A TREATISE

ON

ORAL DEFORMITIES

AS

A BRANCH OF MECHANICAL SURGERY.

BY

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PREFACE.

THIS work was begun ten years since, and in its substantial features was ready for the press some time ago; publication was deferred in order to make the whole more scientifically complete, but I realize that it is useless to wait until a reversal of opinion on some topics is rendered impossible. In the mean time, I have revised and rewritten the whole, and have endeavored to make it the embodiment of the latest knowledge upon the different subjects treated.

Since the act was passed by the New York Legislature in 1868 creating a Board of Censors, I have been the member of that Board upon whom devolved the duty of examining dentists upon these branches.

It has been exceptional that I found any one possessing more than the most elementary knowledge, and the examinations were necessarily wanting in desirable thoroughness because there existed no source from which they could readily obtain the required knowledge; the meager and inadequate instruction of the text-books could only be augmented by a tedious search through journals and voluminous society transactions for scattered contributions to such literature.

Only upon the subject of Maxillary Fractures has there been heretofore any approximation to completeness; even the works of Hamilton and Heath, while containing all that the general surgeon requires, are not of equal value to the special surgeon or dentist.

In the department of Irregularities, a number of illustrations have been introduced which the superficial reader may regard as excessive or confusing, but each was found to possess some valuable principle, or was introduced to contrast its complexity with simpler methods, and prevent "a wasteful expenditure of time in the contrivance of useless apparatus."

A critical reader may detect here and there repetitions, but I regarded the knowledge of so much importance in another connection as to justify an occasional reiteration.

When I began practice in certain specialties herein treated, there was almost no literature upon the subject, and I was obliged to invent nearly every process which I used. The appliances and the methods of treatment are therefore to a large extent original with me; nevertheless, I have not hesitated to adopt, from any source at my command, any and all different methods which had anything in them to commend them. Hamilton very truly says, "It is not in the discovery and multiplication of mechanical expedients that the surgeon of this day declares his superiority, so much as in the skillful and judicious employment of those which are already invented."

I have endeavored to treat these topics with such comprehensiveness that it will not be necessary for any one else to go over the same ground until the progress of science shall make these teachings obsolete.

It has been my desire to present this information in such form that it shall interest and profit, not only the student but the practitioner of dentistry and general surgery.

I doubt if any of my readers will ever be more profoundly conscious of my shortcomings than myself.

To Dr. St. George Elliott, of 39 Upper Brook Street, London, I am much indebted for valuable assistance in the preparation of the chapters on Fractures. His large experience as an army surgeon and his subsequent dental practice in North America, South America, and Japan, rendered him eminently qualified for such a work.

The chapter on Anatomy and Physiology of Expression is, to a considerable extent, an epitome of Sir Charles Bell's work on that subject. I prepared such an article for publication a few years since, not knowing at the time that the late Professor McQuillen had published a similar paper. Upon a conference with him, and by his consent before his death, I have adopted much of his language in my chapter under that title.

If the knowledge herein contained and the plans proposed for treatment shall prove beneficial to needy humanity, and save the practitioner the intensity of thought which they have cost the author, I shall be more than satisfied.

NORMAN W. KINGSLEY.

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PART I.

IRREGULARITIES OF THE TEETH.

CHAPTER I.

ETIOLOGY.

IRREGULARITIES, either in the form of the arch or the position of the teeth, are very uncommon in the deciduous set. We have seldom seen an irregular arch in a child prior to the eruption of the permanent teeth, unless associated with and correlated to some other deformity. In a few instances there has been observed a slight malposition of one or more of the incisors, sometimes of congenital origin, and sometimes the result of mischievous habits; as, for example, the two centrals may be pulled forward by the prolonged use of an artificial nipple, sucking the thumb, or other similar habit.

Congenital deformities rarely amount to more than a trifling displacement of one or two of the incisors; but, considering the temporary character of the deciduous teeth, and more especially the incisors, no irregularity in their position that we have ever seen can be regarded as of special importance, or as justifying any interference for its correction. They are to be classed as mere freaks of nature, not associated with nor indicating any other peculiarity in the child. Nor do they prognosticate an irregularity in the development of the second set. This important fact can not be too prominently borne in mind. The deciduous dental arch is always well formed, and the positions of the teeth are regular (mere freaks of nature excepted). But from this perfectly symmetrical dental arch there develop with the growth of the permanent set some of the most astounding abnormalities.

These peculiarities of the permanent teeth it is unnecessary to describe in detail. In the departure from symmetry they assume almost every variety of position, so that it would be almost impossible for the human mind to conceive of an irregular arrangement which would not find its counterpart in nature. These variations are recognizable by every one of extended observation, and are *deformities*, because they are a greater or less departure from a normal standard. Such a standard can not, in the nature of things, be one shape to which all must conform or be classed as deformed.

Symmetry and harmony do not imply uniformity; and the dental arch may be developed up to the highest type of perfection, and yet there exist as great a variety of form as there would be in the faces of the aggregated beauties of the world. Races, nations, and families are thus represented without deformity.

The normal type of the dental arch I conceive to be a regular line; the arch may be wider or narrower, varying somewhat in individuals or races, but the line will be an easy, graceful curve, without break or tendency to form an angle. Within certain limits a narrow dental arch, as associated with certain features, may become the very perfection of beauty, while with another form of head and face the widest development may be equally pleasing. That which is recognized now as the standard or full measure of beauty, as well as of utility, is not unlike that which existed in the remotest historic ages, nor different from that which is now exhibited among all communities not degenerated by luxury or vice.

In 1864 Messrs. Cartwright and Coleman, of London, made an examination of some two hundred ancient skulls in the crypt of Hythe Church, Kent. Those skulls, of which there is no authentic history, further than that they had been there for centuries, were apparently of both sexes and all ages. The maxillæ presented in all instances unusually well-developed alveolar arches. The teeth were remarkable for regularity of position, only two deviations being noticed: one upper canine shut within the lower jaw on occlusion, and one bicuspid was turned upon its axis, and there might have been other slight irregularities which were unnoticed; but in no single instance was there anything seen approaching to that which, under the term "contracted arch," so commonly exists in the present day. The average width of the dental arch in those skulls, from the outside of the first molar to the corresponding point, was two and a half inches.

In 1869 Mr. John R. Mummery, of London, contributed to the Odontological Society of Great Britain the most valuable paper on this subject which I have ever read. I accord more importance to his personal examinations than I do to the observations of any man not a practical dentist. The statements of all others, even those of ethnologists, being less precise and more general in their character, must be accepted with some allowance. He examined all the available skulls of ancient races, and of modern uncivilized races, to the number of about three thousand, and tabulated more than one half of them, which were classified as follows: Ancient British, 203; Roman British, 143; Anglo-Saxon, 76; and ancient Egyptian, 36. Of modern uncivilized races: North American, 145; Polynesian, 204; East Indian, 223; African, 438; and Australian, 165.

From a careful analysis of the measurements given in his tables, I find that the average width of the dental arch, from first molar across to first molar, in the skulls of ancient races, was a trifle less than two and three eighths inches; the same measurement of the uncivilized moderns showed an average width of a trifle above two and a half inches. The narrowest measurement given by him of any skull of any race is two and one eighth inches. The highest average of any race is nearly two and three fourths inches, and these belong to the New-Zealander, the Feejee-Islander, and the Ashantees. The narrowest average was found among the Hottentots and Bushmen of South Africa.

In these tables there is abundant evidence that the full measure and type of both dental and maxillary arches has been sustained among all races of simple habits in all ages. Dr. Nichols, a dentist, who spent twelve years in the Rocky Mountains and on the Pacific coast, during which period he examined the mouths of thousands of Indians and Chinese, informed me that he never saw an instance of irregularity of the teeth in either of those races, with but one exception, and that a displaced canine in the mouth of a Chinese woman. The jaws of both races are universally well formed and amply developed. And this is also true of all semi-barbarous and savage races of good physical organization.

The standard of normality of the dental arch is a curved line expanding as it approaches the ends, and the teeth all standing on that line.

Abnormality will include such a shape of the arch as is not in harmony with the surrounding features, all crowding and twisting, and all departures from a regular line in the positions of the teeth.

In classifying the causes of irregularities, they will be placed under one of two heads—developmental or accidental; the developmental operating prior to the eruption of the crowns, and the accidental at the time of eruption or subsequently.

Almost the only answer received by the dental student as to the cause of these irregularities has been "premature extraction of the deciduous teeth," and consequent contraction of the jaw; and this answer has been almost universally accepted without a question as to its philosophy. A few facts have been correlated, and a conclusion arrived at as unscientific as it is erroneous.

The premature extraction theory rests upon the supposition that the jawbone contracts upon the removal of the deciduous teeth. The fact seems to have been entirely ignored that the teeth and alveolar processes are a superstructure of the jawbone, growing up on it, fulfilling their destiny, and passing away, without disturbing the foundation much more than an oak disturbs the planet upon which it has been sustained. There is a period in the history of the maxilla when it is itself an entity, and prior to hardly a trace of the subsequent superincumbent structures; and in the ordinary course of nature there comes a period at the other end of life when equally all trace of dentition is gone, and the maxillæ remain undestroyed entities.

While the proofs are conclusive that the jaws are developed independently of the teeth and alveolar processes, and that no ordinary surgical interference with the teeth or processes impedes or impairs that development, and while also it may be true that all the primary teeth may be removed long anterior to the period of eruption of the permanent ones without retarding their development or impairing their regularity, the doctrine may still be correct that the too early extraction of some of the temporary teeth in connection with a tardy development of the maxillæ will be likely to result in a crowded and abnormal condition of their successors. This result is not as likely to show itself with any other teeth as with the canines.

In observing the order of eruption of the permanent set in the regular economy of nature, it will be seen that for every tooth of the deciduous set there is a permanent one lying underneath it in process of formation, and that in due time a deciduous tooth will loosen and fall out, and a permanent one will take its place.

With a normal growth of the maxillæ there will occur no interference and no irregularity. The central incisors will first appear; then the laterals; after that the bicuspids; and lastly the canines. Each predecessor of a permanent tooth will maintain its position until about the period of the emergence of its successor. There will be no contraction of the alveoli, because there will be no opportunity for it.

But take now a disturbed or tardy development of the maxillæ instead of a normal condition, and observe the result. Remove for any cause one after another of the temporary set, or all at once, and the period of eruption will not be interfered with, but the arrangement in the arch may be impaired. The centrals will find a place without difficulty—so will the laterals; the bicuspids will be pretty certain to have sufficient room, as their diameters are generally less than their predecessors; but when these teeth are all fully erupted, it will be found in a majority of cases at the present day that the first bicuspid and the lateral are nearly or quite in contact, filling the space destined for the permanent canine, which must now emerge either anteriorly or posteriorly to its true position, showing conclusively that, if the alveolar arch had not contracted, the contiguous teeth had encroached upon the space destined for the canine and forced it out of position. In either case it is the unquestioned result of the too early removal of the deciduous canines; for no one will doubt that, had the temporary canines been allowed to remain, they would have prevented contraction of the alveoli or an encroachment on their domain. It may be argued that if the original direction of the canine was correct, it would force itself between the lateral and bicuspid, thus making way for itself; but this is against the experience of nearly all observers, and very naturally so.

Admit the fact that from some cause or other the bicuspid and lateral come into contiguity, and from the tardiness of the erupting canine it will find solid and unyielding roots to contend with, which will necessarily force it out of the dental arch.

Mr. Tomes relates a case in which he removed for cause from a child all of the deciduous teeth prior to the eruption of any of their successors, so that for a time the gums were edentulous; nevertheless, in due time the permanent teeth developed in perfect regularity of sequence and of symmetry. While Mr. Tomes's report shows that no abnormality followed the removal of all the teeth at once, such a result is to be feared from such a practice, and most certainly will ensue if there be not *a coincident, independent, and ample development of the maxillæ.* Cases are coming constantly under our observation where from some cause the temporary canines have been sacrificed, the space closed up, and the permanent teeth malposed, with little hope of their ever assuming unaided their rightful positions.

