresponding and sound joint. In forming an opinion as to the possibility of obtaining an increase of movement in ankylosis, the cause of the deformity should be carefully inquired into. Ankylosis after tubercular disease is generally best left alone for the reasons given above, unless the disease has subsided for some years.

The position in which ankylosis has occurred may be good or vicious. In the former event the patient may be congratulated upon the happy event of the arthritic trouble. Vicious positions are the straight in the case of the elbow, the rectangular in the hip and knee. Good positions are the rectangular in the elbow and ankle, and the extended in the hip and knee. In the case of the hip and knee, there are often combined with the antero-posterior deflection considerable rotation, abduction, or adduction.

Pain in fibrous ankylosis is a very variable symptom. If the peri-articular tissues have been implicated in the inflammatory process, any movement of the joint is painful. Considerable pain, swelling, and recurrence of the inflammation follow ill-advised attempts to break down unsuitable cases of ankylosis; and much discomfort is often caused by the application of extension instruments to the same class of cases. During the application of apparatus pain is often felt both at those spots where the pressure of the instrument falls and in the joint itself. The extent of the deformity and disability can be readily seen by the surgeon.

[1] See Mr. H. Marsh's lecture alluded to previously.

Prognosis.—This can best be determined in the case of fibrous ankylosis by an examination under an anæsthetic. If with the employment of very slight force the adhesions readily give way, and but little heat, pain, or swelling follow, then a good result may be looked for when passive motion, douching, and massage are persevered with. But it is not the remotest use breaking down adhesions once and then sending the patient away. Passive motion must be employed within a day or two of the operation and steadily continued. Thus only can a successful result be obtained.

If the ankylosis appear to require any powerful movements to overcome it, then all attempts should be at once desisted from, and the patient advised that nothing more can be done for him except it may be excision of the joint. With reference to bony ankylosis, the limitations of possible improvement of position will be discussed in speaking of the various joints.

Treatment.—A. Of Fibrous Ankylosis.—This appears to be the proper place to indicate certain *prophylactic* measures. In many instances some amount of fibrous ankylosis is due to unwillingness on the part of the patient to move the joint after a slight attack of synovitis, or to want of firmness on the part of the medical attendant in insisting on the patient so doing. Particularly is this the case in some cases of severe sprain, and in inflammation of a joint associated with fracture in the neighbourhood. Such cases drift about until they fall into the hands of the "bone-setter," who with one jerk relieves the patient of his or her disability and arrogates to himself the credit of "putting in a dislocated bone."

Fibrous ankylosis, excepting tubercular, may often be relieved in three ways, viz.—

(*a*) Frequent and gentle daily passive movements with massage and douching.

(*b*) Rapid manipulation under an anæsthetic, succeeded by passive movements, massage, and douching. Preliminary tenotomy and fasciotomy are often of service. The indications for this line of treatment have already been spoken of. For its ultimate success the full co-operation of the patient must be obtained, and he must be told that the passive movements will be painful, but must be steadily persevered in, if the increased movements obtained after the anæsthetic are to be permanent.

(*c*) Gradual extension by weights and instruments. From experience I do not think that any particular advantage in the direction of increased movement is obtained by these means. If the fibrous ankylosis is so firm as to require the force obtained by screws and racks to make it yield in some degree, then this treatment had better not be undertaken. Apart from the questions of time and expense, the results are often disappointing to the surgeon and positively detrimental to the patient.

A few hints may be given here as to the directions in which force should be applied to the various joints.

The Shoulder.—The forearm is flexed on the arm and the limb is kept as close as possible to the chest. The surgeon with his left hand fixes the scapula and with the right hand firmly grasps the patient's elbow, or the forearm immediately below. The humerus is then rotated inwards and outwards until the head is felt to move freely in the glenoid cavity. The arm is then adducted and carefully abducted and finally circumducted, with the limb as near the chest as possible. It is finally raised. All these movements should not be aimed at in one sitting. The anæsthetic must be repeated, and the former gain of movement secured and extended. It is not to be forgotten that numerous accidents have occurred owing to the employment of too much force. Such are fracture of the neck of the humerus, rupture of the artery and vein, rupture of some of the cords of the brachial plexus, and of muscles and tendons. After the anæsthetic, I occasionally give an injection of morphia in neurotic people, on account of the pain.

The Elbow.—With one hand, the left, fixing the affected elbow, the fingers pressing on the olecranon, and the thumb on the head of the radius, the surgeon holds with the other hand the patient's wrist, and makes quick, short movements first of flexion and then extension. If increased movement be secured, then pronation and supination are performed. It is well not to commence with extension, the danger being that the head of the radius may be displaced forwards.

The Wrist.—First flexion and then extension are tried in short, quick movements, and finally circumduction.

The Fingers.—Each joint of a finger is flexed separately, and finally all the fingers together. At the metacarpo-phalangeal joint full flexion and extension are carried out.

The Hip.—The pelvis should be firmly fixed by an assistant, and short flexion movements attempted. If any success is obtained, extension may be tried. In order to free the joint in the directions of abduction and adduction, some of the tendons around the joint will need section. The majority of ankylosed hip-joints are tubercular, and one would hesitate to give any assurance of final success unless the history were perfectly clear as to the absence of that form of affection. If there is limited movement in the joint it is well to advise the patient not to submit himself to forcible manipulation, as in time additional flexibility of the lumbar spine will more than compensate for the loss of movement at the hip.[1]

The Knee.—If the patella is fixed, no good can come of forcible manipulation. The fibrous bands are too extensive. If it is not so, and the joint is flexed, then the tendons and numerous fibrous bands at the back of the joint should be divided, preferably by the open method,[2] and flexion movements tried, to be followed by extension. If the ankylosis be of long standing and the limb bent at right angles, the under surfaces of the condyles lengthen, and it is impossible to bring the tibia into a right line with the femur. In such cases the extremities of the condyles have been cut away. Various accidents have occurred in the attempt to straighten ankylosed knees. Among them are rupture of the popliteal artery and vein,[3] tearing of the soft tissues of the ham, separation of the lower epiphysis of the femur and upper of the tibia, or rupture of the quadriceps tendon.

The Ankle.—If the joint is ankylosed near the right angle, the movements in the tarsal and metatarsal joints will compensate largely for the deficiency at the ankle. If in extension, manipulation with section of the tendo Achillis should first be attempted, and failing that, excision of the astragalus or of the ankle-joint itself.

B. Of Bony Ankylosis.—When the position is bad, a linear or wedge-shaped osteotomy will often improve it. In the case of the shoulder, when the arm is abducted or adducted to a considerable degree, section of the humerus or excision of the joint will rectify it. But if the arm is by the side, it is questionable if it be not better to let matters remain in *statu quo,* as the movements of the

[1] E. Müller, *Annals of Surgery*, vol. viii. p. 319, records a case of acute suppuration in the hip-joint after correction of ankylosis by manual force. The cause of the ankylosis appears to have been acute osteitis of the upper part of the femur. Müller observes that Oberst has published four other similar cases.

[2] Cf. a case by Mr. F. Treves, *Lancet*, 19th Nov. 1892, p. 1191.

[3] J. Fayrer, I.M.S., *Brit. Med. Journal*, 27th May 1891, p. 182, records a case of ankylosis of the knee after acute rheumatism, in which during an attempt to straighten the limb the popliteal artery gave way and a traumatic aneurism occurred. The patient, being young and strong, was discharged at the end of four months with a fairly useful but considerably deformed knee.

PLATE XIV.

FIG. 1. FIG. 2.

Two views of a case of ankylosis of the hip, in which Adams' operation of section of the neck of the femur was performed (Case 97).

PLATE XV.

The appearance of the patient in Plate XIV. after Adams' operation (Case 97).

scapula are so full and free. An elbow ankylosed in the straight position should be excised, and attempts made to secure movement by a false joint; or failing this, the parts should be allowed to ankylose at a right angle. Osteotomy, however, has secured, in the able hands of Mr. W. Adams, a great triumph in rectifying those distressing cases of rectangular bony ankylosis at the hip.

Adams' Operation of Section of the Neck of the Femur.—By the surgeon whose name it bears, this operation was first performed subcutaneously. Whether it be done in this way or by a method more or less open, all antiseptic precautions must be observed. The details of the operation are as follows. The patient lying on the side opposite to the ankylosis, and the pelvis and limb being steadied by an assistant, the top of the great trochanter is felt for. About 1 inch above this an osteotomy knife is entered and carried downwards and inwards on the flat, until the anterior aspect of the neck is felt. The edge is then turned towards the bone, and cuts firmly on to it. Before withdrawing the knife the saw designed by Mr. Adams for the operation is passed along the knife and the neck of the femur is then sawn through. If the neck has been accurately hit by the knife and saw, the section of the bone should not occupy more than four to five minutes. Any tendons or bands of fascia which resist extension of the joint are then divided and the limb is placed in a long Désault's splint.[1] A very successful case in which this operation was performed is given here, and Plate XIV. shows the deformity before operation, and Plate XV. after operation.

CASE 97. *Rectangular Deformity at the Hip cured by Adams' Operation.*—Miss A. J., aged 39, consulted me in 1895 with reference to deformity at the left hip-joint. When she was 9 years of age there was considerable pain in that joint, but no swelling and no suppuration. The family history is tubercular, and it is possible that there was a subacute tubercular synovitis of the hip-joint. She lay in bed for six months, and at the end of that time the hip "stiffened" into its present position. She now finds that the right leg is giving way, on account of the great strain in getting about.

On examination, the left hip was found ankylosed to a right angle,

[1] Mr. Jacobson, *The Operations of Surgery*, 1st ed. p. 1088, observes that "in a report from a committee of the Belgian Academy of Medicine a case is mentioned in which a patient who had been submitted to Adams' operation insisted on getting up on the twentieth day. Hæmorrhage came on from one of the fragments wounding the femoral vessels or some large branch. The femoral artery was tied just below Poupart's ligament; the hæmorrhage ceased, but free incisions were required for suppuration. The patient ultimately recovered. The same committee reported a death from hæmorrhage and one from purulent infiltration."

with extreme lordosis when the toes were brought to the ground. When the right leg was straightened and the patient stood on it, the left foot was 16 inches off the ground. No thickening could be felt in the bone, and the head of the femur was in its place. There was some doubtful movement in the joint, but it was not possible to be absolutely certain on this point. The opposite knee was hyper-extended on standing, with the ligaments considerably relaxed. Section of the muscles at the anterior aspect of the hip-joint was advised, with subsequent division of the neck of the femur. These proceedings were carried out and the limb put up in a Désault's splint.

The thigh was not at first fully extended, on account of a considerable effusion of blood where the sartorius and adductor muscles had been divided, and the tension on the skin. At one time the skin of the groin became so shiny that I feared it might give way. By temporarily diminishing the extension, this unpleasant appearance passed off, and the limb was completely straightened ten days after the operation. Three months after the operation the same doubtful amount of movement, 5° to 10°, was present in the neighbourhood of the left hip. All shortening had disappeared, and the left foot and leg were completely parallel with the right. With the aid of an apparatus the patient could walk with comfort without crutches or sticks.

Mr. Adams' operation is by no means so easy to perform as might appear from the description given by its author. The neck of the femur is not easy to "hit" with the knife, and the tendency is to make the section at the junction of neck and great trochanter. In that event, the time occupied in section varies from a half to one hour, especially if the bone is sclerosed.

In the case of Miss A. J., I found it better to make an incision about 1 inch long above the trochanter, and to burrow with the finger down to the neck of the bone, guiding the saw into place. The difficulties of the operation can thus be readily overcome.

The operation is not suitable in children, in whom the neck of the femur is ill-developed and, it may be, is partially destroyed by ulceration. The best results are obtained for ankylosis after rheumatic fever and acute suppurative arthritis.

Gant's Operation, or Infra-Trochanteric Osteotomy of the Femur.—An osteotomy knife is passed to the outer part of the anterior aspect of the bone at the base of the great trochanter. The saw is entered along the knife, and the outer two-thirds of the femur divided. The remainder is then snapped by carrying the limb inwards.