From this there can be but one deduction, which is that *whatever may be the inducement to remove any or all of the deciduous teeth prior to their period of shedding, the canines should be retained until there is ample evidence of the early emergence of their permanent successors, unless the health or comfort of the child would be sacrificed in so doing.* But it would be far better to remove one or all of the deciduous teeth and take the risks of an irregularity in the permanent ones, than submit the child to constant suffering and consequent injury to its health by their retention.

How much of the malposition of the permanent teeth is due to the prolonged presence of the temporaries is still an unsettled point. Although absorption may be proved to be an independent process, and in no wise connected always with the progress of an erupting tooth, nevertheless the cases are so common in which the absorbed portion of the deciduous tooth corresponds accurately with the new crown as to force upon us the conviction that it is influenced by it, and therefore that if the permanent tooth had persisted in the right direction, the deciduous tooth would have become displaced.

The question naturally arises, Is the presence of the deciduous teeth the *cause* or the *effect* of the irregularity? If their presence be the cause of irregularities, then it is manifest that in this generation of malposed teeth it is our duty to anticipate the trouble, and at an early day remove them before even it is possible for them to give a wrong direction to their successors.

With the present knowledge upon the subject, there is no more evidence that the presence of the temporary tooth caused the irregularity than that the position and tendency of the permanent tooth was originally wrong. It is quite as reasonable to adopt the latter view as to suppose that the function of absorption was arrested and by that the tooth was turned aside. Whether their presence be the cause or the result of the malposition, this we know, that when a permanent tooth has erupted and its deciduous predecessor has not been removed, the immediate extraction of such tooth will go very far toward the complete correction of the deformity, thus showing that the *apparent* cause of the malposition of a single tooth is often the presence of a temporary crown.

Even an unabsorbed spicula of a deciduous root will appear to cause a slight deviation in the inclination of a growing tooth, which, on coming in contact with its opponent of the other jaw at an unnatural angle, will be sufficient to cause the mal-occlusion of the entire dental economy.

A very trifling accident occurring at the period of erupting teeth will sometimes cause most serious results. The fall of a child has produced a slight inversion of an erupting central incisor, which, when further elongated, met the cutting edge of the lower centrals. It was easier and more natural for the child to throw the lower jaw forward and catch outside the upper tooth than otherwise. Thus began a habit which did not end until all the upper incisors were in like manner caught and inverted, and finally the whole dental articulation disorganized.

It would be impossible to describe and give the exact operating cause of all irregularities which could be traced to an accidental source; they could not be ascertained short of a special anatomical examination of each individual case, which is generally out of the question.

Many of the forms of irregularity are directly traceable to inheritance, and are transmitted peculiarities. Probably in a large proportion of cases where the irregularity in a dental arch is confined to one or two teeth, the primary cause, so far as that individual is concerned, is an hereditary family peculiarity. The teeth of every person possess more or less individuality, and most of those peculiarities which stamp their individuality are inherited. The form and color of teeth, when not disturbed by abnormal influences, are derived from the same source. Whenever we find any departure from what we are apt to regard as the typal form of each tooth, or any disproportion of size in their relations to each other, we shall be likely to find them peculiarities of descent. The number of such cases which come under the observation of the dentist shows the universality of the law, that departures from a normal type are liable to be transmitted to succeeding generations, and eventually the peculiarity becomes the fixed type of the family or race.

For example, we have seen two small teeth develop between the central incisor and the canine, neither of which could be called a symmetrically formed lateral incisor, while upon the other side of the median line a single lateral incisor was well developed. This abnormality in a boy a dozen years of age was inherited from the father, in whom exactly the same kind of a deformity existed.

The transmission by inheritance of a predisposition to a defect or a deformity, is the result of the same general law of nature which gives the form and features of progenitors to their offspring. How far back in one's ancestry such peculiarities could be traced before arriving at the initial must be a matter of conjecture. The observations and the data are too limited to form an opinion.

It is a wonderful subject for contemplation that, at some remote period in the history of our progenitors, Nature departed from her normal type, and a dwarfed lateral incisor, a twisted canine, or an undeveloped bicuspid was the result; and, following down the line of descent, we find precisely the same peculiarity appearing and reappearing—not always confined to the direct line, but continuing in the same family, by passing to the children of the brother or sister, and always presenting characteristics identical with the antecedent type. "There is an ingrafted tendency in all living organized matter to reproduce itself."

It is yet to be determined whether the correction of the irregularities of the dental organs exercises any influence upon the offspring. I am of the opinion that such deformities, even where transmitted for generations, may have the tendency stamped out by being corrected immediately on their development—that is, before the deformity has made its fixed impression upon the individual. This we might reasonably expect, because it would be assisting nature to return to its normal type.

There is one form of irregularity which is sometimes due to hereditary predisposition and sometimes to causes acting after eruption. An undue prominence of the upper incisors may be either congenital or acquired. The acquired origin is almost always a habit of thumb-sucking or its equivalent. It is not difficult, as a general thing, to make the distinction even without questioning the patient. In a protrusion of congenital origin the jaw is generally pinched in the bicuspid region, and the protrusion culminates in a pointed or V-shaped position of the central incisors. When such prominence has a mechanical or accidental origin, the whole front of the arch will be found rounded out, and the teeth pulled forward; and there will be likely to be more or less space between each of the teeth anterior to the bicuspids.

A marked case of the latter class came into my hands for treatment. It was an only child, a girl about thirteen years old, brought by her mother. The protrusion of the incisors was considerable, and the effect upon the upper lip most marked, destroying the symmetry of the features. On remarking half inquiringly, "I wonder what could have caused that?" the mother replied with a somewhat shamed face, "I suppose it was my allowing her to nurse until she was nearly nine years old. I did not know it would hurt her teeth."

An undue prominence of the superior incisors is said to be not uncommon among idiots. And to such an extent had it been observed among that class in connection with the habit of thumb-sucking that Dr. Ballard, of London, adopted the theory that the thumb-sucking preceded, and was the *cause of idiocy*. A little further inquiry into the ancestry of the patient, and a better knowledge of the development of the dental organs, would have probably shown the fallacy of this theory. Subsequently Mr. Charles Tomes presented his hypothesis, attributing the deformity to a peculiarity in the development of the maxillæ at a very early period of life, and to mechanical causes operating upon the permanent teeth at the time of their eruption.

The causes operating upon the development of the maxillæ Mr. Tomes does not seem to regard in the light of a transmitted tendency, but rather to forces having their origin in the individual. The mechanical causes at work on the crowns of the teeth at the period of their eruption, forcing them inward, he believes to be the pressure of the cheek; for he says: "It will generally be found that this malformation is associated with greatly enlarged tonsils which necessitate breathing being carried on with the mouth open. Now, as every one can easily verify upon himself, the effect of the mouth being held open is to increase the tension of the soft parts about its angles, and the result of the increased pressure is to bring about a bending inward at the corresponding point, i. e., the bicuspid region; at the same time the median portion of the arch escapes the controlling pressure which would have been exercised by closed lips, and the effect of this is traceable in the excessive prominence of the median pair of incisors, and also in their oblique position, which makes them correspond with the form assumed by the inner surface of the lips when the mouth is open."

My own observation has not shown this association of enlarged tonsils with this kind of deformity so generally as to enable me to accept Mr. Tomes's theory, even if I could believe that the muscular contraction of the cheeks could produce such results under such circumstances. Neither is it quite conceivable that the pressure of the *orbicularis oris* at the center, with the mouth open, would not exert a counteracting influence upon the incisors, and thus restore the equilibrium.

The pinched or V-shaped dental arch I believe to be nearly always of congenital origin—that is, an inherited tendency, favored in all probability by like circumstances with those which initiated it in the ancestry; while the broad or rounded form is often, if not always, due to mechanical causes.

In referring to the same class of cases, Mr. John Tomes says: "The deformity may result from excessive development of the alveolar processes of the anterior part of the upper jaw, but more commonly we shall find that the molar teeth are unusually short, thereby allowing the incisor teeth of the lower to press unduly upon the inclined lingual surfaces of the teeth of the upper jaw. The upper teeth, yielding to the pressure, are forced outward, and are retained in the malposition by the teeth which have led to the displacement. If, in cases resulting from the latter cause, the inquiry be extended to the condition of the lower jaw, it will be found that with the short molar teeth we have a short alveolar range and short rectangular ramus. This conformation is probably the primary cause of the mischief."

Again he says: "The condition under consideration may also arise from the tardy eruption of the molar teeth, leaving the incisors to act for a time upon each other, as they do when from any cause the back teeth are lost. Then, again, the incisors of the lower jaw may attain an unusual height, or they may project in an unusual degree, and produce the mischief. Or the result may be consequent upon a regular linear arrangement of large teeth in a jaw having a small alveolar base, in which case the teeth prior to their eruption will assume an unusual anterior obliquity."

But we naturally ask, What was the cause of the "excessive development," "the short molar teeth," "the short alveolar range," or "the short rectangular ramus"? The explanation must be regarded as a description of antecedent phenomena, rather than as a statement of the origin of the deformity.

In a paper read before the Odontological Society in London in 1864, Mr. Cartwright says: "Want of space in the bones of the jaws may be defined as the true cause of irregularity in the position of the teeth in the majority of instances"; and follows this statement immediately with an inquiry as "to a satisfactory explanation of this want of capacity in the jaws of people of certain communities." He further says: "Irregularity is uncommon among many, if not most, aboriginal peoples and tribes, and also the inhabitants of particular districts and locations. Irregularity is common in most highly civilized communities, and especially so among the upper and middle classes, and it is more constant among the inhabitants of towns than it is among the inhabitants of agricultural districts."

Mr. Cartwright then offers the hypothesis that this abnormality is due to a process of breeding, and brings forward Mr. Darwin's statements that the bones and plumage of birds become altered by such a process. He further supports his position by the results of high breeding among animals, which is maintained by constant and careful selection of such as possess particular points and characteristics. For instance, he says: "Take the horse and the ox, and consider the points which make up a thoroughbred animal, the small head and ears, the thin legs, small fetlocks and feet, the necks and bodies finely and symmetrically proportioned, and then the narrowness and comparative smallness of the maxillæ. From the results obtained by high breeding in animals, they might reasonably argue that small jaws might be a characteristic of breed in certain conditions of life. If they compared two types of human beings, represented by the upper class in one case, and in the other case by a large class of which the prize-fighter furnished an apt example, they would find as a rule in the first: well-shaped lips, a small oral orifice, high and capacious forehead, well-pronounced chin, ears small, and neck long; the ankles, wrists, feet, and hands small; with an expression in which the intellectual predominated over the animal"; while the other class, represented by the prize-fighter, presented exactly the opposite characteristics.

The hypothesis of Mr. Cartwright is not without reason; and yet it is not altogether an explanation of the present phenomena, for the laws which govern selective breeding in animals do not apply to man in any condition in which he is now found. These principles would, without doubt, produce precisely similar results if applied under similar conditions.

Regard man as an animal only; dismiss all cognizance of his intellect and his affections; mate him to the woman with sole reference to the physical development of the race; and it would take but a few generations to see disease and deformity swept from the face of the earth. But to call the intermarriage of families, whose brains have been stimulated to their highest capacity, and whose physical and nervous systems have been deranged by the habits of modern civilization—to call such a mixture high or "selective breeding," is a perversion of the term. If the application of these principles produces a delicacy of form in the whole physique, we should reasonably expect to find a corresponding delicacy and refinement in the condition of the dental organs. That the process of selective breeding should tend to or end in deformity, is manifestly inconsistent with its prime object, which is the elimination of everything which tends to degeneracy or deformity.

The characteristics pointed out by Mr. Cartwright in his illustrations from animals are conspicuously æsthetic. We can conceive of no such force acting uniformly upon the whole physique, and producing such æsthetic results, without its influencing equally the dental organs; and thus there would be not only no irregularity or abnormality, but enhanced beauty—more symmetrically formed, more symmetrically arranged, and more symmetrically related dental organs.

We are therefore irresistibly led to the rejection of the theory of "high or selective breeding," * in its true signification, as exerting any direct influence upon the malposition of the permanent teeth; and while the facts noticed by Mr. Cartwright are in consonance with other observers, we are forced to the conclusion that such abnormalities are not a necessary result of a higher civilization and refinement, and that they are only coincident and correlated thereto.