When practicable, it appears that Adams' operation is preferable to Gant's, especially when the deformity is rectangular or nearly so. Operating by Gant's method for a deformity for this severity is apt to leave a very ugly angle in the shaft of the bone, and may be followed by non-union.

For osseous ankylosis of the knee, a linear osteotomy in moderate cases, and removal of a wedge-shaped portion of bone in severer cases, with division of the flexor tendons, will serve to remedy the deformity to a considerable extent.

CHAPTER II

CONGENITAL DISPLACEMENTS (DISLOCATIONS)

Congenital Displacements in General—Of the Hip, Frequency, Etiology and Causation, Mechanical Theories, Pathological and Physiological Theories—Anatomy of Congenital Hip Displacement—Symptoms—Prognosis—Diagnosis—Treatment by Recumbency and Extension, Paci's Method, and by Operation—Hoffa's and Lorenz' Operation—Summary of Treatment—Congenital Displacements of other Joints.

THE word "dislocation," as commonly accepted, implies separation of those parts of a joint which have been normally in contact. If through an error in development such contact has at no time occurred, I take it there cannot exist a dislocation. Therefore the word "displacement" is more correct. Long usage has sanctioned the expression "congenital dislocation," but, I venture to think, without a due appreciation of the contradiction therein implied. As an example, congenital displacement of the hip may be taken. The pathology of veritable cases teaches us that there has been no perfect acetabulum formed from which the head of the femur could have been dislocated.

Congenital displacements of nearly all joints have been described, but the chief interest centres about that at the hip, on account of its greater frequency, and the serious interference with locomotion it gives rise to.

CONGENITAL DISPLACEMENT OF THE HIP

It is necessary to clear the ground a little before the subject is entered upon. Thus unskilful or violent delivery in breech presentations resulting in dislocation at the moment of birth, cannot be classed as congenital. That such accidents may happen is shown by some experiments of Melicher at Vienna upon women who had died undelivered. In six trials he found that with the fingers or hook it was possible to produce the luxation. In two instances in which the displacement was unilateral, the dislocation was in that hip to which greater traction had been applied as the presenting part. Reduction in these cases was effected with the greatest difficulty. Such are acquired, not congenital, displacements. In these instances the acetabulum was perfectly formed, and no great difficulty would have been subsequently encountered in deepening it sufficiently to again receive the head of the femur. But with ordinary care I doubt if it be possible to produce a dislocation of the head of the femur from a normal acetabulum. If, however, the cotyloid cavity be deficient, especially as regards the upper part of the rim, as is stated to be the case, in some instances, by Lockwood, then displacement of the head of the femur at birth by breech presentation is very probable.

Frequency.—Parise[1] examined the hip-joints of 332 infants who died in L'Hôpital des Enfants Trouvés, and found congenital displacement in three cases. Chaussier,[2] in 23,293 infants delivered at the Maternité, found it present once only. But it must not be forgotten that congenital displacement is often not recognised until the child begins to walk. In 2000 cases of children coming before my notice at the Evelina and Orthopædic Hospitals, I have seen it seven times. Krönlein's[3] statistics, based on 77 cases of Drachmann, 107 of Pravaz, and 90 of his own, found that of 274 cases, 35 occurred in males, and 239 in females, *i.e.* 12·4 per cent in males, and 86·6 per cent in females. Of these cases, 111 were bilateral and 163 were unilateral. The right hip was alone affected 83 times, and the left 80 times. It is thus seen that the affection occurs with greater frequency in girls than boys, and is more often unilateral than bilateral.

Etiology and Causation.—With regard to the causation of the lesion, a large number of theories have been propounded, but there is one only which is confirmed by scientific observation. The theories may be arranged under three headings—the Mechanical, Pathological, and Developmental.

Theory of Mechanical Causation.—Under this heading the following possibilities have been cited, viz. unskilful and violent delivery of breech presentations with the hook or fillet, falls on the part of the mother, malposition of the fœtus *in utero.*

1 *Bull. de la Soc. de Chir.* 1866, vol. vii. p. 331.
2 Chaussier, quoted by Krönlein, *Deutsch. Chir.* B. 26, p. 83.
3 Quoted by Rédard, *op. cit.* p. 498.

With reference to the first we may say that such cannot be considered as congenital, if they are produced at birth by violence. This supposed mode of origin could be verified by the sensation of the bone leaving the socket, and the presence of hæmatoma; as to the second, there is a case of dislocation of the xiphoid cartilage in an infant whose mother fell at the fifth month of pregnancy, but this fact cannot throw any light on the production of displacement at the hip; with reference to the third, the fact that many of the cases have been breech presentations may give colour to it. Yet this alone cannot be the real factor, because of the large number of such presentations in which no displacement of the hip is found to exist, and, secondly, dislocation of the hip cannot occur from a normal acetabulum unless the force used in delivery be extreme. With Bowlby [1] we believe that it is not possible for displacement to occur when the thighs are flexed on the abdomen *in utero*, if the cotyloid cavities are perfect.

Theory of Pathological Causation.—The following conditions have been assigned:—

(*a*) Muscular Contraction, due to some central nervous lesion (Guérin, Melicher, Carnochan), but unfortunately no central nervous lesion has been discovered, and the muscular contraction may, with more probability, be assigned to the displacement of the head of the bone rather than its cause.

(*b*) Paralysis of the Peri-trochanteric Muscles.—In Adams' cases there was no paralysis of the muscles, and the displacement arising from paralysis appears at a period too remote from birth for the lesion to be considered congenital.

(*c*) A Morbid Condition of the Articular Apparatus, viz. softening and other alteration of the ligaments (Sédillot, Stromeyer), hydrarthrosis (Malgaigne, Parise), tubercular disease of the synovial membrane (Broca), and of the articular surfaces (E. Barker). Against the view of the causation of congenital displacement by hip disease in the fœtus, Bowlby [2] brings forward the following facts:—

" 1. The patients in whom the deformity occurs are commonly healthy, and show no evidence of tubercle or struma. (2) Suppuration is never seen in these cases. (3) Ulceration of cartilage, caries, and necrosis have never been described. (4) The limb develops in a normal manner after birth, the displaced femur equalling its

[1] *Path. Soc. Trans.* vol. xxxviii. p. 297.
[2] *Ibid.* p. 297.

fellow in length, conditions which are commonly reversed when hip disease occurs in infants. (5) Disease of the joint does not explain the abnormal development of the acetabulum."

Developmental Causes.—This theory is supported by pathological observation, and is therefore the only one which can be accepted. Originally advanced by Palletta, it has received confirmation by the work of Dollinger,[1] Grawitz,[2] Bowlby, W. Adams,[3] and Lockwood.[4] Dollinger considered that premature ossification of the Y-cartilage at the bottom of the acetabulum was the cause, while Grawitz, from his observations of twelve specimens of congenital hip displacement from seven new-born children, concluded that it was due to arrested development of the acetabulum. Bowlby [5] describes the appearances of the acetabulum in a unilateral case of this nature taken from a girl, aged 13 years, thus: "In the position of the normal acetabular cavity is a triangular depression, which, although it evidently represents the acetabulum, is far too small to have accommodated the head of the femur at any time. . . . The edges of the depression are scarcely raised above the level of the surrounding bone. The upper portion of the normal acetabulum, the iliac segment, appears to have been suppressed, so that the ill-developed acetabulum represented by the above-mentioned triangular depression is formed merely by the coalescence of the pubic and ischiatic segments." Another case shown at the Pathological Society by Mr. J. H. Morgan [6] revealed a triangular acetabulum with the base directed outwards, the height of which was 1 inch, the breadth $\frac{1}{2}$ inch. Mr. Shattock [7] also mentioned another probably congenital case from a girl, aged 16 years, in whom both acetabula were triangular. The two specimens in the Hunterian Museum also show the same unusual appearance of the acetabulum. Mr. Lockwood has demonstrated that in one case the margin of the acetabulum was deficient.[8] The development of joints is touched on by him, and he states that "the hip-joint is not at first a pelvic socket in which the head

[1] *Archiv f. klin. Chir.* 1877, Bd. xx.
[2] Virchow's *Archiv*, 1878, 74, i.
[3] *Path. Soc. Trans.* vol. xxxviii. pp. 300, 301.
[4] *Ibid.* pp. 303-311.
[5] *Loc. sup. cit.* [6] *Ibid.* [7] *Ibid.*
[8] *Loc. sup. cit.* In this case the head of the femur was displaced on to the dorsum ilii. There was also ectopion of the abdomen with protrusion of several viscera, displacement of the head of the radius on to the front surface of the carpus, and the carpus towards the flexor aspect of the radius and ulna, and forward displacement at the knee-joints. Mr. Lockwood cites another case of absence of the margin of the acetabulum without displacement.

of the femur lies, but the acetabulum is formed by a growth of pelvic cartilage up and round the head of the femur. By the third month of intra-uterine life this process is far advanced, and the acetabulum is a deep cup."

In these observations then we have the etiology and causation of congenital displacement at the hip. It is well to bear in mind, in view of the various operations for deepening the acetabulum, that it is originally shallow, is smaller than normal and of unusual shape, and that in truly congenital cases the rim is deficient.

FIG. 284.—Front view of a case of bilateral congenital displacement of the hip-joint (after Rédard).

FIG. 285.—Back view of Fig. 284 (after Rédard).

These facts alone must throw a shadow of doubt on the reported success of some operators. Are all the cases which are stated to be congenital, and which have been operated on, really congenital, and not traumatic or paralytic?

There is a hereditary tendency in some cases of congenital displacement. Bradford and Lovett quote Dupuytren,[1] who had met with three families where the affection was present in several

[1] *Leçons Orales de Clin. Chir.* Paris, 1832, tome iii. Art. viii.

members. Cases have been recorded by Bouvier,[1] Verneuil,[2] and Volkmann.[3]

The Anatomy of Congenital Displacement.—Unfortunately, there exist but few authentic specimens in museums in this country.[4] The luxation is said to be complete or incomplete ; and in the latter case, according to Guérin, it becomes complete when the child walks. As to the position assumed by the head of the femur, it is stated that the displacement is nearly always dorsal, and rather postero-superior than directly superior. It is said to be exceptional for the head to come forward and to be found in front of the pubis or at the obturator foramen. According to Bouvier,[5] they are the greatest of rarities. But of seven cases I have had under my care, three were anterior.

At a meeting of the British Orthopædic Society in July 1895, Mr. H. A. Reeves drew attention to the fact that, in congenital cases, the displacement was more often anterior than was generally supposed. In his practice Mr. Reeves had met with several cases.

It will be convenient from the point of view of treatment to describe the appearances met with at three different periods, viz.—

1. At birth.
2. In young children who have walked.
3. In adults.

1. *Appearances at Birth.*—The acetabulum is in its normal position, but it is abnormal in shape, being either triangular, oval, or elongated. Very seldom indeed, if ever, has it been found completely absent. The cartilaginous rim may be wanting, as in the case described by Lockwood, and the mass of fat at the fundus of the acetabulum, the gland of Havers, is much hypertrophied. When the cotyloid border is defective, the cavity is almost continuous with a flattened surface on the iliac bone, sometimes covered with cartilage, which indicates the new position taken by the displaced head. Grawitz has shown by microscopical observation

[1] *Leçons Clin. sur les malad. chron. de l'app. locomoteur.*

[2] *Gaz. des Hôpitaux*, 1868, pp. 68 and 76.

[3] *Krankheiten des Bewegungsorgane.*

[4] Some of these are : an authentic one (described by Bowlby, *Path. Soc. Trans.*) and a doubtful one (described by D'Arcy Power) in St. Bartholomew's Hospital Museum, one in Charing Cross Hospital Museum, two in St. Thomas's Hospital Museum, a doubtful one without any history in the Middlesex Hospital Museum, one in Guy's Hospital Museum, and four in the Hunterian Museum, including Carnochan's.

[5] *Archiv. Gén. de Méd.* xiv. p. 439.

that the edges of the Y-shaped cartilage are much hypertrophied, and that the bone developed at the margins is very thick.

The head of the femur is round, or irregular or flattened, and is said to have been absent. The neck is short and conical, and forms an angle, less obtuse than the normal, with the diaphysis. The round ligament is flattened, slender, and of greater length than natural. It is sometimes softened and, exceptionally, it may, according to Ziegler, be of greater thickness than in a normal joint.

The capsule which is inserted around the margin of the original acetabular cavity is elongated, thinned, its capacity much increased, and it is sometimes distended with fluid. The muscles are often atrophied and retracted. Lockwood, in the case he described, states that "the muscles which surround the joint participated in the disturbance of position, and the obturator externus and quadratus femoris were especially dragged upwards by the ascent of the femur. The ilio-psoas lay in a deep groove, which was situated just below and internal to the anterior inferior spine of the ilium, and the tendon of the psoas wound backwards in an exaggerated way to reach the lesser trochanter." In an autopsy on an infant, the subject of congenital displacement on the left side, the muscles on that side were shorter and less developed than on the right.

2. *In Children who have Walked.*—The acetabulum is seen to remain small, shallow, and triangular. Above and posterior to it and around the new socket there is sometimes found a growth of bone which forms a partial rim for the latter, and to which the capsular ligament is attached. In Bowlby's case, a girl, aged 13, there was "a slightly depressed surface of bone covered by dense fibrous tissue which was continuous with a fibrous capsule around the neck of the femur. No attempt had been made at the formation of a new socket, either by the absorption of the ilium or by the development of new bone. The ilium itself is abnormally smooth, all the ridges for attachments of muscles being very slight." Occasionally where the head of the femur has rested the bone is hard, flat, and ivory-like. As an effect of the body-weight the femoral head moves further away from its proper place. Palletta in one case observed on the ilium three slight but distinct impressions, which appearance he interpreted as indicating that the head of the femur had occupied three successive positions.

The head of the femur is small, conical or flattened at the part where it comes into contact with the ilium, *i.e.* superiorly and posteriorly. The cartilage is present in most cases, but wanting in a few. The neck may be shortened or absent, and then the head is supported directly by the shaft. The capsular ligament is elongated, dilated, in some cases thinned, and in others much thickened. It sometimes has a curious hour-glass shape,[1] and its cavity is obliterated at the middle. According to Pravaz, this condition is only seen when the round ligament has disappeared. The upper insertion of the capsular ligament embraces both the new and old cotyloid cavities. The round ligament has been found in various conditions, occasionally thick and solid,[2] as if it had helped to support the body-weight, more often elongated and attenuated, and frequently absent (Bowlby, Adams), or merged into the joint-capsule.[3] The muscles are stated by Volkmann and Krönlein not to be contracted during infancy, but to become so during adolescence. In the history of a specimen shown by Mr. Shattock, probably congenital, from a girl, aged 16 years, it is stated that both thighs were flexed and the muscles appear to have been permanently contracted during life. According to Hoffa and others, muscular contracture is undoubtedly present in some cases in infants. The importance of determining the presence or absence of muscular contraction during the early years of life in these congenital cases is great in view of the extremely thorough division of muscles advocated by some in their operative procedures.

3. *In Adults.*—All the above conditions are much exaggerated. The displacement of the femoral head becomes greater, the capsule is now much thinned, or is sometimes pushed at its upper and posterior part between the caput femoris and the ilium, and may form a sort of bursa between the bones.[4] Rédard, to whom I am indebted for much information on the pathology of congenital displacement, says: "In certain cases in adults the capsule wears away and the round ligament is destroyed; the caput femoris then comes into immediate contact with the periosteum of the ilium, and forms a new and sufficiently perfect cavity for the reception of the

[1] Carnochan, *N.Y. Journal of Med.* 1848; Holmes Coote, *Lancet,* 1860; Canton, *Med. Gaz.* xli.

[2] Adams' *Todd's Encycl.* vol. ii.

[3] Bouvier, *Archiv. Gén. de Méd.* xiv. p. 439.

[4] In Mr. Canton's specimen, described by Mr. J. H. Morgan, it is stated that "the head and neck of the femur were found on the dorsum ilii, while a large bursa existed between the capsular ligament (*and?*) which immediately covered the head of the femur like a hood." *Path. Soc. Trans.* vol. xxxviii. p. 298.

head, with definite margins, while the old cavity becomes more and more distorted.[1] The new cavity is placed more or less above or behind the old cavity, sometimes in the middle of it (Coudray)." Bradford and Lovett remark "that the new cavity is often deep enough to form good support. The pressure of the head of the femur in its new position causes absorption of the periosteum and joint-capsule in that place, and the capsule finds a new attachment in the osteophytes, thrown out to form an upper rim to the cavity in favourable cases."

It is very interesting to know what becomes in adult life of all the cases of congenital hip disease which are seen in childhood. Some shrinkage of the capsule and fixation must take place and the condition thus improved, or else more would be heard in later years of these cases.

The muscles are, according to Rédard, much altered, some are contractured, and their points of attachment are approximated. Krönlein and Bardeleben assert that they undergo fatty and fibrous degeneration. The muscular contractures are best seen in adults; and they are no doubt due to the abnormal position of the head of the femur,[2] and to the slight flexion and rotation of the thighs. Considerable shortening is found in the psoas and iliacus and in the peri-trochanteric muscles, while the adductors and internal rotators are affected to a less degree.

The pelvis undergoes considerable change. The crests of the ilia approach each other, while the tubera ischii are separated and everted, and the ramus of the ischium becomes somewhat twisted. The transverse diameter of the true cavity of the pelvis is increased, while that of the false pelvis is diminished. The changes arise from the heads of the femora in their new positions on the dorsa iliorum pushing the alæ together somewhat. The effect of these alterations on the pelvis is to facilitate parturition rather than to prevent it.

Symptoms.—A. In bilateral cases.

1. *Mode of Progression.*—Very frequently the deformity escapes observation until the child commences to walk. Then he is seen to waddle, and to be the subject of lordosis. Pravaz thus describes

[1] In specimen 742 in the Musée Dupuytren the original acetabulum is nearly obliterated, and partially replaced by a prominence of bone.

[2] J. H. Morgan described the head and neck of the femur as being on the dorsum ilii, the former having passed beneath the external rotators. *Path. Soc. Trans.* vol. xxxviii. p. 298.

FIG. 286.—Back view of a case of bilateral congenital displacement of the hip-joint (M. A. F——, aged 8½ years).

FIG. 287.—Side view of Fig. 286.

the mode of progression: "The patient first raises himself somewhat on his toes and inclines the upper part of the trunk towards that foot which is chiefly supporting the weight of the body; then the other foot is slowly carried forward. At that moment the trochanter of the limb, on which the weight of the body mainly falls, can be felt to move upwards towards the crest of the ilium, and then resumes very nearly its former position when the weight is taken off that side." When running, the waddling effect is not so marked.

2. Lordosis is present on account of the disturbance of the equilibrium of the trunk. The vertical line through the centre of gravity of the body falls behind its normal position, and the trunk tends to fall backwards. To compensate for this, the lumbar region is arched and the abdomen protruded.

3. A disproportion of the lower limbs to the general bodily development is at once observable (Fig. 286), and when the patient's hands are placed by the side, they reach lower down on the thighs than in a well-proportioned individual. The muscles of the lower extremities are small and ill-developed, and the appearance is exaggerated by the want of proportion between the size of the pelvis and lower limbs. The pelvis appears broader than natural.

4. The great trochanters are unduly prominent when the child stands, and they are nearer the crests of the ilia, or on the pubes, being displaced upwards to the extent of $\frac{1}{2}$ inch to 2 inches. The gluteal muscles form a cone whose base is at the ilium and apex at the great trochanter, so that the tubera ischii are not covered by muscle.

5. The heels are rotated inwards, while the toes point outwards, and the knees are brought close together. Abduction of the limb is limited in dorsal displacements.

6. On the patient lying down, the lordosis disappears, and the tops of the great trochanters are not so near the crests of the ilia as when the patient is standing. The upper borders of the trochanters are, however, still above Nélaton's line.

7. Measurement of the limb from the anterior superior spine of the ilium to the internal malleolus shows that it is shorter than normal. But if the measurement be taken from the upper margin of the great trochanter on the affected side in a unilateral case, the actual length of the affected limb is but little, if any, less than is natural.

8. Much of the shortening may be made to disappear in infants

and children by steady traction on the affected limb. If, while making traction, one hand of the surgeon be placed on the prominent trochanter, it can be felt to descend and almost touch Nélaton's line. This is a most important point in diagnosis.

B. In a unilateral case.

In walking a very decided limp on the affected side is seen, the shoulder on that side is lower than the other, while the trunk inclines to the sound side. The disproportion in size of the affected limb, the wasting of the muscles, the prominence of the trochanter, the upward displacement of its head, and the diminished measurement from the anterior superior spine are readily appreciated by comparison with the sound side.

Negatively, there is a total absence of pain, no limitation of movement in young children, and but little in adolescents.

Importance of Early Recognition of these Cases.—1. As to the possibility of cure. The earlier the treatment is commenced the more likely are mechanical methods to effect a cure. Especially is this so if treatment is begun before the child has walked, and before the caput femoris has become much displaced, with the accompanying elongation of the capsular ligament.

2. Unjust accusations have been made against nurses and others in charge of children, the subjects of the deformity, of their having been allowed to fall. A careful examination of the case at the time will readily disprove any such accusation.

3. On account of the want of early and complete recognition, an incorrect diagnosis is made, and the patient may be wrongly treated for some time.

Diagnosis.—The first thing to be clear about is that a displacement of the head of the femur is really congenital, and not due to traumatism. In the history the points which assist the formation of an opinion as to the congenital nature of the deformity are the possibly hereditary nature of the affection, the onset of limping or waddling *without pain* when the child commences to walk. One must be careful not to readily accept the assertion of the parents that the child has had a fall.

The main features of congenital displacement are as stated above, the displacement of the head of the femur above Nélaton's line, the ease with which the head may be pulled downwards when the patient is recumbent, and the great mobility of the parts without pain.

A. When the affection is *bilateral*, it is easier to form an opinion than when it is unilateral. But even in the former case mistakes have been made, and confusion has arisen with the following conditions.

1. *Coxa Vara.*—In this deformity, although the great trochanter is displaced above Nélaton's line, it cannot be drawn down by traction on the limb, and the head of the bone can be felt in its normal position. The waddling gait and the prominence of the trochanter in coxa vara, together with the difficulty in abducting the limb, have caused the two affections to be confounded.

FIG. 288.—Unilateral congenital displacement of the hip-joint (after Rédard).

2. In children the lordosis and the imperfect balance of the body occurring in pseudo-hypertrophic paralysis have given rise to some difficulty in distinguishing it from congenital displacement. But again, in pseudo-hypertrophic paralysis the head of the bone is in its normal position, the trochanter is not excessively prominent, many of the muscles, such as the gastrocnemius, and extensors of the thigh are seen to be hypertrophied, while others, such as the lower part of the pectoralis major, the latissimus dorsi and teres major are atrophied, and the peculiar movements of the child affected with this form of paralysis on rising from the horizontal to the vertical position are diagnostic. As is well known, the child climbs up himself in rising from the couch to the standing position.

Generally in bilateral affections the diagnosis is easy, but in slight cases of displacement, and especially in young children, the lordosis and undue prominence of the gluteal region are not marked, and it is difficult to be sure if the upper margin of the trochanter be on Nélaton's line or not.

B. When the displacement is *unilateral.* The difficulties of diagnosis are much increased, especially in slight and early cases, but great reliance must still be placed on the abnormal position and rounded shape of the head, its excessive mobility, and the ease with which it can be made to move over the external surface of the ilium, or, in cases of anterior displacement, over the pubes: the absence of pain in walking and the freedom of the movements at the hip, together with the disappearance of shortening on gently drawing on the affected limb. The diagnosis has to be made from :—

1. *Coxitis*, especially when the head of the femur has undergone pathological dislocation. But a careful inquiry into the history of the affection in this case, its progress, the presence of abscesses or sinuses, the painful limitation of the movements of the joint, the existence of adduction of the thigh rather than abduction, and finally, if doubt still exist, an examination under an anæsthetic will render the case clear.