There is a kind of breeding which does undoubtedly produce abnormalities of the kind under consideration. It is a manifestation not uncommon in this country of mixed nationalities, but it can hardly be called *high* or *selective breeding*. The laws of inheritance, confirmed by common observation, show how constant is the mingling in the offspring of the traits of character and the peculiar features of two diverse races brought together in marriage. This mixing, without blending or harmonizing, is productive of deformity in character and deformity in physique. Thus, so far as the jaws and teeth are concerned, they may exist in

* It is more than probable that Mr. Cartwright uses the term "selective" here in its broadest signification; meaning the mixing of peculiarities or types which have a tendency to depart from normality, and not in its more restricted and limited sense of combining only excellences, as the term when applied to breeding is commonly understood.

each parent in perfect symmetry: in one parent the jaws and teeth are large, in the other parent both jaws and teeth are small; but each in its way is a normal development. If now (and for this we can give no reason) the small jaw of one parent and the large teeth of the other appear in the offspring, deformity is sure to follow; and in any efforts made thereafter toward correction these facts must be taken into consideration.

In examining the maxillæ of a child between the ages of four and seven years, with the external walls removed, so as to expose the developing permanent teeth, we shall be struck with the advanced stage of growth which the crowns have attained, and with the crowded and jumbled condition in which they are placed. Of such an exhibition the late Professor McQuillen made the following remark: "When examining a series of jaws of different ages, arranged so as to show deciduous and permanent teeth, it is not a matter of surprise that there should be irregularity in the permanent set; but, when observing their crowded and irregular arrangement in the jaw prior to eruption, it is rather a matter of astonishment that they should ever assume a regular and symmetrical appearance." In such specimens we see that while there is no transposition of these crowns—each one maintaining its individual locality—they nevertheless stand in almost every variety of position. They will be seen deflected within or without the line, twisted, lapping, and sometimes completely overlapping one another.

In Fig. 1 the lower permanent central incisors have recently erupted, showing the age to be about seven years. Their predecessors are the only ones of the deciduous set which have been removed. The general contiguity of the temporary teeth shows that but little enlargement of the dental arch had taken place, while the presence of the crowns of all the permanent teeth (the third molars excepted) is an ample illustration of the crowded confusion and disorder which has been described. In the upper jaw the left central incisor is partially twisted; both of the lateral incisors are within the arch, and, if continued on the same line, would shut within the lower jaw. The crowns of the canines over-ride and are in front of the laterals and in contact with the central incisors save by a thin partition of process. The first bicuspids on each side are in close contiguity with the lat-

FIG. 1.

erals. The crowns of all the bicuspids are either twisted or tipped in such a way as to show that some new direction must be given to nearly every tooth, or irregularity of the most pronounced character must ensue. The general condition of the lower teeth is not dissimilar to that of the upper ones, and this example is not an exceptional case. These crowns, we also observe, are of their full diameter, and are placed upon a maxilla which at this age has not developed sufficiently to allow them to range side by side upon a true dental line; hence, they must remain in this crowded and irregular condition until the maxilla itself has grown large enough to allow the change.

It is now an established fact that the development of the teeth and alveolar processes and the development of the jaws are two distinct and independent operations. Maxillæ will go on in their growth until they have reached the measure prescribed by the Creator, whether a tooth develops or not; and likewise the teeth will grow into undiminished crowns and erupt either in order or disorder, whether the maxillæ increase or remain stunted.

I examined a few years since the mouth of the celebrated dwarf "Tom Thumb." I found the teeth of a man in individual size; but the maxillæ, in harmony with the rest of his osseous system, was dwarfed. The result was what we should naturally expect—a most marked malposition of the teeth; so much so that he said he "had a double row of teeth all around." And this is uniformly the case with dwarfs where the whole physique is symmetrically dwarfed. The converse is also true of giants, except in those cases where the extraordinary stature is a characteristic of race.

To such an extent are these observations in accordance with science, that it is quite possible to judge of the nature of both these monstrosities, whether they be congenital, hereditary, or *lusus naturæ*. If, upon the examination of the fully developed teeth of a giant, I found them large, regular, and in a well-formed arch, the whole in harmonious relation to his other enlarged features, I should have little hesitation in pronouncing him a congenital giant—a large man by nature, and belonging to a family or race of giants. If, on the other hand, I found the teeth the size of those of a man of ordinary stature, and standing apart from each other in an enlarged jaw, I should pronounce him the result of forces which did not antedate his own existence, but continued their power long after the development of the teeth after their hereditary pattern had been completed. And in like manner a dwarf belonging to a race of small stature would not necessarily show irregularity or crowding of the teeth, but would be expected to show a reduction in size of the dental organs in consonance and in harmony with the type of his race.

This is but a confirmation of the theory of the independence of these organizations; the evidence from a variety of sources going to show that the forces which preside over the growth of the osseous system are separate and distinct from those which originate and develop the dental organs, and that while in a normal state both teeth and jaws would grow in harmony, in an abnormal condition the teeth might be far in advance of the growth of the jaws, or they might be equally retarded. If the former, they must erupt in a crowded condition; if the latter, they would, other things being equal, be likely to be in line.

No one of extended observation will hesitate in believing that there is a faculty or power at work, modifying materially the physique of the present generation, altogether inexplicable by the too commonly asserted influencing power of climate, hygiene, or diet.

"This change indicates the existence of less muscle, more nerve; less physical vitality, more nervous energy; less power of endurance, but more mental activity.

"This same change is also indicated in the anatomy and physiology of the person. The framework of the body generally is not so large, is not so compact, nor so well proportioned; the countenance is paler, the features are more pointed and not so expressive of health, though more so of intelligence. The texture or quality of organization is more delicate and refined; the brain is becoming developed more and more relatively, and too frequently at the expense of the body; or, in other words, the nervous temperament, with all its advantages and disadvantages, is becoming too predominant for other parts of the body. As one of the consequences, we have more diseases of the brain and nervous system, more sudden deaths from apoplexy, paralysis, and also from diseases of the heart. No truth in vital statistics is better established than the fact that large cities and a dense population tend to diminish the physical energies of the body and shorten human life. . . .

"The simple reason is, as we conceive, that their style of living taxes the brain altogether too much; it develops a great predominance of the nervous temperament at the sacrifice of other parts of the body, which by inheritance is increased from generation to generation. The balance of structure and harmony of function in organization is radically changed, and carried to an intense development of nervous tissue, which in its very nature is unfavorable to the preservation of offspring. . . .

"But it is in the accumulated, the intensified effect produced by the law of inheritance, that the most striking and destructive results are to be witnessed." *

As the peculiarities of progenitors in mind, temperament, and physique are by nature stamped upon their offspring, we see a generation of children inheriting a tendency to a nervous exaltation which very slight favoring circumstances encourage and stimulate. This is unquestionably more noticeable in the centers of luxury in this country than in any other portion of the civilized globe. Fathers who are under a mental strain to the very verge of insanity transmit that exaltation to their offspring. Children are no longer children, except in their immature physical development; their emotions are under constant stimulus and excitement, and, if there is not in all instances an absolute intellectual precocity, there is relatively a mental and nervous development far in advance of the physical. Hence, if the mental is only up to the average of its years, we will find it associated

* Dr. Nathan Allen, of Lowell, Massachusetts.

with anything but a robust physique; and the contrast remains the same. One of the manifestations of this precocious, emotional, and exquisitely developed nervous system is its influence upon the development of the teeth, while the physical system is following in tardy but vain efforts to keep pace with it.

The conclusion, then, is this: Laying aside all cases that may be due to an inherited tendency to follow or exaggerate some given type, together with those which are manifestly due to forces operating only after eruption, the primary cause, so far as the individual is concerned, of any general disturbance in the development of the permanent teeth, showing itself particularly in their malposition, is directly traceable to a lesion or innervation of the trigeminal nerve; it is an interference, more or less prolonged, with one of the prominent functions of that nerve, and operating at its origin. While there may be no way to prove this by any examination, microscopical or otherwise, while the nerve-center is under this influence, it is nevertheless sufficiently proved by secondary phenomena which could only have originated from such a source. The function of the trigeminus, thus stimulated or interrupted, is that which supports, regulates, and governs the nutrition of the tissues to which its terminal branches are distributed.

That such a lesion or innervation would be likely to produce such a result is clearly foreshadowed in the following statement made by the late Professor Anstie in one of his lectures on the fifth nerve: "The nervous center in which the trigeminus is implanted is, of all nervous centers, the one which in the human subject is most liable to congenital imperfection of the kind which necessitates a break-down in its governing functions at special crises in the development of the organism."

No author on the causes of malposition of the teeth has made this direct connection between the abnormality and a disturbance of the nerve-center, during the formative and eruptive period; but I find a large array of facts, confirmed by my own observations, which point in my mind to this only conclusion; and, although other observers of similar facts have attempted in many instances an explanation of what they saw, they have failed to refer them to any satisfactory *primary* cause.

In Mr. Mummery's paper, before referred to, in speaking of *diseases* of the teeth, he says: "It is to be feared that a large amount of dental disease is originated by overtaxing the brain-action of children. According to the best authorities, the most rapid increase in the growth of the brain takes place before seven years of age; and it must be remembered that the crowns of all the permanent teeth, with the exception of the third molars, are simultaneously in the course of development with this great advance in the size of the brain. May we not, therefore, reasonably suppose that through the diminished vitality consequent upon this diversion of the formative energy from the teeth, by premature mental exertion, these organs necessarily become degenerated, and that this circumstance constitutes one great difference between the teeth of the intellectual and those of the uncultivated families of mankind?"

The argument from this universally recognized condition is this: During the formative and eruptive periods of the permanent teeth they are under the influence of an independent and peculiar vital (nervous) force; this innervation pushes on their development regardless of the more tardy growth of the osseous system; being implanted in a crowded position, in undeveloped maxillæ, they never have an opportunity to recover from it, and emerge in the same disordered arrangements in which the crowns were formed. In these positions, when fully erupted and surrounded by their alveolar walls, they become fixed regardless of any subsequent growth of the jaw; for it is one of nature's laws that, when the climax of development has been reached and the type is complete, function ceases. Under such circumstances it would not be expected that any or all organic changes in the nerve-center would manifest the same results in detail; a disturbance of function would produce general results, the details of which might vary in every case. That such a lesion or innervation could only operate upon the permanent teeth is easily seen, when it is remembered that, to produce any marked effect upon the deciduous teeth, we should have to go back to intra-uterine life for the period of its influence, and before the child had an independent and sentient being.

This hypothesis does not find any contradiction in our daily observation; for such a disturbance of nerve-function might occur only for a limited period, and no other exhibition or evidence of it ever again appear.

The logical result of such reasoning would be that in individuals and families of sluggish or feeble intellects and phlegmatic temperaments, but with good physique, we should find capacious jaws and teeth not crowded. If a precocious or stimulated brain in infancy urges on and crowds the dental organs in advance of the growth of the jaws, then a brain of low caliber, or power, will be likely to have associated with it a retarded dentition, but with abundance of room. The grounds for such a conclusion are not merely theoretical, but are the results of observations in private practice for more than a quarter of a century in connection with investigations of different classes, nations, and races, ancient and modern, including all ranks and conditions of life from the highest order of intelligence down to the idiotic.

A perfect dental development is the result of well-balanced physical and nervous systems, without hereditary taint.

The causes of irregularities we classify as developmental and accidental; the developmental operating prior to the eruption of the teeth, and the accidental subsequently.

Abnormalities of development having their origin in the same individual are due to a disturbance of the trigeminal nerve during the period in which the crowns of the permanent teeth are forming and arranging themselves in the jaw prior to eruption; or, when arising from causes antedating the life of the individual, are traceable to an inherited tendency, which tendency had its origin in a like disturbance in one of the progenitors, and was subsequently transmitted; or are the result of mixing different and distinctly marked types of jaws and teeth by the progenitors.