2. *From Paralytic Dislocation of the Hip.*—If the child has not walked, the difficulties are great. According to Verneuil, many so-called congenital displacements are really paralytic. And confusion is the more likely to arise because the caput femoris is very mobile, and the great trochanter is much displaced, while moderate traction brings the head back into its position. But the muscles should be very carefully tested for signs of degeneration secondary to anterior polio-myelitis. By careful and skilful movements, the head of the femur may be replaced in the acetabulum, while in congenital displacement it cannot.

3. *From Traumatic Dislocation.*—Although the head of the bone is full and rounded, and is in a new position, yet the rigidity of the limb, the history of the case, and, if recent, the bruising of the parts will render the diagnosis sufficiently clear.

Prognosis.—In untreated cases the outlook is bad. Much will depend upon the extent of the displacement, taken with the age of the patient when first seen. In some cases a more or less perfect acetabulum is formed or the capsule shrinks, and the joint becomes firmer, but the lordosis, prominence of the gluteal region, and the rolling gait persist. It remains to be seen later to what extent the deformity may be remedied by treatment.

Treatment.—The methods of treating congenital displacement of the hip are three, viz.—

1. Extension either in the Recumbent Position or by Apparatus.
2. Forcible Reduction.
3. Reduction by Operative Measures.

1. *Extension either in the Recumbent Position or by Apparatus.*—The oldest form of treatment is by continuous extension. Among

its advocates are Pravaz, father[1] and son,[2] Buckminster Brown,[3] and William Adams.[4] But to Buckminster Brown should be ascribed the credit of having been the first to treat cases in this way with considerable success. He subjected his patient, a little girl, aged 4 years, to complete recumbency with extension for thirteen months, and then allowed her to get about for a year in an arrangement by which she could imitate the movements of walking without bearing the weight on the legs. At the end of two years and three months the trochanters were in place, the lordosis had disappeared, and the child was able to run about normally. This is a classical case, and is extensively quoted by the advocates of this line of treatment. But as the question of treatment is still

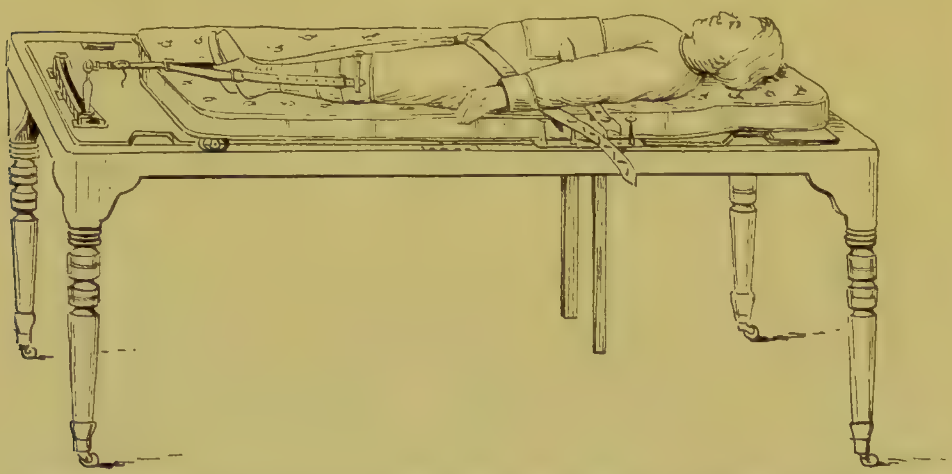

FIG. 289.—Mr. Adams' extension-couch for cases of congenital displacement of the hip-joint. The part on which the patient lies is detachable, and can be placed in a carriage.

sub judice, it would be very interesting to trace this case, and to ascertain if after a lapse of nine years there is any sign of recurrence of the displacement.[5] Dr. Post[6] treated successfully, under an anæsthetic, a case of unilateral displacement by placing the head of the femur in a young child as nearly in the normal position as possible, and then immobilising the parts in plaster of Paris for a year, allowing the child to get about on crutches.

1 *Bull. de l'Acad. de Méd.* vol. iii. p. 438.
2 *Bull. de la Soc. de Chir.* 1864, p. 218.
3 *Boston Med. and Surg. Journ.* 4th June 1885.
4 *Brit. Med. Journ.* 23rd April 1887, and 22nd Feb. 1890.
5 This has taken place, according to Dr. Myers, *Annals of Surg.* Aug. 1894.
6 *Boston Med. and Surg. Journ.* No. 23. In 1894 this case had suffered a slight relapse.

In this country Mr. Adams has advocated this line of treatment, and has carried it out in two cases with satisfactory results, the remaining four being under observation. Of Mr. Adams' six cases, two were double and four single displacements. But in the two cases given by him,[1] we are not told that the patients were able to get about ultimately without apparatus of any kind.

In connection with this method it is interesting to inquire what are the objects of treatment by recumbency for so prolonged a time as two years, and what changes may be effected in the parts by it?

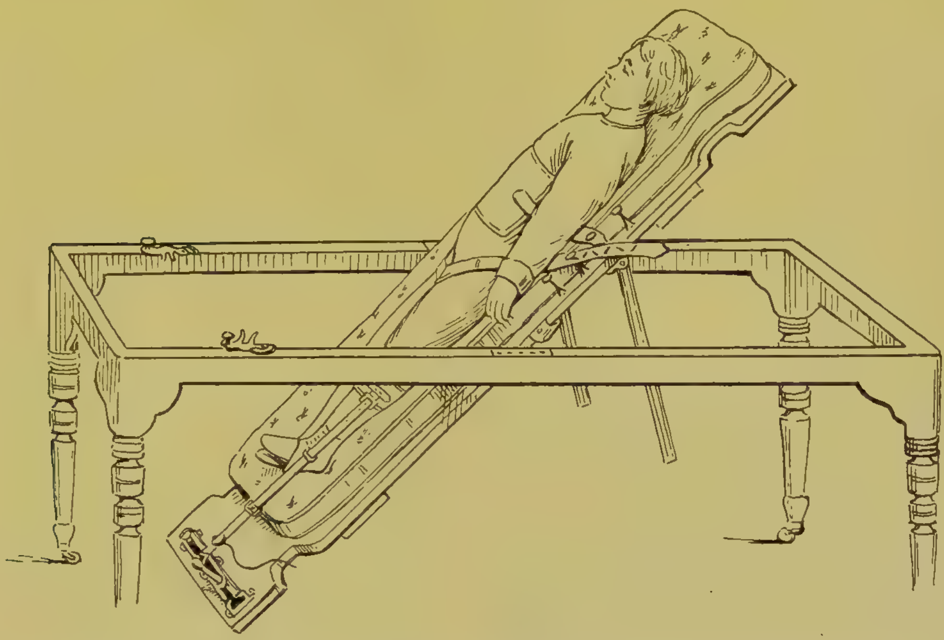

FIG. 290.—The extension-couch tilted for meals, etc. The couch may also be tilted the reverse way, so that the weight of the body acts as counter-extension.

According to Mr. Adams, if the treatment is begun under 2 years of age, the gradual displacement of the head of the femur by the elongation of the capsular ligament will be prevented, and further he thinks there will be "adapted growth of the capsular ligaments and all the surrounding muscles and fibrous structures," when the head of the femur is retained for so long a time in as nearly as possible its normal position; and as a result "a circular flattened depression will be formed in the bone near the acetabulum, and this, together with the adapted growth of the capsular ligament and fibrous structures, will keep the head in position. The upper

[1] *Brit. Med. Journ.* 22nd Feb. 1890.

portion of the capsule we may also hope will contract." [1] That something of this kind does occur is shown by another case quoted by Mr. Adams of a young man, aged 19 years, who had been treated by recumbency for twenty-six months at the age of 6 to 8 years. At the nineteenth year there was only $1\frac{1}{4}$ inch shortening, and with a cork sole the limp in walking was very slight, and he could take any amount of exercise. This may be considered satisfactory, seeing that if the cases go untreated, the shortening at the age of 19 is usually 2 to 3 inches or more.

In any event, the result of Buckminster Brown's case has encouraged many surgeons to pursue the same line of treatment. Schede [2] has, since 1880, treated cases of congenital displacements, in whom *no secondary changes have been caused by walking*, by simple traction, slight abduction, and moderate lateral pressure on the trochanter, by which the head of the bone is retained in the acetabulum. He holds that in many cases the condition is by no means so incurable as it is supposed to be, and it can be not only greatly improved, but brought to a complete cure. But after the child has commenced to walk, the prognosis is less favourable. By the end of the second year, certainly in the third, the changes in the joint have become so marked that intermittent extension no longer suffices to reduce the deformity. But in such cases the employment of continuous extension by means of weights for a few weeks or months so restores the position that, with abduction and pressure over the great trochanter, the head of the bone may be made to go back into its place, and remain so firmly fixed that pressure upon the sole of the foot no longer causes it to ride out. Schede's apparatus is essentially an outside steel support from the pelvis, with an abduction screw, by turning which pressure may be made on the trochanter. This is employed during the day, and extension of four to five pounds at night "till a cure is effected." Schede reports 43 cases treated by his method. Of these 1 was entirely and absolutely cured, [3] 13 almost cured, 15 greatly improved, 10 but slightly improved, and 4 lost sight of. He also reports 4 cures by operation.

[1] Cf. the changes which are described on p. 529 in the outline and density of the capsular ligament, and notably the hour-glass contraction which has been seen.

[2] *Verhandlungen der Deutsch. Geselsch. für Chir.* xxiii. Congress, 1894; and *Annals of Surgery*, March 1895, pp. 347-351.

[3] Dr. T. H. Myers says (*Annals of Surgery*, Aug. 1894) that Dr. Schede has written him to say that he has completely cured four cases by this method.

Volkmann also obtained good results by these methods of extension with abduction.

I have tried the treatment by recumbency and extension in two cases with a great measure of success, and I here give the details.

CASE 98. *Congenital Displacement of both Hips treated by Recumbency and Extension for Two Years. Subsequent Retention of the Heads of the*

FIG. 291.—Case 98: congenital displacement of the hip, fitted with walking apparatus and crutches.

FIG. 292.—Case 98: photograph taken one year later than in Fig. 291. The boy is able to walk without crutches, and all lordosis has disappeared.

Femora in Good Position.—Edgar M——, aged 7 years, came under my care at the National Orthopædic Hospital on 4th April 1892. He was the first child, and was born by the breech, but no instruments were used. On admission he was seen to be a well-nourished boy, but the lower limbs were small in proportion to the rest of the body. There were the typical lordosis on standing, and waddling gait in walking, and the prominence of the trochanters was marked. In the horizontal position it was noted that the heads of the femora were displaced dorsally, and were nearer the crests of the ilia than is normal. By measurement it was found that the upper border of the right trochanter was ¾ inch above Nélaton's line, and the left ½ inch, but both could be brought into proper position by traction on the limb. The boy was placed on a couch constructed by Ernst on Mr. Adams' model (Figs. 289, 290), and sufficient extension applied to bring the trochanters downwards to their normal position. No attempt was made to reduce the displacement on either side. On 11th July 1892 it was noted that when the extension was removed the upper margins of the trochanters were not more than ½ inch above Nélaton's line, improvement therefore being greater on the right side. The recumbency and extension were maintained till May 1894, and he was then fitted with an apparatus (Fig. 291) by Ernst, which allowed him to move with the aid of crutches, while at the same time the feet did not touch the ground, extension being kept up by pressure on the tubera ischii, and over the great trochanter. At night the extension was maintained by a stirrup and weights. In January 1896, as there was no sign of the upward movement of the great trochanters when the apparatus was removed, moderate force was applied upwards in the long axis of the limbs, and failed to cause any shortening, and the boy was allowed to dispense with his crutches, the instrument being altered so that he used his feet in walking (Fig. 292). After two months there was not the slightest upward deflection of the trochanters. So far, then, this case may be considered satisfactory, and in about six months I intend to dispense altogether with apparatus.