This proposition may be stated in another form as follows: The cause of irregularities of the teeth other than accidental lies in a want of development of the jaws commensurate with the size of the teeth; and this want of relation is sometimes due to a retarded growth of the jaw while the development and eruption of the teeth is not retarded, and sometimes due to the inheritance of large teeth out of all proportion to the size of the inherited jaw.

In our view we do not call a feeble mind, a sluggish brain, or a dull intellect a nerve-lesion or a brain-disturbance; for it is abundantly proved that when this condition is associated with an average physique, the development of the dental organs is tardy, but in regular order.

We have before us, then, both the solution of the problem and the evidence of most alarming symptoms in the physical and mental condition of the inhabitants of the centers of civilization.

There can be no question that the Creator intended that there should be perfect harmony in the development of the physical and nervous systems, and that where such harmony exists we come nearest to the standard of a perfect organization. This harmony of organization or true balance of the two systems demands that in the earlier years of life the brain and the nervous system be held in abeyance to the physical.

The healthier mental organization is of slower growth. If, therefore, we find that a certain mode of life destroys this harmony, breaks up this balance, there will follow necessarily deterioration and destruction of the race; and this is based on a well-recognized physiological law: if the brain and the nervous system are in an undue state of activity, the drain upon the sources of nutrition will be at the expense of the physique.

No force operating on the brain can interrupt or alter the type or inherited model of the dental arch, after the first decade of life. All cerebral disturbances occurring during that period, showing mental aberration, we should class under the head of idiocy—imbecility. After that period, such manifestations come more properly under the head of lunacy—insanity—which might degenerate into imbecility or idiocy. Consequently, neither lunacy nor insanity, in the ordinary acceptation of the terms, can have any direct bearing upon the development of the dental organs; but such a condition would be most potent of evil if transmitted to offspring.

I do not hesitate to place it upon record that *the next generation will see more of abnormality in dental development, and an increase of nervous and cerebral diseases, and that the two are correlated and spring from the same cause.* It is too late to stop it in those who have passed infancy, but it is not too late to modify and partially remedy the evil in those now being born, and those who may be begotten hereafter.

To fathers and mothers surrounded by luxury and flattered with the precocity of their infants, which they are stimulating to the last degree, we say: Do not under peril encourage this brilliancy, which is now so charming; let the mind stagnate rather. For the first seven years of life give concern *only* to his morals and to his physique. Nourish him as you would nourish an animal from which you desired the finest development, stimulating *only* his moral nature, and his intellect will take care of itself. Thus, if he have no hereditary taint, will be laid the foundation of a splendid specimen of his race.

CHAPTER II.

CORRELATION OF IRREGULARITIES TO IDIOCY.

A FEW years since, Dr. Langdon Down, physician to the Earlswood Asylum for Idiots near London, reported the results of his investigations into the dental development of nearly a thousand feeble-minded youths who had come under his observations. His examination satisfied him that there was always narrowing between the posterior bicuspids of the two sides and inordinate vaulting of the palate; the only exceptions being certain macrocephalic idiots, in whom the mouth like the rest of the cranium was extraordinarily large. In a paper read before the Odontological Society of Great Britain, he says:

"A marked character of the teeth of idiots is their irregularity as to position. They are often crowded, so crowded as to present their sides instead of their anterior surfaces. They are often arranged on different planes. The canine teeth are frequently unduly prominent, and a marked sulcus is sometimes seen between the incisors and canines, with prominence of the incisors. . . .

"Of the most significant value, however, is the condition of the palate. I have made a very large number of careful measurements of the mouths of the congenitally feeble-minded and of intelligent persons of the same age, with the result of indicating, with some few exceptions, a markedly diminished width between the posterior bicuspids of the two sides. . . .

"One result, or rather one accompaniment, of this narrowing, is the inordinate vaulting of the palate. The palate assumes a roof-like form. The vaulting is not simply apparent from the approximation of the two sides; it is absolute, the line of junction between the palatal bones occupying a higher plane. Often there is an antero-posterior sulcus corresponding to the line of approximation of the two bones. . . .

"An appeal to the condition of the mouth is an important aid in determining whether the lesion on which the mental weakness depends is of intra-uterine or post-uterine origin. In the event of the mouth being abnormal, it indicates a congenital origin; while if the mouth be well formed, and the teeth in a healthy condition, it would lead to the opinion that the calamity had occurred subsequently to embryonic life."

Subsequently, Mr. Charles Tomes, in an essay "On the Developmental Origin of the V-shaped Contracted Maxilla," based upon the investigations of Dr. Down, undertook to trace the phenomena back to their origin and explain them.

Such opinions advanced by such distinguished authority I should have accepted unhesitatingly, did not my own experience fail to endorse them; for during a period of twenty-five years I had been noting and treating all forms of abnormalities, and the V-shaped or contracted arch was universally associated with a higher order of intelligence. On the very day of this writing, I examined the mouth of a lady in which there were seen contracted and V-shaped arches in both upper and lower jaws of most decided character. The lady was one of unusually well-balanced mind and of a superior order of intelligence. No ordinary observer could possibly associate any feebleness of intellect with the abnormality in the person of this lady. Furthermore, in a large majority of the contracted dental arches which have come under my observation and treatment, I do not believe that the maxillæ were affected.

In the widening of a dental and alveolar arch no pressure brought upon teeth will perceptibly affect their osseous basal structure. If the maxillæ were actually pinched, the widening of the dental arch would be likely to produce external deformity.

Having some doubts of the correctness of the inferences that had been drawn upon this subject, I undertook, a few years since, a somewhat extended investigation to collect evidence bearing upon the subject. In entering upon an investigation of this kind, with a view of demonstrating a fact in science, it is of the utmost importance that there be no ambiguity of language or terms.

I have heretofore spoken of the normal type of the dental arch being a regular curved line. I wish now to state that the absolutely perfectly regular line is very rarely found in either ancient or modern skulls. To be more explicit, it will be found that nearly every case which would be pronounced regular by an expert on looking at it, will show variations when put to a mathematical test. For instance, if a piece of soft wire be bent around the outside of the circle so as to touch every tooth, it will show places indicating that certain teeth are either within or without the line, and yet the deviations are so little as to be hardly observable by the ordinary critic. Such deviations as this I do not class under the head of irregularities, because they are no more out of the limit of normality than are the varieties of feature in different members of the same family. Furthermore, it is not certain that they are in any sense developmental in their origin; and if not, they can not be used as an argument in an investigation into development.

My own opinion is that, with the exception of inherited deformities, almost all cases of slight peculiarities of position result from the accommodation of articulation with the opposing jaw.

We remember the anomalous position of the teeth before eruption; if they continued to grow in the same direction, great general disorder would be the result. That they ever come perfectly into line, is due partly to the enlargement of the jaw encouraging it, and partly from articulation with the antagonizing teeth on occlusion. As it is only *inclined* surfaces that come in contact, we can readily see that a jaw which has the full measure of natural tendency to regularity, may thus show some deviations as the permanency of the structure is attained. A peculiar rotary movement in masticating, when teeth are erupting, may be sufficient to throw a bicuspid ever so slightly out of position, which malposition may be considerably increased or may be corrected by contact with the opposite tooth on occlusion.

In my investigations I used pieces of thick cardboard cut about two and a half inches square, which were inserted in the mouth, the teeth closed, and with a pencil a line was drawn around the circle and close to the teeth. In this diagram both the size of the arch and its form were indicated. Such an examination was made of hundreds of youth above twelve years of age in our public schools, where I found as great a variety of nationalities probably as I would in any quarter of the globe. The investigation included the inmates of the Asylum for Idiots on Randall's Island, and subsequently some weeks were devoted to an investigation of cretinism in Switzerland, and an examination of idiots found in the various asylums and hospitals of Paris, and to a more limited extent in Great Britain. The results were briefly as follows:

In private practice I have seen a very large aggregate of dental deformity, and in most instances associated with an intellectual capacity above the average of mankind. These abnormalities have not been confined to any prevailing type, but have included nearly every possible variety of irregular development. In the public schools, among the middle and lower classes of society, I have found but a small percentage of pronounced irregularity. Such as I have found was in nearly every case among the brightest children of the schools. Among the children of good physique and fair mental capacity the development was on the whole regular and normal, a noticeable fact being that the jaws were generally capacious and ample for the regularity of the teeth. In an occasional instance there might be found a jaw of undue capacity, and with separated and straggled teeth. One instance of this kind was particularly marked, and, on making inquiry of the principal as to the status of the scholar, I was told that she was the dullest one in the school of over three hundred, and, although of an age to justify an entrance into the highest class, she could not rise above the lowest.

Among the cretins, capacious jaws were universal.

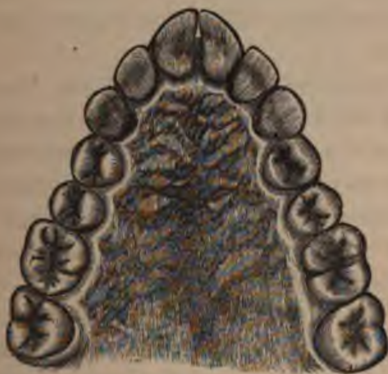
In the examination of idiots I endeavored to separate those where the mental defect dated from birth from those who in infancy showed the average mental capacity, and who from accident or disease afterward degenerated into imbeciles. No more reliance is to be placed upon an examination of the jaws and teeth of the latter class, in a question of development, than upon an examination of the inmates of an insane asylum.

Confining myself to congenital idiocy, I found only a small percentage of pronounced irregularity in form of the jaws or arrangement of the teeth, and that generally associated with the lowest type of idiocy and the kind of which mental improvement was the most hopeless. Associated with deformities of the jaws were usually other abnormalities of physique showing a general constitutional disturbance. Only among idiots drawn from the higher classes in Great Britain were there found exceptions.

The examination of some two hundred inmates of the asylum on Randall's Island did not show a single pronounced case of V-shaped dental arch, such as is shown in Fig. 2. I saw but very few cases of narrowed palatine arch; there were but three or four of saddle-shaped palates, i. e., where the sides of the palate approximated in the bicuspid region, such as shown in Fig. 3.

There was but little irregularity in the positions of the teeth; very few teeth that were out of line, whatever that line was. The little malposition that I saw was generally

FIG. 2.



confined to the six front teeth; of these six, the lateral incisors were more generally at fault, being inverted, everted,

FIG. 3.

or twisted. It was not a common thing to find the canines out of line. Many of the malposed cases were those where the teeth were still erupting, and did not show such abnormal position that I would have felt justified in interfering if the patient had been brought to me for treatment. There was every reason to hope that when fully developed they would appear in good position. There were also many cases of retarded dentition.

There was no more irregularity, decay, loss of teeth, or neglect, than I have seen in the same number of youths picked up from the street. The prevailing impression was, that I had seen an unusual number of well-developed jaws; they would average larger than the fully developed jaws of the average of my patients; and that they were above the average for density and probable durability.

The dental arch was generally a broad and regular curve; the variations from this, but within the range of normality, were a smaller circle, anterior to the bicuspids, and straighter lines behind them. The lower jaw corresponded with the form of the upper in nearly every case, and therefore the articulation was almost always *good*. There were three or four cases (those with saddle-shaped palates) where there was a narrowed or somewhat pinched condition of each side against the first molar, with which the lower jaw did not correspond, and the lower teeth articulated there outside the upper ones. Associated with the last-named peculiarity, there were four or five where the superior incisors appeared tipped up, as in the so-called thumb-sucking cases, and which it is quite possible were caused by sucking habits; in some of them a vertical gap, of from one quarter to three eighths of an inch, between the incisors of both jaws when the teeth were closed, was observed. There were several cases where the arch was well curved upon the right side, but the left side showed a variation from that curve and a depression of the line. There were more cases where the arch was depressed on only one side than upon both. I did not see a single case in which there was any abnormality of size or shape of the jaws before the eruption of the permanent teeth.

FIG. 4.

I was informed that a very considerable number of these patients are of Hebrew extraction. The others are made up from nearly all civilized nationalities.

FIG. 5.