CASE 99. *Double Congenital Displacement of both Hips, treated as in Case* 98.—Mary Ann F——, aged 8½ years, came to me at the National Orthopædic Hospital on 6th December 1893. Her appearance then is seen in Figs. 286, 287. The symptoms were similar to those in Case 98, except that the displacement above Nélaton's line was 2 inches on the right side and 2½ inches on the left, and the displacement was not dorsal but pubic,[1] and there was some tension of the adductor muscles. She was treated by continuous recumbency and extension, with the limbs somewhat abducted, for two years. In January 1896 the heads of the femora were almost fixed, and it would have required a strong pull to draw the limbs downwards ½ inch, and more so on the left than on the right. She left the hospital wearing the extension-apparatus and walking on crutches.

I do not claim that these cases are cured, but so far there is every indication of it, and I shall take an opportunity of reporting their condition two years after they have ceased to wear any apparatus.

It is evident that treatment on these lines is tedious to a degree, and difficult to carry out, and some parents will strongly object to

[1] Phelps, *Trans. Amer. Orth. Assoc.* vol. iv. p. 132, quotes a case of Ridlon's, and gives two of his own of forward dislocation.

it. In such cases I have, following Mr. Adams, carried out a mode of treatment which is a compromise, and in one instance with great success. The method is for the patient to wear an extension instrument with a cork sole on the boot of the sound limb by day, and to have a weight applied at night. The following is an example :—

CASE 100. *Congenital Displacement of Left Hip. Treatment by Means of a Walking Apparatus, and Extension at Night.*— Ethel E———, aged 4, was seen by me on 11th October 1893, in consultation with Dr. Herron. For the past two years it had been noticed that the child limped, halting on the left leg. There was no pain, either in standing or walking. The birth was by the vertex. On examination, the movements of the leg were free in all directions, the head of the femur was displaced on to the pubes, the left leg was 1 inch shorter than the right, and the great trochanter was 1 inch above Nélaton's line. It could be pulled down ½ inch by traction. There was scoliosis in the left lumbar and right dorsal region. She was ordered to wear one of Ernst's extension apparatus by day, and to have a weight of 2½ pounds applied to the leg at night. In April 1894, with the instrument removed, the top of the great trochanter was ⅜ inch above Nélaton's line, and it could be pulled down so that the shortening entirely disappeared. On 8th December 1894 the left leg was ¼ inch shorter than the right, and the trochanter could not be displaced upward by any reasonable amount of force. She walked without any perceptible limp, and the scoliosis had entirely disappeared.

FIG. 293.—Ernst's walking apparatus for unilateral congenital displacement of the hip.

This is the modification of Buckminster Brown's plan I should recommend in children under 4 years of age, when the method of prolonged recumbency, described above, is impracticable.[1] It is not to be wondered at, then, in view of the length of treatment, the necessity of selecting cases in which the displacement is not excessive and in which the children are not too old, that surgeons have attacked the matter in other ways.

2. *Forcible Reduction.*—Paci has brought this method into prominence. By his manœuvres he does not claim to put the head into its normal position, but to make it descend into the neighbourhood, with the idea of securing a new joint in that situation, and thus relieving the patient of the shortening, lordosis, and waddling gait. Professor Post of Boston has tried this method, and both surgeons claim to have cured some cases.

The manœuvres of Paci are as follows:—The patient is placed recumbent, and the surgeon flexes the leg fully on the thigh, and the thigh on the pelvis, thus carrying the head of the femur downwards. The thigh is now abducted slightly (too much abduction may cause anterior displacement), and the limb is strongly rotated outwards,[2] and then extended fully. By the last-named movement the head is brought as near to the acetabulum as possible. As a rule an anæsthetic should be given for this proceeding. Afterwards the limb is put up in silicate or plaster of Paris bandages for a month, followed by continuous extension for three months. Then walking may be commenced on crutches. It seems that this method of Paci's has commended itself to Professor Lorenz, one of the pioneers in the operative treatment of congenital luxation. "After much thought and careful observation of the cases operated on, Lorenz resolved to alter his treatment in 1895, and since that time has treated thirteen cases with perfect success and without

[1] With the idea of exciting the formation of a bony growth at the spot where the head of the femur rests in recumbency, Lannelongue (*La Semaine Méd.* 1891, p. 510) injects a few drops of 10 per cent solution of chloride of zinc. In a child of 3 years he made eight punctures, and in each deposited two drops of the solution. Three weeks later he deposited twenty drops, and he states that five weeks from the first injection there was a bony growth apparent below the crest of the ilium and above the great trochanter. The result appeared to be good, and it was reported to the Congress of Surgeons in 1891 as a cure. Coudray (*Bull. et Mémoires de la Soc. de Chir.* Paris, 1891, xvii. p. 770) reports the cure of a case treated by Paci's method, injections of chloride of zinc solution, and continuous extension for five months. Jewell (*Ann. d'Orthopédie*, December 1893) reports three cases treated by these injections, repeated from two to five times. Two were cured, one of them a bilateral displacement. (Quoted from an article by T. Halsted Myers on "Congenital Dislocations of Hip," *Ann. Surg.* Aug. 1894).

[2] If the displacement be anterior, the limb should be adducted and rotated inwards.

cutting."[1] Lorenz states, however, that the bloodless reposition is unsuitable in cases where the child has been allowed to continue to walk untreated till the seventh or eighth year, and the rudimentary acetabulum has become effaced.

Paci has by his method achieved success in ten of eleven cases, and Rédard[2] in three of five cases.

3. *Operative Treatment.*—This mode of treatment is at the present time (March 1896) still on trial, and it is difficult to express any decided opinion about it, as we wait to be convinced that, even with the most recent and improved forms, the removal of the deformity is complete and permanent, since sufficient time has not yet elapsed.

Many forms of operation have been practised, and their aim seems to be naturally either to diminish the size of the caput femoris so as to make it fit the deformed acetabulum, or to increase the size and depth of the latter so as to make it receive the head.

Among the earlier operations is that of decapitation of the femur, which Margary proposed after an unhappy attempt to form a new acetabulum. Margary's efforts have been imitated by numerous surgeons, viz. Motta, Vincent of Lyons, and Ogston,[3] but I fail to find any examples of permanent success by these means. The last-named surgeon has proposed and carried out a method in which the head of the femur is removed by a horizontal section through the neck, and a wedge-shaped piece cut out of the os innominatum at the site of the acetabulum, with the intent that the femur may fix into the mortice thus left. The futility of such an idea is at once apparent, as is shown by reference to the diagrams accompanying his paper.

At the present day the operations which command attention are Hoffa's method and Lorenz' modification.

Hoffa's Operation.[4]—The joint is opened by Langenbeck's, or

[1] *Med. Press and Circ.* 19th Feb. 1896, p. 191; and here the details of Lorenz' most recent procedure are given.

[2] *Op. sup. cit.* p. 528.

[3] *Annals of Surgery*, vol. viii. p. 161.

[4] See *Annals of Surgery*, vol. xii. p. 463, and articles by E. H. Bradford, also by T. Halsted Myers, *Annals of Surgery*, Aug. 1895. From Dr. Myers' article many of the points dealing with Hoffa's operation are taken. In the *Med. Week*, 27th April 1894, p. 194, is an account of an autopsy in one of Hoffa's cases, which died from diphtheria six months after operation, together with a discussion on the subject. Hoffa states that the autopsy showed that the result of the operation was the formation of a completely new acetabulum, the articular surfaces being everywhere covered by hyaline cartilage, as was seen by microscopical observation. The cotyloid cavity was deep, furnishing a good support for the head of the femur, and everywhere perfectly invested

the posterior incision, and the capsule is divided at its insertion with the neck of the femur. Then the muscles are peeled from the great trochanter by a periosteal elevator. Hoffa finds that in children under 5 years of age it is almost always possible by flexion of the thigh and direct pressure upon the head to bring it into the old acetabulum,[1] and there is no need to deepen the latter. When the head of the femur is replaced, the hip and knee are often seen to be flexed. This is overcome by holding the head firmly in the acetabulum while an assistant gradually extends the leg on the thigh, so stretching the muscles attached to the tubera ischii.

In children of 6 years and upwards, Hoffa divides the last-named muscles before opening the joint (on Lorenz' recommendation). The limb is now abducted, and the adductors subcutaneously divided. It is then hyper-extended, and the soft parts attached to the anterior superior spine of the ilium, and the fascia lata divided by the open method to better control the hæmorrhage. The joint is now opened and the head freed so completely that it can be brought out of the wound. The ligamentum teres is now extirpated. The acetabulum is deepened and broadened by using a bayonet-shaped Volkmann's spoon: and its cartilage, fat, and a good portion of spongy tissue scraped out, but the margins of the cavity are preserved as much as possible. Reduction of the head is now possible. Hoffa puts the limb afterwards in moderate inversion to prevent the escape of the head from its new position, and after a few weeks brings it into its normal position. Care is taken to keep the limb abducted and extended. The first fixation dressing is kept on four to five weeks, and the massage and careful passive motion are carried out. After that time the child can stand and walk in an apparatus which allows motion at the hip, but prevents the head escaping from the acetabulum. This is worn for weeks or months[2] until the joint is fully consolidated.[3]

by cartilage. Further, it was obvious from the great thickness of bone that a deep cavity can be formed without danger of perforation; and even if perforation should occur in the course of the operation, the consequences are not so bad as they have been alleged to be, but Kirmisson's two deaths in which perforation had occurred should be noted in this connection.

[1] How can this be so, if, as the pathological observations show on p. 528, the triangular or oval acetabulum is too small to receive it?

[2] Surely a weak point in Hoffa's operation, since but little time is gained on the recumbency and extension method, and cure is by no means certain.

[3] In the "Epitome of Current Med. Lit." *B.M.J.* 14th July 1895, p. 5, there is an abstract from an article of Hoffa's in the *Berliner klin. Wochenschr.* detailing the results of his operation. The results of 112 operations on 82 patients are given; 30 of them

Lorenz'[1] *Modifications of Hoffa's Operation.*—Lorenz states that his operation comprises these stages: formation of a femoral head, which does not always exist, reduction of the head of the femur, enlargement of the cotyloid cavity, and fixation of the head into the cotyloid cavity. He rejects Hoffa's opinion that the muscles inserted into the greater and less trochanters are shortened, and states that they are actually lengthened. Lorenz, therefore, does not sever them. The parts which are shortened are the outer part of the fascia lata, some bundles of the adductor magnus, the sartorius, and the hamstrings. The details of Lorenz' operation are division of the tensor vaginæ femoris through a longitudinal incision starting from the anterior superior spine of the ilium, and to the first incision is added another, passing transversely inwards at the level of the trochanter. The anterior wall of the capsule is then denuded, and the capsule opened by a crucial incision.[2] The acetabulum is hollowed out, and the head of the femur re-formed, if necessary. After which it only remains to pull on the latter until it is brought down to a level with the cotyloid cavity. Much assistance is now afforded by the section of the hamstrings. Lastly, the limb is put up in a position of slight abduction. In four weeks' time massage and gymnastic exercises are begun, and these must be continued for a year. The advantages of this operation consist in causing but comparatively little interference with the muscles.

Lorenz has operated on sixty-three children, and in some cases thus treated eighteen months ago, "the result obtained is really brilliant," it being impossible to detect the slightest trace of the dislocation which formerly existed.

Comparing the two forms of operation, one unhesitatingly prefers Lorenz' method when one decides to operate. The severity of Hoffa's operation is very great; it is almost amputation at the hip-joint, with the femoral artery and vein, the anterior crural and the sciatic nerves alone left intact. Personally I may add that I

had bilateral and 53 unilateral displacements. Death occurred in 3 cases, being due in 2 of them to prolonged anæsthesia, hæmorrhage, and shock, and in the third to iodoform poisoning. In 9 cases, ankylosis of the hip followed, and return of the luxation in 11. These statistics, in view of the severity of the operation, are not encouraging.

[1] *Centralbl. f. Chir.* Aug. 1892; *Ann. Surg.* vol. xvi. p. 582; *Brit. Med. Journ.* Sept. 1892; *ibid.* 6th June, 1893; *Wien. med. Presse*, No. 11, 1892; *Med. Week*, 13th April 1894; *Annals of Surgery*, Aug. 1894.