From conversations with those in charge of the education of the idiots, I was able to note the intellectual status of the patient and the corresponding condition of the dental organs. It was thus I discovered that, in those cases where there was a fair physical constitution and development, the intellect in a progressive state, and considerable hopes entertained of mental improvement, the jaws and teeth were in a normal condition. As the scale descended until we arrived at that melancholy condition of absolute idiocy upon which all improvement was hopeless, I found jaws and teeth, and in a measure the whole physical condition, degenerate. Thus did I see the extremes and the gradations, beginning with a sluggish or feeble mind, in a fair organization with well-developed jaws, descending in regular sequences through all the grades of imbecility to unconditional vacuity, associated with corresponding disorganization and degeneracy of the teeth, jaws, and whole physical system.

The accompanying cuts represent casts illustrating these extremes in the dental development of idiots. Both these subjects were found in the asylum on Randall's Island, and both are congenital idiots.

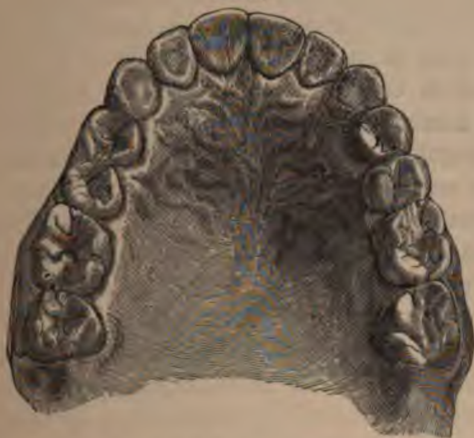
Figs. 4 and 5 show the form of jaws and arrangement of teeth in the mouth of John Rowse, an idiot of the lowest type and incapable of improvement. He was born in 1843, weighs now seventy-two pounds, and is four feet seven and a half inches high.

Figs. 6 and 7 represent the jaws of a boy fourteen years of age, of full average height and good physical organization. The record shows him to be "disorderly and wild; incapable of improvement under special training."

The examination of between three and four hundred of the inmates of the Paris asylums showed substantially the same results as that in this country.

I also visited Dr. Down's private asylum near London, and together we made a careful examination of every inmate of the institution, with a result not so widely different as I had supposed must exist. There was, to be sure, a larger percentage of irregularities of the teeth than I had before observed. About five per cent. might be said to be pronounced cases of narrowed or V-shaped arches, and another five to ten per cent. might be said to have more or less ten-

FIG. 6.



dency in that direction; but of the more positive cases I did not see one so marked as I have seen and treated in private

FIG. 7.

practice, and associated with full intellectual development. Of the total number, I could not pronounce one half, or fifty per cent., as showing an irregularity of dental development out of the range of normality, or that might not have arisen from accidental causes operating on the crowns of the teeth after eruption, and therefore only incidentally connected with idiocy and in nowise correlated thereto. In this way only is to be accounted for the difference of opinion which existed between us upon many cases which seemed to him an unduly high vault to the palate, narrowed arch, or irregularity, but which to my eye came clearly within the limit of normality. Nevertheless, there was no mistaking the fact that there was a larger percentage of the kind of deformities which he had described than I had found in any other collection of idiots. This type of idiocy seemed to be the result of a long line of hereditary transmission occurring in the higher walks of life, brought about by various causes; showing itself first in an overwrought nervous system and a stimulated mental activity transmitted to children in an exaggerated form; showing also coincidently in the children irregular dental development, and the evils further increased by transmission, and finally ending in a complete break-down of mental power.

By a comparison of my observations of idiots with those of all ranks and conditions in life, as represented in our public schools, I found that, taking the idiots as a class and comparing them with the lower orders of society as found in this country, there were no more irregularities in the one than in the other. In both cases did I find that amply developed jaws and teeth were the rule, and narrow, pinched, and V-shaped maxillæ and dental arches were the exception. And this was equally true of the idiots in France and of the cretins in Switzerland, among whom I did not see a single case of narrowed arch or high-vaulted palate.

In Dr. James W. White's report of a visit which he made to the Pennsylvania Training School for Feeble-Minded Children he says: "In the mouths of some of the inmates—especially those whose mental development was little above zero—there were teeth which, for size, regularity, density, and perfection of form, would answer as models. There were also teeth which were faulty in every respect and relation; but on the whole we had to admit they were about an average lot, neither better nor worse than those of the same number of similarly neglected people of ordinary intelligence."

Professor Stellwagen, of the Philadelphia Dental College, visited the same institution, and says: "I examined the mouths of ninety-seven males and eighty-seven females, making in all one hundred and eighty-four patients. Among these there was a very small percentage that, had they been presented to me in my office, would have warranted interference in any manner as regards the regularity of the teeth. . . . The jaws were unusually large as compared with the same number of jaws in the mouths of intelligent children—such as would seek the services of the dentist."

Professor C. N. Pierce, of the Pennsylvania Dental College, says: "While traveling through the Tyrol of Southern Austria, and Lombardy, Italy, I had the opportunity of seeing a large number of cretins—disgusting, jabbering idiots as they were, unable to articulate a word distinctly. By the aid of a few small coins I obtained a hasty glance at the oral cavity, which, though not critical or satisfactory, was sufficient to satisfy me of an unusually large development of both superior and inferior maxillæ, with an abundance of room for the teeth. Opportunities have also not unfrequently offered for viewing the mouths of negroes, where mental growth was far below the average, with a decidedly retreating forehead; in such the jaws were invariably large, the teeth far from crowded, and quite projecting. In my regular practice, cases have not unfrequently occurred where one or two in a family would have what might be termed *straggling* teeth, or teeth standing alone with an unusually wide space between them; while with other members the reverse condition would predominate. In the former the mental condition was always far below the latter, being a marked reversion to a lower order of development."

In these apparent contradictions between Dr. Down and other observers, it is difficult to form an opinion which will reconcile the differences; and it might be just as well to leave it as it is, were it not for the startling conclusion to which Dr. Down comes and its bearing upon the welfare of the community. In his essay he says: "It was in my inquiry into the condition of the teeth and mouth especially, that I arrived at the conclusion that, in by far the larger number of instances, I was able to indicate the period at which the depressed condition commenced, and to predict in some degree the amount of improvement which physical, intellectual, and moral training might possibly effect. In children where idiocy is accidental, arising from causes operating after uterine life, there is but slight deviation from a normal condition in the state of the mouth and teeth; while it is in those whose malady is congenital, especially where arising from causes operating at a very early period of embryonic life, that the deviation of the mouth and its appendages from a normal condition is most pronounced."

The bearing of this opinion may not seem at first of much consequence, but it becomes of the utmost importance when applied, as it has been by Dr. Down, in determining the mental capacity of an heir to manage his estates. In such a case the contracted condition of the mouth was the deciding point of evidence, in the opinion of Dr. Down, that the patient was a congenital idiot.

We do not believe that any irregularity in the position of the dental organs is any evidence *per se* of idiocy in the individual. The cases are so common where such deformities are found associated with the highest order of intelligence that, if we are to draw any inference from that condition in the abstract, we should say that it was more likely to indicate a precocity of mental development, with a stimulated emotional nature in the child, and possibly a more brilliant intellect in the adult. There are so many cases where the proof is incontestable that the idiocy is of congenital origin and where the dental development is perfect, that we can also reasonably say that the regularity of the dental organs showed conclusively that there had been no lesion or cerebral disturbance (in the true sense) after birth, but that the teeth grew in accordance with physiological laws under a low order of intellect.

We do not see any connection between these phenomena and causes acting especially "at a very early period of embryonic life," when we consider that the deciduous teeth are well arranged, and that it is only after they pass away that abnormality appears; also, as it is only at the very latest period of embryonic life that even the germs of the permanent teeth are found, it is difficult to conceive the connection or correlation. If the cause antedates the birth of the child, we should seek for its origin not during intra-uterine life, but in a like deformity existing in the parents or ancestry, which may appear exaggerated in the child under favoring circumstances. An inherited taint, disturbance, lesion, predisposition, or tendency to idiocy (of which these irregularities may be a symptom, but not a proof) may show itself in a precocious mental development in one instance, and be the precursor of insanity in the same individual, or appear as idiocy in posterity.

CHAPTER III.

DIAGNOSIS.

Much of the success in treating irregularities will depend upon a correct diagnosis and prognosis.

This is one of the most difficult problems in the practice of dentistry, and its proper performance must take into consideration the efficiency of the masticating apparatus, the enunciation of the voice, the organism of the teeth, the ravages of decay, the family type, and the relation of the features; the constitution, temperament, and systemic condition of the patient; the sex, age, and social status; the causes of displacement, whether accidental, congenital, or hereditary; the means and appliances for correction; the time, trouble, and skill required of the operator, and the time, annoyance, and endurance of the patient; the risk of inflammation and of destruction of pulps; and, finally, the character and permanency of the change wrought.

It is not a question of the ability to bring one or more teeth into the line of a regular dental arch, so much as it is, Will the result, when obtained, be permanent and justify the means used? For example, a bicuspid or a canine in a person of mature years may be turned upon its axis to the extent of a quarter of a circle; the mechanical difficulty in returning it to its place being in some instances very serious, involving much time, ingenious appliances, and often the perforation of the enamel for a pin to obtain an attachment, and the result being no probable gain to its masticating power nor its preservation, and so little benefit to the appearance as to be of doubtful expediency.

Cases are constantly coming before our observation where most remarkable achievements are within the scope of scientific skill, but where a conservative view would not justify the means required to produce such a result. Neither can it be asserted incontrovertibly that all irregularities in the position of teeth are deformities, and require our interposition. A fine æsthetic taste may maintain that there are multitudinous departures from a normal type where neither the utility nor the beauty of these organs, nor the symmetry of surrounding features, is seriously affected by the malposition.

Nowhere in developmental nature will we find mathematical uniformity in size, shape, or position. The trees of the forest take every conceivable form within the limits of their type. No two leaves are precisely alike. The two sides, even, of every leaf differ in outline. Every human figure differs from every other human figure; face from face—even the two sides of the same face are not mechanically mated. Variation from mathematical precision in nature is universal, and any appearance of absolute regularity always suggests the interference of man.

The eye soon tires of the stiffness and formality of unbroken uniformity, and is only permanently pleased with the beauty which comes from graceful variation. If it were possible to bring all dental arches to one standard of arrangement, deformities of facial expression would probably be more common than now. An apt illustration of such a result is found in the limited variety in form of the artificial teeth in the market, and the still more limited skill in arranging and adapting them for service; consequently, there are seen all over the country prevailing patterns of teeth made in rows, devoid of grace, and inserted indiscriminately in the mouths of the beautiful and the mouths of the ugly.

Æsthetically considered it can hardly be claimed that a dental arch with all the teeth in contact is positively more beautiful than one where slight spaces occur, while experience is uniform in showing that in this age of degenerate teeth their durability is much enhanced by separation.

An erroneous teaching has maintained that the full number of teeth must be retained in the mouth, regardless of their organization, the progress of decay, the limited capacity of the arch, or the external features.

Two arguments are advanced to support such a judgment: First, that a certain number of teeth are developed by nature, and therefore every one must be preserved. Such an opinion might be of some force if we were passing judgment upon a normal condition of the human race, but, as the condition we are considering is wholly abnormal, the argument is of little value. A second argument in favor of the retention of all the natural teeth is, that the alveolar arch and the associated maxilla will become contracted, narrowed, pinched, as the result of such loss, consequently the articulation of the teeth broken up and the efficiency of the masticating organs impaired.

An experience of sufficient length to determine results has shown very conclusively that the retention of every tooth in the mouth is *not* necessary to the efficiency of the masticating apparatus, is not required to maintain the contour of the jaw, and the loss of certain teeth produces no visible external effects.

I have heard the statement gravely made in an association of dentists that the extraction of the first permanent molar produced such an effect upon the facial features as to be always perceptible, and that in a community where such dental practice was common the individuals who had lost their first molar teeth could be readily distinguished in an assemblage from those who had not. Such an absurd statement would be hardly worth repeating except to show how the imagination overleaped all reason. It comes within our daily observation that one half the masticating power of the dental apparatus is not utilized, it being the exception that patients use equally both sides of the mouth, and this without any apparent detriment to digestion or general health.

The *articulation* of masticating organs is of much more importance than their number, and a limited number of grinding teeth fitting closely on occlusion will be of far greater benefit to the individual than a mouthful of teeth with the articulation disturbed.

It requires a profounder knowledge than most of us possess to decide always upon the wisdom of extraction, and when such conviction is settled the judgment may be equally at a loss as to the choice of teeth to be removed.

It is a disputed point as to which of the teeth behind the six front can be best spared from the mouth; the arguments being principally for or against the retention of the first permanent or sixth-year molar.

There are so many considerations to be taken into account that it is hardly possible to lay down any rule of universal application. If the sixth-year molars are badly decayed, their removal would be indicated. If they were sound, and also the bicuspids, there might be no greater reason for their removal than either of the bicuspids. In fact, sound molars in the jaw are of more value as masticating organs than equally sound bicuspids.

Narrowing the decision to the bicuspids, there can be no general reason given for selecting one in preference to the other for appearance' sake. The two teeth are so nearly alike that they might change places without detection; and, therefore, if the mechanical difficulties in treating an irregularity were lessened by the choice of one, that would be sufficient to determine the course.

As a general rule, extraction of any teeth from a pinched or V-shaped jaw before it is widened would be likely to prove bad practice. Certainly the extraction of any teeth from the sides of the jaw in such cases for the purpose of correcting or improving the condition without immediate subsequent steps being instituted to widen the arch would be most unscientific and detrimental.

The following case, taken from Tomes's "Dental Surgery," illustrates the want of foresight in such a proceeding.

FIG. 8.

Fig. 8 "shows a case in which the V-shaped conformation was attended with unusual contraction in the neighborhood of the bicuspids and first permanent molar teeth. On the left side both of the bicuspids were removed, and in the right the second bicuspid (and lateral) was extracted without any advantage being gained as regards the contracted condition of the palate."

Such a case may be likened to an arch where the stones have become loosened and displaced, but, still impinging upon each other, the integrity of the arch is maintained. Remove now any one of the stones, and the whole collapses in absolute ruin.

There are many cases where the utility of the dental apparatus would not be seriously impaired by the extraction of one or more teeth, even in the forward part of the mouth. For example, there are cases of a very regular arch and good articulation with the lower teeth, but with both laterals entirely within the line, the canines being on the line with all the other teeth nearly or quite in contact, and the occlusion good. Such cases sometimes occur from the development of large teeth, out of all proportion to the size of the maxilla and to the facial features, and where the expansion of the arch sufficient to admit them into line without the removal of any teeth would result in increasing the size of the jaw to a deformity. In such cases the considerations are purely æsthetic; the usefulness of the masticating apparatus would not be affected.

Whether the correction shall be reduced to the simple surgical operation of removing the laterals, or whether it is better to extract one of the side teeth and introduce mechanical appliances with all their attendant objections, can not be decided in the abstract, and can only be determined by the operator, whose judgment must take cognizance of considerations before referred to.

Such cases, in my own practice, have been treated both ways, and often with the feeling that the greatest benefit to the patient might possibly have been derived from the other course.

In extensive deformities of inherited origin the extent of the correction must be governed much by the probable effect upon the external features, for there can be but little justification for creating a deformity of one feature in the process of correcting a deformity in features less exposed.

When the abnormality can be clearly traced to the parents or ancestry, the course of treatment may be varied from what it would be if caused by influences operating subsequent to birth.

In a transmitted tendency arising from the mixing of inharmonious types, as the small jaw of one parent with the large teeth of the other, resulting in a crowded condition, it is very doubtful if the arch can be made regular without the extraction of some of the teeth.

Again, a transmitted deformity may show itself in teeth which may not be too large for their proper relation to the facial bones and features, but may be placed upon a maxilla too narrow for a symmetrical dental arch, showing itself in a narrowed palate in the upper jaw and often associated with a lower jaw abnormally wide.

The attempt to widen the upper arch in such a case to the extent of establishing its proper relation to the lower teeth would probably end in failure, or if successful in getting the proper enlargement, might result as in the former case in producing deformity of the external features.

If extraction is indicated, as it might be in a case of inherited origin where unduly large teeth were crowded upon a small maxilla, the selection of the tooth or teeth to be sacrificed would be less difficult after a close observation of all the articulating surfaces on occlusion.

While in many cases there may be very grave doubts about the removal of teeth for regulating purposes, there are others where extraction can not possibly be beneficial and when to do so would be little short of a crime.

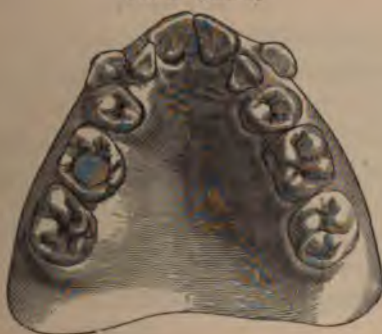
For example, there came to me for consultation a lady belonging to a well-known family in this country, bringing her daughter, about fourteen years of age, with a full mouth and moderately prominent teeth in both jaws. The teeth were regular in the arch and the articulation was good, and the only criticism would be upon the prominence of the teeth and the consequent expression of the mouth.

The arrangement presented to my mind every evidence of an inherited characteristic.

The desire of both mother and daughter was to have the undue prominence reduced. My diagnosis of the inherited character of the presentation was sustained by my memory of her uncle and her grandfather, whom I had met, the expression of whose mouths was identical with the young lady's before me, although the father of the young lady was unlike the other members of the family in this respect.

I declined to interfere, on the ground that whatever I might accomplish would be but temporary. The tendency of the jaw would be continually toward the inherited type, and ten years from this time the mouth would probably present the same expression as if nothing had been done. But in that mouth was exhibited the egregious blunder of a dentist who had extracted from the lower jaw the first permanent molars on each side, both teeth being perfectly sound, and all the teeth articulating most accurately with those of the upper jaw, all of which were also sound. The explanation of the dentist was that he did it to allow the ten teeth forward of the space thus made to fall back, and thus reduce the

FIG. 9. (Case I.)



prominence of the mouth. The fallacy and absurdity of such an expectation needs no comment. With a view to illustrate this subject further, some cases from practice are here introduced. Fig. 9 represents the teeth of a young lady thirteen years of age. The features externally were regular excepting an undue prominence of the upper lip over the canines; the articulation of the teeth was not defective; the arch in both jaws was of sufficient capacity for distinct enunciation, and the teeth in the upper jaw were nearly in contact, but between the lateral incisor and first molar on each side there was but one tooth, viz., a bicuspid—the other bicuspid and the canines were crowded out.

At the period at which this model was taken no history of the missing bicuspid could be obtained. The patient was uncertain about teeth which had been previously extracted, and there was no external evidence of the teeth being undeveloped. Believing, from a careful observation of all the appearances, that the bicuspids were hidden in the jaw, and could not emerge with the teeth crowded as they were, the first molar on each side was taken out to make room, and because they were defective. An apparatus was applied and the canines were brought into line, the first bicuspid being crowded back to make room. In a few weeks the missing bicuspids made their appearance in the gaps of the extracted

FIG. 10. (Case II.)

molars, and at this day the arch is full of sound teeth in regular order and close contact.

Fig. 10 represents the mouth of a young lady of fifteen. The arch is capacious, and the articulation of the masticating teeth would have been good but for the fact that she had worn some badly-adapted regulating plates before she came into my hands, which had permitted the last molars to elongate.

The six front teeth in both jaws were crowded and irregular, and the lower lip had an undue prominence. My study of the case brought the conclusion that, if the lower teeth were all brought into line, the arch would be enlarged and the deformity of the lower lip increased; if, added to that, the upper teeth were all advanced over the lower ones, the mouth would be made very ugly. The treatment left the upper teeth without change except to bring the laterals into line, and the prominence and irregularity of the lower teeth were corrected by the extraction of the right central incisor and bringing the others into line. The result was a perfectly even row of teeth, and no one would notice the loss of the incisor except by a studied observation.

My third example (Fig. 11) is that of a young lady of small stature and spare face. The model shows large teeth,

FIG. 11. (Case III.)

a narrowed arch, but with good articulation. But on the upper jaw the canines are crowded completely out of line, while on the lower jaw there is a generally jumbled position of all the front teeth. Believing that both the narrowed arch and the crowded state of the teeth were abnormal conditions, the superior arch was expanded sufficiently to bring the teeth into line. It then became apparent that while one deformity had been removed a new one had been created. The expanded dental arch was a disfigurement. It was out of harmony with the external features. The mouth, when opened, gave the appearance of "too much teeth." The continuation of that treatment was abandoned; a bicuspid was taken out on each side, and the irregular teeth were brought on to substantially the same line as before treatment. The articulation of the masticating surfaces was preserved, and the expression of her mouth followed her family type.

My fourth illustration (Fig. 12) shows a very irregular arrangement of the six front teeth of the upper jaw, involving also four others. The irregularity of the six front teeth is manifest at a glance; but the bicuspids were also malposed, being inside the proper articulation of the lower teeth.

Fig. 12. (Case IV.)

No teeth were extracted here for regulating purposes; the first molars were removed because they were badly decayed, their pulps exposed and diseased. Appliances were used, and in exactly eight weeks from the commencement of the work all the teeth were brought into perfectly regular arrangement.

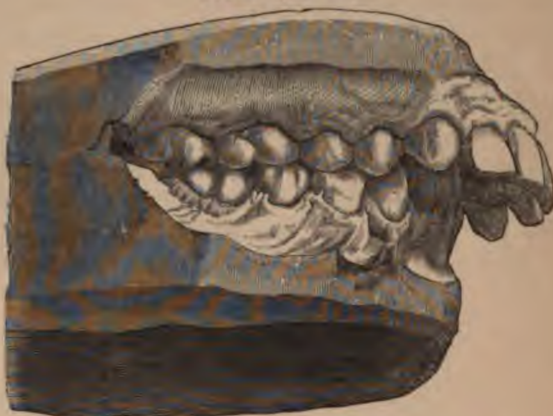
My fifth example (Fig. 13) shows a condition so nearly like the last that only a long experience and a deep insight into the future could have suggested a different treatment. Such a judgment I did not possess. The case called No. 4 was that of a miss about thirteen years of age. The case now under consideration was that of a lad of the same age. The course of treatment attempted was substantially the same; varied, however, continually, as the means employed failed to produce the full result expected. I gave this case my undivided consideration, but, instead of producing a satisfactory result in eight weeks' time, it was more than eighteen months before I ceased giving it active attention. In the mean time I had been on the verge of sacrificing the very organs I was attempting to preserve. I had seen both lateral incisors loosen and elongate more than half the length of their crowns—so loose that I feared they would drop out—and their preservation was so apparently impossible that I suffered in advance all the mortification of a failure; but

Fig. 13. (Case V.)

they were retained and driven back to their position by appliances, and ultimately the result was a regular arch, all the teeth in line without elongation or loss of vitality. But I am firmly convinced that what I ought to have done in the beginning was to have *extracted the lateral incisors*, when the canines would have dropped into line without extraneous aid.

My sixth and last illustration (Fig. 14) is the case of another miss of about the same age. This presentation is entirely unlike any of the preceding ones. The upper incisors are exceedingly prominent, while the lower jaw is excessively retreating or under-hung. This discrepancy in the relation of the jaws is seen in the model of the case, Fig. 14, and also in a cast of the profile, Fig. 15. This case was brought

FIG. 14. (Case VI.)



to me by a gentleman of excellent attainments in our profession, and I made an appointment to examine the patient

FIG. 15.

and form a plan of treatment. After a careful study, I came to the conclusion to extract a tooth on each side of the upper jaw previous to the reduction of the anterior prominence. The necessities of such a removal were clear in my own mind, and the step was delayed only as a matter of convenience. In the mean time I made the models here illustrated, and continued my study of the subject from the models. The result of which was that I saw that extraction was not indicated, that it could do no good, but, if done, would produce positive harm. What was required was a little widening of the arch, a flattening of the superior incisors, and a "jumping of the bite"; and the extraction of a tooth could in no wise contribute to such a result.