[2] Bradford insists upon the necessity of free division of the Y-ligament of Bigelow in these cases. *Annals of Surgery*, Aug. 1894.

should strongly dissuade a patient with congenital displacement from being subjected to Hoffa's procedure, because—

1. *The Danger.*—Dr. Halsted Myers [1] states that he has notes of 177 cases of Hoffa's operation or some of its modification, and among these are six [2] deaths due directly to operation.[3] To these may be added one that Lorenz mentions as having occurred from septicæmia, and Kirmisson states that he "knows of a few fatal cases in the hands of other surgeons, which he is not authorised to mention." [4] And if all the cases which have been operated on by

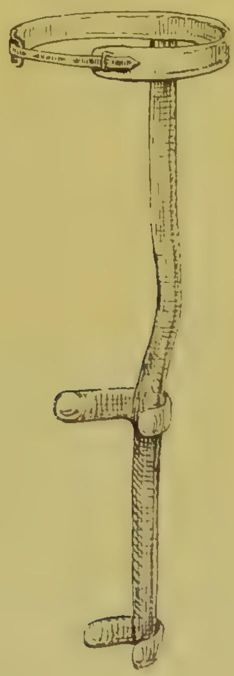

FIG. 294.—Thomas' hip-splint.

FIG. 295.—Thomas' hip-splint applied. The patten on the left foot is not very clearly shown.

this method were reported, it is certain that other deaths will be found to have occurred.

2. *The Probability of Cure.*—Hoffa himself states that he wishes it to be distinctly understood that these children cannot be completely cured, since there is always left some shortening of the limb. In bilateral cases, however, he can reduce the waddling gait to a minimum, and can almost completely overcome the lordosis.

[1] *Loc. sup. cit.*

[2] Bradford and Lovett, *loc. sup. cit.* mention another.

[3] Viz. 3 of Hoffa's, 2 of Kirmisson's, 1 from hæmorrhage and peritonitis eight days after the operation, following perforation of the acetabulum, and 1 from septicæmia, following perforation of the acetabulum, and 1 of Broca's.

[4] Bradford and Lovett, *loc. sup. cit.* p. 130.

These points have made most surgeons discountenance operations of such severity, and even Lorenz, the originator of a much less severe form of operation, has, "after much thought and careful observation of the cases he has operated on, resolved to alter his procedure in 1895 in some cases, and has carried out bloodless reduction in thirteen cases with perfect success and without cutting."

To sum up the Treatment.—1. Of the non-operative methods of treatment, it seems that Paci's is the best, and should undoubtedly be tried in the first place.[1] The great advantage of this method is the immediate reduction of the displacement in the sense that the head is placed either on or in the acetabulum, while the traumatism caused by the movements may give rise to inflammatory exudation, which fixes the head of the bone. It is essential that sufficient rest, extension, and support to the limb should be given for some months afterwards.

2. The well-tried method of complete recumbency, extension and abduction for a period of many months, should not be abandoned. It is of special value in children under 2 years, and may effect a cure. In older cases the symptoms are much improved. The chief objection to it are its duration, tedium, and the possibility of disappointment, owing to recurrence of the deformity at a later period in some instances.

3. As a compromise, in slight cases with not more than $\frac{1}{2}$ inch shortening in young children, the use of an extension-apparatus for walking, and pads over the trochanter, with traction by weights at night, is often very effective (cf. Case 100).

4. Operative measures cannot be necessary if the displacement is recognised early. In cases which have gone untreated for several years, when the bloodless methods have been tried and failed, and an operation is demanded, the best form is that of Lorenz, but surgical intervention can never be regarded as a routine method of treatment. If it is undertaken, the following points, excellently summarised by Rédard, must be clearly put before the patient:—

(*a*) The number of perfect cures by operation is small.

(*b*) Cases are, however, frequently much improved.

(*c*) Lameness persists to a slight degree, and the limb remains more or less shortened.

(*d*) The formation of a complete new joint is very rare.

[1] He reports fifteen cases, which are almost perfect a year or more after operation. They have been examined by many surgeons, who have expressed themselves as greatly pleased with the results (*Archivio di Ortopedia*, Anno IX. No. 6, and Anno X. No. 1).

(*e*) The lordosis is generally corrected.

(*f*) The danger of operating by Hoffa's method is considerable, and complete cure is problematical.

Other Congenital Displacements[1]

Of the Lower Jaw.—Imperfect development of the jaw with partial displacement has been seen. Frequently some other congenital deformity is present, such as the persistence of the branchial clefts, malformations of the ear, macrostoma, etc. A double displacement forwards and another backwards have been described.

Of the Spine.—In monstrosities the cranium is sometimes seen to be displaced forwards or backwards on the vertebral column.

Of the Joints of the Upper Extremity.—The clavicle has been seen congenitally displaced at both extremities (Guérin). The shoulder[2]: the head of the humerus may be displaced forwards or backwards on the scapula. I have met with an example of the latter condition at the Evelina Hospital. Occasionally a downward displacement is seen, sub-glenoid. The elbow: both bones may be displaced backwards, or the head of the radius forwards or backwards. The wrist: in club-hand there are met with anterior, posterior, inward and outward displacements at the wrist. The fingers: Chaussier instances a fœtus in which the outer three fingers were displaced at the metacarpo-phalangeal articulation.[3]

Of the Lower Extremity.—The hip: the description of the forms is set forth in the preceding pages. The knee: a forward displacement partial or complete is met with, associated with congenital talipes varus and valgus. Hibon[4] collected 11 cases. The patella: this is generally outwards, and is partial or complete.[5] Bajardi describes a case in which the patella was partially displaced outwards on the right, and completely on the left side. He had collected 34 other cases.[6] The ankle: complete luxations are very rare. The partial displacements are seen in congenital club-foot.

1 *Vide* the treatise of Krönlein in the *Deutsche Chirurgie.*

2 Cf. M. Smith, *Dublin Journ. of Med. Science*, 1839; and Stimson, *Treatise on Dislocations*, p. 107.

3 Cf. also Bérard, *Dict. de Méd.* Art. "Main," vol. xviii.

4 "Luxation du tibia en avant," *Thèse de Paris*, 1881.

5 Bajardi, *Archiv. di Ortoped.* Ann. XI. vol. iv.

6 Schon (*Ugeskrift for Laeger*, 17th Nov. 1893) reports a case of congenital dislocation of the left patella. The patient's mother and one sister had similar deformities.

CHAPTER III

DEFORMITIES ARISING FROM CEREBRAL AND SPINAL PARALYSES

Cerebral Paralysis in Children—Causes—Symptoms, Early and Late—Diagnosis—Deformities and their Treatment—Spinal Paralysis in Children—Infantile Paralysis—Deformities of Arms, Trunk, and Legs—Paralytic Dislocations—Treatment by Mechanical and Operative Measures—Arthrodesis—Other Spinal Paralyses of Children.

Cerebral Paralysis in Children

Under this somewhat vague term are included two conditions:—

Infantile Hemiplegia.
Spastic Paralysis.

And associated with them is frequently an idiotic condition both of mind and muscle.

Osler[1] has stated the *causes* of infantile hemiplegia to be—

1. Hæmorrhage occurring during violent convulsions, or in the course of whooping-cough,[2] or at birth (meningeal), and due to pressure of the forceps, also meningeal hæmorrhage following a fall.

2. Post-febrile processes resulting in embolism,[3] endo- and peri-arterial changes and encephalitis.

3. Thrombosis of cerebral veins.[4]

To these might be added microcephalus, which is so frequently found associated with defective and abnormal development of the brain.

A case of this latter description has been under my care at the Evelina Hospital, partly as an in- and partly as an out-patient since 1893. I performed linear craniectomy on him in 1894, but with no relief to the hemiplegia, and no improvement in the mental

[1] *Philad. Med. News*, 11th Aug. 1888, p. 143. [2] *West. Med. Press and Circ.* 1887.

[3] Landouzy and Soredey, *Rev. de Méd.* 1885.

[4] Gowers and Handford, *Brit. Med. Journ.* 1887, vol. i. p. 1098.

condition, which has remained idiotic. Of three other cases on which I performed craniectomy, two were in no wise benefitted, and one died a week after operation, and *post-mortem* there was found sclerosis of the whole left cerebral hemisphere, with great dilatation of the ventricular cavity, and a large abnormal fissure extending obliquely through the cortex into the lateral ventricle.

The date of onset varies. In some cases hemiplegia exists from birth, and it is then due to mal-development of the brain, asphyxia neonatorum, or trauma in delivery; in others it commences at the age of 5 or 6 years, and in a third class at the time of the second dentition.

Symptoms.—*Early.*—1. Convulsions frequently usher in the disease, either after a blow on the head or a fall, or in the course of an acute illness, or with whooping-cough.

2. The paralysis is unilateral. The face is paralysed on one side, but the orbicularis palpebrarum usually escapes. Strabismus, often external, is very frequent. The arm suffers more than the leg. As a rule the facial paralysis disappears first, and in most instances completely. The arm remains more completely and permanently affected than the leg.

3. Sensation on the affected side is as a rule unimpaired.

4. Aphasia is commonly seen at the beginning, but is often temporary.

5. The reflexes are generally exaggerated.

6. Unilateral sweating has been seen during an attack.

Late.—1. Rigidity of the limbs sets in at an uncertain period after the attack, and varies in degree. It is sometimes so extreme that it is not possible to obtain any reflex contraction of the muscles. It disappears during sleep and under an anæsthetic, but is increased on any effort being made to overcome it. In rare cases the limbs remain completely paralysed and limp.

2. Athetosis or spurious chorea develops after a time in a proportion of the cases.

3. The mental powers are defective. This is not so in all cases, many of these patients being quite up to the ordinary standard of intelligence.

4. The affected limbs become wasted, blue and cold. They are frequently shorter and more slender than natural, owing to delayed development of the bones.

5. Deformities of a most persistent and intractable nature ensue. The arm is, as stated above, more affected than the leg.

The position assumed by the *arm* is quite typical. In this member flexion predominates. The shoulder is sometimes raised, and sometimes lowered. The upper arm is generally kept parallel with the trunk, or is a little advanced and adducted by the contracted pectoralis major. The forearm is flexed at a right angle, and is generally in apposition with the lower part of the chest or upper part of the abdomen. It is almost invariably pronated, very rarely supinated. This pronation of the forearm is most difficult to diminish. It is the position which in slight cases is the first to become fixed in the forearm, and is the last to yield to treatment. The wrist is also strongly flexed and the hand is adducted. The thumb is adducted and flexed into the palm. The fingers are firmly contracted.

The *leg* is in a condition of extension and the foot assumes a talipedic form, either equinus or equino-varus. In one case of infantile cerebral paralysis which came under my notice, both thighs were somewhat flexed and adducted, both knees were bent at an acute angle, and the feet were in a position of equinus. By suitable tenotomy, fasciotomy, and the use of extension apparatus, the deformity was completely overcome, so that the girl was ultimately able to walk well.

6. *The Mode of Walking.*—The heel is raised and the foot is lifted from the ground with difficulty. The toes scrape along the floor.

Diagnosis.—The following conditions should be carefully eliminated:—

1. Paralysis arising during delivery or obstetrical paralysis. As a rule this is limited to single nerve-trunks, *e.g.* paralysis of the facial nerve due to pressure of the forceps, or injury of the brachial plexus arising in delivery of "arm-posterior presentations."

2. From spastic paralysis the result of primary lateral sclerosis. There is no doubt that cases of spastic paralysis in both legs do occur in which there are no cerebral symptoms present, but examination of these cases shows no lesion in the spinal cord.

3. From certain forms of congenital contracture (p. 511) in which no nerve-lesions are present.

Prognosis.—When deformities have occurred the prognosis, so far as they are concerned, is far from favourable. In some instances the spastic condition improves, but by that time the affected limbs have become stunted and dwarfed, and fixed in various positions. On these grounds parents should be warned that no great improvement is likely to take place if the spastic condition when first seen is at all well marked. If athetosis, mental deficiency, or epilepsy be present, then the outlook is decidedly bad, in so far as the duration of life, usefulness of the patient, and correction of the deformity are concerned.