These six examples illustrate the following points, viz.: Every case of considerable irregularity of the teeth shows peculiarities which make it differ from every other one of similar aspect.

A diagnosis and a prognosis can not be made without giving the case more study and more reflection than has usually been deemed necessary.

An opinion formed by the most experienced observer on a cursory examination may be changed upon a more careful study of the features, the family type, and the model of the teeth. I desire to call especial attention to this point, that *a correct opinion can rarely be formed from the models alone.* I am constantly called upon to indicate a line of treatment for a patient whom I have never seen, and the only basis given me being some very crude models sent by mail with little or no explanation.

It is not always advisable to attempt to change the expression of a mouth where the condition is an inherited peculiarity, a part of the family type, and where the change would involve very prolonged effort, possible breaking up of a good articulation of masticating organs, and with the knowledge that nature will be constantly making an effort to return to the hereditary type.

In patients who have by inheritance small features and small jaws with large teeth, and a tendency to overlap or to be crowded out of line, the extraction of a pair of teeth is indicated rather than the enlargement of the arch.

Cases are of frequent occurrence, which show that a pair of any of the teeth in the mouth may be removed to correct an irregularity, excepting the canines of both jaws and the superior central incisors. It would be an inconceivable case which would justify the extraction of the superior central incisors; but the upper lateral incisors and any pair of the lower incisors may be removed, in certain cases, without serious detriment to the appearance of the mouth.

It is not necessary to the contour, symmetry, or harmony of the features that every one of the masticating organs should be retained in the mouth.

In the treatment of irregularities, the comfort and permanent good of the patient are secured in larger measure by not moving organs that are not themselves offending members.

It is often better to extract a malposed tooth than disturb a whole arch to bring it into line. In such cases as are represented by my fourth and fifth examples, other things being equal, the question of sex should make a factor of the prognosis. The fourth illustration was of the mouth of a young lady with regular, handsome features. The extraction of both the canines or both the laterals from the upper jaw would have left the arch full of teeth, but the deficiency would likely have been observed, and would have marred her beauty all her life. In the fifth example we find a lad likely to grow up with strongly-marked features and, quite possibly, a hirsute covering, which might hide the mouth completely. The articulation of the masticating organs being good, the dental arch being broad enough for distinct enunciation of speech, there remains but slight objection to the removal of the lateral incisors; and, when the alternative is the risk to all the teeth involved in bringing them into line, the weight of the argument is in favor of removal.

A consideration not to be lost sight of is the tax upon the nervous system. With appliances carefully and skillfully adapted, and with proper vigilance in their attention, the strain upon the nervous system need not be serious, and need not be sufficient in itself to decide against treatment; but, in connection with other considerations, it may become an important factor.

Of minor importance, and yet not without weight, is the condition in life of the patient.

In a purely scientific view the social standing of the patient can have no weight, but in a conservative view the present and probable future position of the patient in society must necessarily influence the treatment. If of a low order in both social scale and intellect, associated as it generally is with a total lack of appreciation of the benefit conferred, and with but little hope of advancement in either direction, the æsthetic considerations would be of little importance.

The utilitarian would naturally be the chief object. The children of a charity hospital may be largely benefited by a limited and comparatively inexpensive treatment, while such a course would not be justified if applied to the daughters of refinement and exalted social position.

And lastly comes a consideration which neither the purposes of science nor the philanthropic and humanitarian view entitles to enter into a diagnosis of the case, but which, as society is now organized, can not in all cases be ignored.

What may be of the greatest benefit to the patient, without reference to the time and skill required of the operator, may be one thing; how much of that time and skill he shall give without adequate remuneration becomes a question of casuistry, and is a very different thing.

It is rightfully somewhat within the power of the patient or those acting for him, to elect whether the more extended treatment with the finer æsthetic results shall be undertaken, with the consequent remunerative fee, or whether a more limited benefit be accepted, and with less tax upon the charitable disposition of the operator. Patients are not apt to value that which has been obtained at little expense, and while in one view it is the duty of every honorable practitioner to render in all cases only his most skillful service without regard to fee, yet it will be often found that such service was entirely unappreciated, and, considering all things, not of sufficient importance to the patient to justify the effort—the chief benefit derived being an increase of the practitioner's experience.

The remarks of the late Dr. Westcott, which will be found on page 184, are worthy of careful attention.

CHAPTER IV.

PHYSIOLOGY AND PATHOLOGY.

THE movement of teeth in correcting irregularities is based on an anatomical and a physiological fact. The anatomical, that the teeth are placed upon the maxillæ surrounded by vascular, elastic, bony processes, which are easily moved, absorbed, and reproduced; the roots penetrating but little into the true maxillæ, and in their movement affecting the maxillæ but slightly if at all.

The physiological fact being that bone will yield or become absorbed under certain influences, and also be reproduced.

That teeth can be moved and become firm in their new positions, and that they are moved frequently at nearly all periods of life, is a matter of common observation.

Teeth which have been used as supports for a plate with clasps are very often, through the bad adaptation of the plate, or through the strain arising from mastication on the artificial teeth, drawn away from their original places, and assume and become firm in new positions.

In like manner we frequently find, where scattered teeth are extracted from both jaws, the remaining ones change position and assume new relations on occlusion.

So, from one cause or another, there is more or less change of position going on through life, and not inconsistent with their healthy retention in the jaw nor their firmness.

In moving teeth the power used creates a pressure which produces absorption.

The function of reproduction is nature's means of coming to the rescue and restoring lost parts.

In correcting irregularities it is not probable that there is any lateral movement at the apex of the root. In that respect it is virtually a fixed point. The tooth may be driven up into its socket under pressure or elongated under strain, but rarely, if ever, do we find evidence of lateral movement at the apex. The greatest motion is at the cutting or grinding ends, and the least at the apices.

The only exceptions I have ever seen or thought I saw were where, in consequence of loss of front teeth, the molars have seemed to travel bodily forward without tipping.

The function of absorption and reproduction may or may not go on coincidently, simultaneously, and with equal rapidity.

That bone will become absorbed under pressure, and that bone must be deposited to fill up the socket of a displaced tooth before it will become fixed in its new position, is used as an argument that such a state exists always as a consequence of change in the position of a tooth, and that the success of the movement is dependent upon both these functions. In a slow movement this is probably the case, in a rapid movement it is doubtful.

To account for certain results which have been accomplished by this theory alone, we must believe that the function of reproduction goes on with greater rapidity than has ever been proved.

For example, the superior dental arch has been frequently enlarged to a considerable degree within a very few days.

If the enlargement depended solely upon absorption and reproduction, it would necessitate an entire change of substance in the external alveolar walls, as the movement has often been sufficient to displace the process entirely; but we see the bony covering remains intact, neither impaired nor perceptibly diminished. By its integrity the vital connection and condition of the teeth were maintained until nature filled up the sockets behind them.

In a case now under observation, it is but forty-eight hours (at the present writing) since I applied a fixture across the roof of the mouth of a miss of thirteen years, for the purpose of widening the dental arch.

It has already, by careful measurement, accomplished that result to the extent of half the diameter of the bicuspids.

The patient says there has been no tenderness sufficient to disturb her sleep nor interfere with her mastication.

No one for a moment will suppose that, coincident with that outward movement, there has been an absorption of the external alveolar wall to the extent that the movement indicates.

If the movement is due alone to absorption, then reproduction must be equally rapid, as the external alveolar walls bear all the evidence of undiminished integrity.

Nor is it altogether explained by the theory of Mr. Tomes that the pressure has lifted the teeth partially from their sockets, and, owing to the conical form of their roots, they have simply moved against the farther wall. This hypothesis may account for a limited lateral movement, but if there were elongation we should discover it in soreness or otherwise on the occlusion of the teeth. The circumstances are analogous to the separation of teeth with wedges preparatory to filling proximal cavities, which is performed every day by dentists and at all ages.

In such cases any elongation of the teeth acted upon would be immediately noticed.

Patients are very susceptible to the most trifling elongation, as is daily evidenced in finishing off fillings which are inserted upon grinding surfaces, the removal of the diameter of a hair often being perceptibly noticed.

If, therefore, this lateral movement of the teeth were to be attributed to their being lifted from their sockets, its effects would be shown in every case where the teeth were spread for filling, where there were antagonizing teeth; but, so far from this being the case, we often find by the complaints of patients that the soreness is not confined to the teeth in contact with the wedge, but is distributed to several contiguous teeth; very often the patient saying that a tooth two or three removes from the wedge is the most painful.

Furthermore, the slight interference with the natural occlusion of the masticating surfaces while the wedge is in the mouth, is fully accounted for by a purely lateral movement which breaks up temporarily their perfect articulation.

In a reverse movement, as for example the contraction of the superior dental arch, we find no such rapid progress is made as in an outward movement, for the reason that the large body of bone resists the pressure as against both expansion and compression.

It is probable that in the last-named movement we make progress no faster than the bone is absorbed, and here we get another proof that the function of absorption progresses more rapidly than that of reproduction; for, while we may be but a few weeks in carrying a tooth to a certain position, we find it is as many months before deposition of new bone has made it solid in its new location.

The enlargement of the arch can be accomplished with great rapidity and with perfect safety; so rapidly as to preclude the idea that the external walls of process are broken down by absorption to permit it, and the only conclusion is that the vascularity of the alveoli permits an elasticity which allows the teeth to be moved outwardly, carrying the external processes along with them.

This process is not necessarily absorbed at any subsequent period, simply because pressure has been brought against it. It has not been stretched beyond its powers of elasticity, no sequestrum has been formed, and it will remain the same process and continue to perform its functions until deposition of new bone shall have filled up to it and the whole become solid.

Nevertheless there must be a limit to the rapid movement of teeth outwardly, lest destruction of the process ensue.

In the movement of the anterior teeth of the lower jaw it is not probable that absorption plays any more important part, either in expanding or contracting the arch. The processes are so thin upon both external and internal surfaces that they would be likely to yield before they became absorbed, and therefore the principal action would be one of reproduction of bone to make them solid.

The movement of a single incisor or canine of the lower jaw can be made inward or outward with much the same readiness, save only that in an inward movement the tooth is apt to bind on an adjoining tooth, and thus retard it. The resistance of the internal and external alveolar wall is much the same.

It has been maintained by some that teeth can not be moved with safety faster than bone can be absorbed or reproduced, but an extended experience has shown that in the outward movement of the superior arch and in the movement in either direction of the anterior teeth of the lower jaw, the idea is fallacious.

The functions of absorption and reproduction vary, however, very much at different ages and under different systemic conditions, but are most active during the formative period of the tissues, so that operations undertaken in youth with impunity could not be carried out at other periods of life without bringing the vitality of the organs acted upon into jeopardy.

It may be assumed as a rule that as soon after eruption as it becomes certain that an irregular denture is inevitable, there is no longer justification for delay, and that after that period every year increases the difficulties, both mechanical and pathological, and prejudices the stability of the dental apparatus. Consequently, if at the age of eight years one of the superior centrals has locked within the lower teeth, immediate interference is demanded; there can be no good reasons under ordinary circumstances for delay.

Every week strengthens the partially formed root in its unnatural position, and the occlusion of the lower teeth will prevent it by any possibility from ever assuming its true place unaided. It might be argued in favor of a postponement of action that some of the other teeth may develop irregularly at a subsequent period, and the necessity might again arise for aid; but the answer to this is, that there is less liability for the others to come in crowded if the front ones are in line, and again it is impossible to foretell irregularities that may need appliances for correction.

In some of the illustrations given in this work, it will be seen that the author has not hesitated to undertake treatment of very extensive irregularities, even while teeth were emerging from the gums.

It is not uncommon for parents to be unobservant of the irregular condition of their children's teeth until the eruption of the canines which so often appear high up on the gum, and give the appearance of tusks.

If it is clear to the dentist that mechanical interference is inevitable, it is better generally to begin as soon as they have emerged sufficiently to get a bearing upon their surfaces.

The movement of teeth is comparatively easy at this age and for one or two years following, but at seventeen, eighteen, and nineteen, the action is slower, growing more and more difficult, and in cases where a considerable number of teeth are to be moved the results become more and more doubtful with advancing years.