Treatment.—Every effort must be made, if the case is seen early, to prevent the onset of deformity. For this purpose the limbs should be well rubbed and manipulated, and passive movements of the joints of the affected parts freely carried out in all directions. The patient should also be well drilled, and taught, so far as the mental condition will permit, to use the affected limbs as much as possible. For instance, in hemiplegic contraction of the arm it has been found advantageous to tie up the unaffected arm, and to insist upon the hemiplegic arm being used. In the case of the leg, every encouragement by precept and practice should be given, so that the affected limb may be used in walking; and passive movements of the hip, knee, and ankle carried out, especially abduction of the hip, extension of the knee, and dorsiflexion of the ankle. Much improvement may be expected in slighter cases.

With reference to the use of retention-apparatus, my experience is that directly they are removed the spasm returns.

As to operative measures, I have found it to be absolutely useless to divide the tendons of the rigid muscles in the upper extremity. I have performed section of the biceps, flexor carpi radialis, pronator radii teres, and of all the flexor tendons of the wrist at one sitting without any permanent benefit.

In the lower extremity the results have been less disappointing. In one case the adductors of the thighs, the hamstrings, and the tendo Achillis were divided, with permanent benefit to the patient so far as locomotion was concerned. The point, I take it, is this: Walking is impossible not so much on account of the loss of muscular power, but because of the abnormal position of the parts, the patient being unable to plant the foot on the ground as the heel is so much raised. Similarly, the adductor spasm prevents free movement. If by section of appropriate tendons the malpositions can be rectified, then the locomotion is much improved, and in some instances becomes moderately good, if care be taken to keep the limbs in normal position for several months afterwards.[1]

[1] Cf. Gibney on the "Treatment of Spastic Paralysis," *Amer. Journal of Nervous and Mental Disease*, Aug. 1890.

Spinal Paralysis in Children

Acute Anterior Polio-Myelitis or Infantile Paralysis.—On this subject much has been written in dealing with paralytic club-foot, and it is not necessary here to go freely into detail concerning the causation, onset, and diagnosis of the disease, but rather to deal with some varieties of deformity which have not been treated of in previous chapters. It is sufficient to say that the disease presents three stages: (*a*) an acute stage, characterised by febrile symptoms

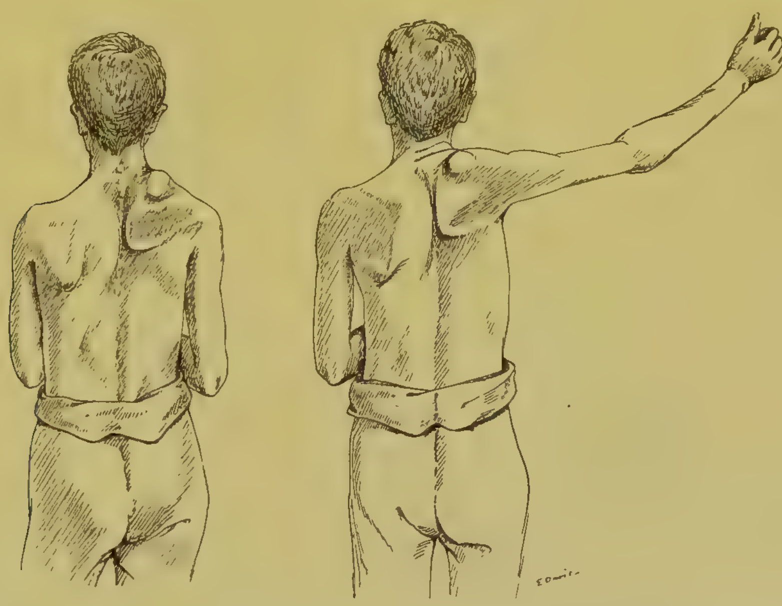

Fig. 296.—Infantile paralysis of the lower part of the trapezius and of the serratus magnus (H. H., aged 11 years).

and the development of paralysis; (*b*) a period of convalescence, which commences when the paralysis is at its height, and from which a partial recovery of the affected limb or limbs dates; (*c*) a period when deformity sets in, which arises from two conditions—paralysis and atrophy of the muscles, and atrophy and shortening of the bones. The nature of the affection is peculiar in that it is very selective in its effect on the muscles. Not only are groups of muscles paralysed, but individual muscles, and even separate fibres, are, as it were, picked out.[1]

[1] Cases of acute anterior polio-myelitis are liable from time to time to distressing attacks of vomiting, independently of any recognisable cause, and lasting two or three days at a time. The son of a medical friend was an instance of this.

As a rule, the muscles of the terminal portion of the extremities are more paralysed than those nearer the trunk, and the legs more than the arms. In the upper extremity the deltoid is often paralysed either alone or with other muscles. But the distribution of the paralysis may be very unequal; thus in a case (Fig. 296) which came to me at the National Orthopædic Hospital, the whole serratus magnus and the lower part of the trapezius below the spine of the scapula and deltoid were paralysed, while the teres major and minor had escaped; the scapula was seen to have undergone considerable displacement. In the leg, the extensors of the toes and the peronei suffer more than the flexors and the adductors of the foot.

The muscles of the face are almost invariably unaffected, while those of the trunk are occasionally involved. Thus lateral curvature sometimes arises from unilateral paralysis of the erector spinæ. When the abdominal muscles are involved, the lordosis is extreme, and the trunk appears to be falling backwards.

The onset of deformity is from four to six months after the appearance of the purely nervous symptoms, but is occasionally more rapid. It is during this interval that every effort should be made, by suitable splints or mechanical apparatus, with attention to posture, to prevent deformity. As to the immediate causation of deformity, it is found in partial paralysis of a limb, due to the more powerful action of unopposed muscles and to the effect of position.

Deformities of the Arms.—It is rare for the whole upper extremity to be paralysed. As stated above, the deltoid is generally affected, and there results, not infrequently, a paralytic subluxation at the shoulder-joint, with loss of roundness there. Such a case I have met, in which it appeared that there were at least $1\frac{1}{2}$ inches between the articular surfaces, and the head of the humerus could be made to assume any of the forms described in traumatic dislocation. Rarely, as in the "forearm type" of Remak, the extensor muscles are paralysed, while the supinator longus escapes. Wrist-drop then results. Occasionally the adductor muscles of the thumb are affected.

Deformities of the Trunk.—These are scoliosis, kyphosis, and lordosis of paralytic origin. As a result of inequality of the lower limbs, the pelvis is frequently tilted, and static scoliosis results.

Deformities of the Lower Extremities.—When the whole limb is affected, it is small, cold, bluish, perfectly limp, and swings like a flail in all directions with the patient's movements (*jambe de polichinelle*—Charcot). The joints are lax, and the segments of the limb may be caused to assume almost any position. There is, however, one important point worthy of notice. In those instances in which at first sight it appears as if all the functions of the part were entirely lost, careful examination of the muscles of the hip shows that the psoas and iliacus have escaped either partially or entirely, and that some flexion is left. It is important to be aware of this, for so long as some power is left in these muscles, the patient can be made to walk by the aid of instruments after deformities lower down in the limb have been rectified.

FIG. 297.—Infantile spinal paralysis of the lower extremities with multiple deformities (after Rédard).

In partial paralysis of the limb the antero-internal muscles of the thigh are the most severely affected, and extension of the leg upon the thigh is lost. With this condition there is frequently considerable abduction of the thighs and lordosis. The knee is flexed more or less, and later on, if the hamstring muscles are not involved, contracture of them takes place with subluxation backwards. If the hamstrings, however, are paralysed, or when the ligaments of the knee give, the latter becomes hyperextended, and one form of genu recurvatum results. In old-standing cases there are outward rotation of the tibia and eversion of the foot.

The deformities of the foot have been fully considered in the chapters on talipes.

Paralytic Subluxations in the Lower Limb.—These occur at the hip, knee, and ankle.

The Hip.—They have been studied by Verneuil, Reclus, and

Karewski.[1] The forms are anterior and posterior dislocation, more usually the latter. Associated with the displacements is paralysis of the gluteal and thigh muscles. The way in which the dislocations come about is as follows:—In the case of the dorsal form, the gluteal and peri-trochanteric muscles being paralysed, the support which they naturally give to the capsular ligament is withdrawn, and further the head of the femur is gradually pushed out of place by the tonic action of the adductors until it rests against the upper and posterior part of the capsule. This gradually yields, and finally the caput femoris lies on the dorsum ilii. In the case of the anterior dislocations, the adductors and the psoas are paralysed, so that the glutei and peri-trochanteric muscles gradually push the head out of place. In dorsal displacements the lower extremity becomes fixed in the position of adduction and inversion, and external rotation and abduction are impossible. In anterior or pubic dislocations the reverse obtains. If the displacement is recent, the head may be replaced, but it is difficult to do so in old-standing cases. But under an anæsthetic replacement is often possible, and the difficulty then arises of keeping the head in its proper position.[2]

FIG. 298.—Infantile paralysis with genu recurvatum, and talipes varus on the left side (Mary D——, aged 16 years).

[1] *Deutsche med. Wochenschr.* No. 6, 1889, and *Annals of Surgery*, vol. x. p. 226. He gives two very interesting cases; one was sub-pubic and the other was on the ramus of the pubes. In the second case, after section of the muscles attached to the trochanter major and incision of the capsule, the head of the femur could be replaced in the acetabulum.

[2] Cf. a case of Bradford and Lovett's, *op. cit.* pp. 552, 553. A figure, No. 565, is given of this case in their work on Orthopedic Surgery.

As stated in writing on congenital displacement of the hip, difficulty may arise in distinguishing it from paralytic displacement, but the differential signs are given on p. 535.

The Knee is subluxated backwards, so that the tibia moves in a plane posterior to that of the femur.

The Ankle.—Various subluxations are seen, viz. forwards with talipes equinus, backwards with calcaneus, inwards and outwards with varus and valgus.

The Treatment of Paralytic Deformities.—In the first place, every effort should be made from the time of onset of the paralysis to retain the limbs in as nearly normal a position as possible, particular attention being given to the fact that the feet do not assume the equinus position. Electrical stimulation of the muscles, friction and massage should be assiduously persevered with. The active treatment of these deformities must be of two kinds, mechanical and operative.

The object of mechanical treatment is twofold:—

"1. To support and protect the paralysed limb in such a way that the muscles shall work to the best advantage, and that the joints are supported and controlled. By doing this the occurrence of contraction-deformities is prevented, and the nutrition of the limb is kept in the best possible condition by enabling the limb to be used in a comparatively normal way.

"2. To overcome by means of suitable apparatus deformities which have already occurred, and to prevent their recurrence" (Bradford and Lovett).

In order to make the mechanical treatment clear, it will be well to arrange the details under the following heads: (*a*) Paralysis below the knee. (*b*) Paralysis below the hip. (*c*) Paralysis involving the pelvis and parts below. In paralytic cases no instrument should be fitted until all distortions have been corrected by tenotomy, and a cork sole is nearly always required on account of the shortening.

(*a*) *Mechanical Treatment in Paralysis below the Knee.*—The most usual forms are talipes equinus and calcaneus. In talipes equinus the lost power of the extensor muscles may be replaced by a toe-uplifting spring, so that in such cases the apparatus which is to be ordered is the following, a walking: apparatus, double (*i.e.* with steel supports on the inner and outer side of the leg), from ground to calf, with toe-uplifting spring and three-quarter "stop" at ankle-joint. But inasmuch as some degree of varus or valgus is frequently present, it will be necessary to add a varus or valgus T-strap, and if much valgus exist, a valgus pad. Rectangular tin-shoes for night-wear should be ordered. In the case of calcaneus, the apparatus extends from the ground to the calf, has a toe-depressing spring, and a small accumulator passing from the garter-piece above to the heel below, so as to prevent the latter coming into contact with the

FIG. 299.—Apparatus for complete paralysis of the lower extremities.

ground too soon. A half "stop" at the ankle-joint is desirable. The tin-shoe should be put on at night, and care must be taken that the sole of the foot is placed in the shoe as flat as possible.

(*b*) *Paralysis below the Hip.*—The instruments just mentioned should be extended to the upper part of the thigh on either side of the limb. They should be fitted with a double knee-cap and ring-catch joint at the knee. The object of the latter is to make the apparatus rigid from the hip to ankle in walking, while in sitting it can be slipped up so as to allow of flexion at the knee.

If there is much tendency to inversion or eversion, it is always better to carry the apparatus up to the pelvis by a continuation of the outside steel support to a pelvic band. A joint is made opposite the hip.

(*c*) *From the Pelvis downward.*—The instrument which is of most service in these cases has the following technical description if applied to both sides: a walking instrument for both legs, double from ground to thigh, single to pelvis, movable joint at hip, double knee-caps, ring-catch joint at knee, with toe-elevating or toe-depressing spring according as equinus or calcaneus is present, and with varus T-strap or valgus T-strap and pad, according as varus or valgus are combined with equinus or calcaneus (Fig. 299). *So long as the ilio-psoas muscle retains part or all of its power, i.e.* so long as some flexion at the hip is present, good results from the use of this instrument may be expected.

To give an example, a case came under my observation of almost total paralysis of both limbs with double talipes equino-varus, contraction at both knees and hips, but with power left in both the psoas muscles. The child could merely go along on its gluteal region and hands, but some power of contraction remained in the ilio-psoas. By suitable tenotomies the limbs were unfolded from below upwards, and were made parallel. The apparatus described under heading (*c*) was applied, and so much power returned to the limb that the child was able to walk, supported by the apparatus but without crutches, for two miles.

In the case of paralytic dislocation at the hip, the head of the femur must be drawn into its proper place by weight-extension in the recumbent position, and the vicious position of the thigh corrected by traction. The improvement so gained can be maintained by the use of a leather splint or poroplastic spica, the child being allowed to go about on crutches. After a time a walking apparatus with a joint at the hip may be ordered.

Operative Treatment.—There are the following:—

Tenotomy and Fasciotomy.

Osteotomy.

Arthrodesis.

With reference to tenotomy, in the case of paralytic affections of the knee and ankle, the manner of section has been fully described in the preceding chapters, and it is not necessary to reiterate it. In the case of the hip, the section may require to be very extensive and deep, even including part of the capsule of the joint. It is always better then to perform open section, as difficulty may arise from hæmorrhage. In some cases it is not possible to reduce all the deformity by operation at one sitting, on account of the great tension on the vessels and nerves. It is better in this case to be content at first with partial reposition, and to apply extension by weights for a time, and then proceed again with the division.

Osteotomy.—When there is extreme flexion at the hip, and the section of the soft tissues must necessarily be very deep and extensive, it is better to perform Gant's operation of sub-trochanteric osteotomy. In some cases of paralytic knock-knee, osteotomy may be required.

Arthrodesis.—This term is defined as an operation designed to fix a joint in a paralytic case. The object of it is ankylosis, either fibrous or osseous. The latter condition is obtained by complete removal of the articular cartilages.

The history of the operation is recent. It was first performed by Albert of Vienna, on 20th July 1878, although his claim to priority is disputed by von Lesser. Subsequently Winiwarter, Ried, Ewinger, Reyhier, Wolff, Kirmisson, Rochard, and Robert Jones have done the operation. At the International Medical Congress at Berlin in 1880 the subject was discussed by Petersen, Lesser, and Bessel-Hagen, who proposed various methods.

Arthrodesis is performed either on the ankle or knee-joint, generally the former.

Indications for Arthrodesis.—1. When the paralytic condition is very severe.

2. In poor patients who are unable to provide themselves with apparatus.

3. When the wearing of an apparatus is badly tolerated and causes pressure sores.

4. It should never be done in spastic cases; nor in paralytic cases after acute febrile disorders, as paralysis, secondary to zymotic diseases, shows a strong tendency to recovery.

5. When two joints in a limb are hopelessly flail-like, it is advisable to fix one or both of them.

Method.—At the ankle. Considerable difference of opinion exists as to the most convenient incision, whether it should be anterior, posterior, internal, or external. But the consensus is in favour of the external incision as for excision of the ankle. Against the anterior incision there are urged: the section of the artery, deprivation of a foot of a part of its scanty supply of blood, and the difficulty of getting the tendons to unite satisfactorily. The joint should be freely opened, and all the articular cartilage removed with a curette or sharp Volkmann's spoon, if osseous ankylosis be desired. It is not necessary to carefully dissect away the synovial membrane, since in those cases in which it has been left its presence has not interfered with the formation of bone, but no loose pieces

FIG. 300.

FIG. 301.

FIG. 302.

Three views of a flail-like ankle-joint, due to infantile paralysis and suitable for arthrodesis.

of cartilage are to be left in the wound, and none attached to the bone-surfaces.

The bones are fixed together by Albert and Zinsmeister with catgut or kangaroo tendon; by Petersen with nickel needles; by Karewski with ivory pegs. Albert and Zinsmeister have left plugs of iodoform gauze between the bone-surfaces, so as to excite suppuration. But Mr. Howard Marsh has shown that suppuration is not always followed by bony ankylosis. It is better, if no plugs are to be left in, to arrest all hæmorrhage, and close the wound at once.

In the case of the knee, the technique does not differ from that of an ordinary arthrectomy, care being taken, however, that all the cartilage is excised.

As to results. In one of Albert's cases ankylosis followed after a few months. In Winiwarter's, Wolff's, Lesser's, and Rydygier's the success has been complete. Robert Jones has reported [1] fifteen cases in which he has ankylosed the knee or ankle. Considerable improvement in the use of the limb was noted in nearly all the cases.

Various deformities are met with as the result of other spinal lesions; thus there are cases of bilateral paralysis in which the legs are in a spastic condition, and unaccompanied by any cerebral symptoms or affections of the upper extremities. These seem to be analogous to the cases of primary spastic paraplegia met with in adults. In both instances section of the tendines Achillis enables the heels to be brought to the ground and the patient to walk with much more security than previously, and the same remark applies to pseudo-hypertrophic paralysis before the complete paralytic stage has set in. I had the privilege of assisting Mr. Adams at an operation on a man, aged 24, the subject of pseudo-hypertrophic paralysis, and the patient's powers of locomotion were much improved. Other spinal diseases such as cervical pachymeningitis, syphilitic myelitis, amyotrophic lateral sclerosis, Friedreich's disease, syringomyelia are associated with deformities which cannot unfortunately be remedied by orthopædic surgery.

[1] *Prov. Med. Journ.* Dec. 1894.

BIBLIOGRAPHY OF ARTHRODESIS

ALBERT—*Lehrbuch der Chir.* Bd. ii. s. 254.
Beitrage z. Operat. Chir. 1888, Bd. ii. p. 88.
Wiener med. Press, 1882, No. 23, p. 725.
Centralblatt f. Chir. 1881, No. 48, p. 766.
"Falle von Kunstlich. Ankylosis bild. An paral. Gliedmassen," *Wien. med. Press*, 1882, No. 23.

BRAATZ—Internal. Congress, 1890.

COCHON—"Contrib. à l'étude d'arthrodèse," *Thèse*, Lille, 1892.

COTTERELL—*Lancet*, 13th May 1893, "On Arthrodesis," etc.

DARAIGNEZ—"Contrib. à l'étude d'arthrodèse," *Thèse*, Bordeaux, 1891.

DEFONTAINE—*Bull. de la Soc. de Chir.* 29 Mai 1889, p. 453, et *Gaz. des hôpitaux*, 1891, No. 23.

DESCHAMPS—"Arthrodèse pour pied bot paral." *Bull. Soc. Chir.* 29 Mai 1889, et *Gaz. des hôp.* 1889, No. 93.

DOLLINGER—"Arthrodesis bei der Kinderlähmung," *Centralblatt f. Chir.* 1891, No. 36.

EULENBURG—"Paral. spin. subaiguë avec relachm. paral. de l'artic. de l'épaule. Arthrodèse," *Berlin. klin. Woch.* January 1890, No. 3.

EURINGER—"Ein Beitrag z. Arth. paral. Gelenk. v. Muskel," *Med. Woch.* 1889, No. 6.

GIORDANO—"Contrib. alla cura Artodesi," *Arch. di Ortop.* 1890, p. 22.

HEUSSNER—*Archiv f. klin. Chir.* t. xxxi. 1885, p. 66.

HOFFA—*Munch. med. Woch.* February 1889.

HOLTMEIER—"Ueber Arthrodesis," *Inaug. Dissert.* Greifswald, 1888.

JALAGUIER—*De l'Arthrotomie*, Paris, 1886.

JONES (ROBERT)—"15 Cases of Arthrodesis," *Prov. Med. Journ.* December 1894.

KAREWSKI—*Soc. med. de Berlin*, 1889, 20th November. "Ueber Operativ. an paral. Gelenk." *Deutsche med. Woch.* 1890, Nos. 4 and 5; Congress internal. Berlin, Section der Chir. Orthop. 1891.

KIRMISSON—"Leçons Cliniques sur les malad. de l'appareil locomoteur, 1889," *Bull. Méd.* 1891, p. 601.

LAMPUGNANI—*Centralbl. f. Chir.* 1886.

LESSER—*Ibid.* 1879, No. 31, and 1886, No. 46.

LORENZ—*Allgem. med. Zeitg.* 1887, Nos. 12, 13, and 14.

MOTTA—"Due casi di Artrodesi," *Acad. di med. di Torin*, 24th April 1891. *Riforma med.* 1st May 1891.

NATRAISSON—*Th. Doctor. de Paris*, 1892.

NICOLADONI—*Archiv f. klin. Chir.* t. xxvi. p. 488.

PETERSEN—*Ibid.* t. xxxvii. p. 235; Internal. Congress in Berlin, 1890.

Phocas—*Cong. de Chir. de Paris,* 1892.
Piechaud—*Ibid.*
Poncet—*Deuxieme Congres français de Chir.* Paris, 1886, p. 669.
Rammallay—"De l'Arthrodèse," *Thèse de Lyon,* 1891, No. 591.
Rénault—*Thèse de Paris,* 1892-93, No. 395.
Reyher—*Centralbl. f. Chir.* 1888, No. 14.
Ried—*Deutsche Zeitschr. f. Chir.* 1885, 1886.
Rochard—"L'Arthrodèse," *Rev. d'orthop.* 1890, ii.
Roersch—*Rev. de Chir.* 1892, No. 6.
Rydygier—*Centralbl. f. Chir.* 1886.
Schreiber—"Contratt. paral. etc., Artrodesi del ginocchio e dell' anca," *Archir d'ortop.* 1889, p. 34.
Schussler—"Für Beh. der paral. Schlottengelenk der Schulter," *Beitr. klin. Woch.* 1887, p. 612. "Für Arthrodesis des Schultergelenks," *Ibid.* 5th May 1890, No. 18.
Schwartz et Riffel—*Rev. d'orthop.* March 1893.
Schwartz—*Th. Aggregat.* 1893.
Winiwarter—*XIV. Cong. der Deutsche Chir.* 1885, Erste Theil, p. 141. "Arthrodèse du membre inf. dans un cas de paral. infant," *Ann. de soc. méd. chir. de Liege,* No. 11, 1889.
Wolff (J.)—*Deutsche med. Woch.* 1886, Nos. 13 and 29; Cong. Internal. Berlin, 1890. *Centralbl. f. Chir.* 1887.
Zinsmeister—"Ueber de Oper. Behand paral. Gelenk." *Deut. Zeit. f. Chir.* Bd. xxvi. p. 498, 1887; *Deutsche med. Woch.* p. 498, 1888.

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ABBREVIATIONS :—Cong. = congenital ; displ. = displacement ; tal. = talipes ; anat. = anatomy.

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ABBREVIATIONS :—Anat. = anatomy ; tal. = talipes ; cong. = congenital ; int. = internal ; ext. = external ; displ. = displacement ; fds. = forwards ; bwds. = backwards.

THE END

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