It is less so with one or two teeth, and there need be but little apprehension of the results in such cases up to the period of full maturity, particularly if the antagonizing teeth would favor the change when made.

For example, a lady over forty years of age applied to me for artificial teeth in place of the two central incisors and the left lateral of the upper jaw. The right lateral was remaining, in good condition and position, but the right canine was very far within the arch and articulating inside of the lower teeth—in fact, with a decided inclination toward the roof of the mouth. As she was now compelled to resort to artificial teeth, it was her desire that this life-long deformity of the malposition of the canine should be corrected by extraction, and its place supplied by an artificial crown. As the tooth was a thoroughly sound one and the mouth in a healthy condition, I proposed the experiment of bringing it out into line; and, if sacrificed in the attempt, neither the comfort nor the appearance of the patient would be jeopardized. A plate of vulcanite was made, to which were attached the required artificial teeth. This plate accomplished the double purpose of a support for the artificial teeth, and a regulating plate, by the attachment of a jack-screw, with the conical end resting in a little pit on the lingual surface of the misplaced canine. In one week the canine was forced outside of its articulation with the lower teeth and into its true dental line. There was no more soreness than is common in wedging teeth for filling. There was no more elongation, and no subsequent loss of vitality. A new plate of gold was made, which served as a retaining plate and for the support of the artificial teeth. The canine tooth became in time perfectly firm, and five years afterward showed no evidence of change.

It may be regarded as a settled fact that there is hardly any limit to the age when the movement of teeth might not succeed. Such success must depend on favoring circumstances. It is a common occurrence at all ages, but particularly with people of advanced age, to see teeth changing and assuming new positions, as the result of the loss of adjoining or occluding teeth, or by the attachment of artificial teeth. In any case, movement will go on until the force has spent its power, or until the resistance is equal to the power. The occlusion of the teeth is a most potent factor in determining the stability in a new position. If the occlusion of the teeth will be such as to favor the retention of moved teeth in their new position, then considerable movement may be attempted at almost any age at which it might be desired, and with an expectation of success; but if, on the other hand, the occlusion would be bad, with a tendency to drive them to their former position, then all efforts at regulating would be folly at any age.

Teeth could only be retained in a changed position, under such circumstances, by constantly wearing fixtures which would jeopardize their durability and permanency. The wearing of retaining plates, as well as all other fixtures, upon the teeth is undesirable in itself and objectionable; they are an evil, necessary in some cases, but to be avoided as much as possible. Nevertheless, the fruits of a skillful and successful effort in regulating teeth must not be lost by neglecting to retain them in place until they not only become firm, but the tendency to return to their former position has been seemingly overcome.

The length of time which it is necessary to wear such fixtures must vary with each case, to be governed by the judgment of the operator, bearing in mind a few general principles.

The number of teeth moved, the distance, the occlusion, the age of the patient, and the cause of the malposition, whether hereditary or otherwise, are all factors in forming an opinion. For example, if it be a central incisor shutting inside of the lower arch which is brought outside in a patient eight to ten years of age, a few days even may be all that is necessary to wear anything to retain it, even if the occlusion of the lower teeth be not all-sufficient, which it would be in most cases. The same case in a much older person might require a retaining fixture for some weeks. The younger the patient and the fewer the teeth moved, the shorter time will fixtures be required. The older the patient and the larger the number of teeth to be moved, the longer time must they be held by some means external to themselves;

and, in cases of hereditary irregularities, including nearly all the teeth, where the correction has not been undertaken very early, it will be safer to hold them for a long period, even to two or three years. *In hereditary cases of extensive character, which have been delayed until at or near maturity, we can never feel certain but that the original tendency to malposition, so long unbroken, will reassert itself at any time that we abandon retaining fixtures.*

Different opinions are held as to the kind of pressure most in accordance with physiological action; some maintaining that the pressure must be constant and uninterrupted, while others claim that interrupted pressure will produce the most beneficent result. I doubt if either can be shown to be the best in all cases. The resilience of elastic rubber represents the usual means of obtaining constant pressure, while the movement of a jack-screw describes the interrupted. Irritation and inflammation will sometimes follow from very slight pressure, and again will not follow where very high pressure is used. It would be difficult to make a test of the different methods with any accuracy, as the coincident but unknown factors might not be the same. A moderate degree of soreness for a short time after the first application of pressure is to be expected, but is likely to pass away within a day or two without injurious results, if the pressure be constant and not too great. When circulation on the side of resistance is stopped by pressure, the pain ceases.

A recent writer has claimed that there is an exact limit to the distance to which teeth can be moved in a given time without injurious action, and places it at $\frac{1}{240}$ to $\frac{1}{160}$ of an inch in every twelve hours. It is hardly necessary to show the absurdity of placing physiological or pathological action under a mathematical law, no matter how broad.

So far as pressure itself is concerned, it is immaterial whence it is derived. The same weight, force, or power will produce the same result. It is only a matter of convenience what source shall be employed. The only difference of opinion can be upon the point as to whether constant or interrupted pressure is preferable.

The care of a patient wearing regulating fixtures must be based on general principles, and adapted in some degree to the peculiarities of the patient. With the same kind of a fixture, other things being apparently equal, one will require much more personal attention than others. Some are quite capable of managing an apparatus entirely themselves, reporting only occasionally to the dentist, while others may need the almost daily attention of the dentist, especially in the beginning. No rules can, therefore, be given applicable to all. In a general way it may be stated that for the first few days the patient should be seen daily, and after that the intervals may be gradually lengthened to a week or more.

In complicated cases there often comes a critical period after the teeth have become loosened under pressure and considerable distance yet to be attained, when, if they are not watched with exceeding care, some tooth or teeth may be sacrificed to the movement. Under such circumstances it is not safe to allow any prolonged absence on the part of the patient. He should be instructed, in the event of any marked change in the movement, either laterally or of elongation, to report immediately. If there is an undue movement, the pressure must be relaxed, and only sufficient strain put on to keep the ground gained.

As a rule, it is objectionable to take away all force from moving teeth until the completion of the movement. Inflammation that might be a necessary concomitant to the movement, and not such as to be prejudicial to the teeth or surrounding tissues, would be likely to be considerably increased by a complete relaxation of force.

So far as is possible, such apparatus should be made as can be readily removed, and thorough cleanliness insisted upon. Inflammation to the extent of ulceration will quickly ensue from an ill-adapted appliance, or from a properly adapted one if not kept clean. The accumulation and retention of foreign matter under such circumstances is one of the most potent agents for evil. Antiseptic and astringent washes may be applied as occasion demands.

But by far the greatest evil is to be apprehended from badly-fitting apparatus. The importance of more care and more skill than are usually exhibited can not be too strongly insisted upon.

Wherever it is proper that a regulating plate should touch a tooth, it should be made to fit the neck of the tooth accurately; otherwise, in a short time will be developed a spongy growth of the gum which would not have taken place if the apparatus had been properly adjusted. Whenever irritation of the gums is discovered arising from this cause, the remedy, which lies principally and many times wholly in the removal of the cause, should be immediate, even if it should involve remaking the apparatus.

CHAPTER V.

FORCES.

The treatment of irregularities of the teeth is almost entirely mechanical, but is lifted above the plane of ordinary mechanics because it has to do with vital organs, and thus becomes an important branch of mechanical surgery.

To the anatomical, physiological, and pathological knowledge required of the operator, there must be added a knowledge of mechanics and a clearness of perception and ingenuity to apply it. Precisely the same ability is required as would be demanded of a mechanical engineer in the construction of a machine for a given purpose. He is to apply, directly, one of the mechanical powers, or to invent a combination of those powers, as shall best answer the purpose. Levers, pulleys, inclined planes, wedges, and screws are all at his command; and it is quite as impossible to describe an apparatus, such as would be applicable to every case, as it would be to anticipate the future and describe every invention that the fertile mind of man may make for his comfort or convenience. It is impossible for one to overcome a complicated case of irregularity who has not a comprehension of each and all the above-named powers, singly and in combination with each other.

As an illustration: There came to me a dentist, with his patient, for consultation. The fixture was very nicely made, and had been in the mouth for some days, but with no observable change. As I had previously suggested the kind of appliance to be used, the question very properly followed, why it did not work. It needed but a single glance to see that its force was working against itself, and this fact was unrecognized by the operator. All that was required was to change the bearings of the ligature, using the same appliance, and within forty-eight hours there was a perceptible movement of the teeth.

Every case of complicated irregularity requires a variation in the application of forces necessary to produce the result. No complex case that I have ever seen could be corrected by following the exact steps of any preceding case, which might have been, to all appearances, precisely like it. Consequently no plan of treatment, however detailed in description or profuse in illustration, can be of much benefit to the reader who has not a knowledge of mechanical powers and a ready ability to apply them, or to combine and apply such as are best adapted to the end.

Regulating appliances call into requisition the power to be derived from screws, wedges, levers, inclined planes, and elasticity.

SCREWS.

The screw is one of the most valuable adjuncts at our command in regulating teeth. On its first introduction it seemed a cumbersome apparatus, taking up valuable room in the mouth, interfering with mastication and articulation, irregular in its movements, requiring constant attention, and liable to injure the teeth by impinging and wearing upon them. It was a common idea that the pressure on the teeth, for their safety, must be moderate, uniform, and uninterrupted, and the action of a screw could be neither uniform nor uninterrupted. But experience has demonstrated its safety and its wonderful adaptability. By it a narrow arch of the most refractory character can be made to yield, and with it almost every movement we desire can be accomplished. It is not recommended for universal use, but, if we were deprived of every other mechanical power, we could do nearly all things in regulating by the aid of a screw. The jack-screw of the present day is a delicate and strong instrument of steel, with provision made to prevent oxidation. This contrivance was first used in dentistry by Dr. William H. Dwinelle, to whose ingenuity, skill, and various attainments, during a period of forty years, the profession is largely indebted for its rapid advancement. His discovery of a simple means to avoid oxidation rendered a screw of steel admissible, and thus overcame the instability of screws which theretofore he had made of gold. The form used by Dr. Dwinelle is shown in Fig. 16 and again in Fig. 20. The application of jack-screws in the author's practice is illustrated in the following cuts.

FIG. 16.

It is seldom desirable to use the screw alone; metallic bearings upon and in contact with the teeth are generally objectionable. An excellent plan is, to make a plate reaching across the mouth and bearing against the offending teeth. The jack-screw is placed in a straight line across from or near the extremes of the plate, the plate being made light enough in the center or slit up a certain distance to allow it to straighten under pressure. By this method the pressure can be distributed among all the teeth on one side, and concentrated upon one tooth upon the other side if desired. Such an arrangement is shown in Fig. 16. Before jack-screws were made by the instrument-makers and placed on sale, those which I required were made in my own laboratory, and especially adapted to the case under treatment, and even now the plan then followed would be found advantageous.

Fig. 17 shows the employment of two screws upon the upper jaw. The plate was of vulcanite, and the screws have no other nut than the plate itself. The plate was vulcanized

FIG. 17.

around the screws, thus making the thread very perfect. This plate was used to drive out a very stubborn canine, and also to twist a central incisor.

FIG. 18.

Fig. 18 shows another combination of plate and screw, and adapted to the lower jaw. In this case a piece of gold was inserted to form the nut of the screw, as shown in the engraving. This apparatus was used to force out two bicuspids, the first of which was considerably within the line, and the second one less so. Its action can readily be comprehended from the cut. The force of the screw here is distributed to all the teeth on one side, and concentrated on the bicuspids on the other. Fig. 19 is an illustration of the same principle applied to both sides of the lower jaw, and was used in a case where the inferior dental arch was narrowed and the canines pushed outside the line. Elastic

FIG. 19.

straps were attached to the extremities of the plate, as seen in the engraving, and drawn forward over the canines, which came into line as soon as the arch was widened. The spreading of the lower jaw is ordinarily much more difficult than of the upper, and such appliances as Figs. 18 and 19 possess peculiar advantages in utilizing the extraordinary power of the screw, when the presence of the tongue would make a screw bearing directly on the teeth inadmissible.

The jack-screws which have been placed on the market are very neat and effective instruments. There are three kinds represented in the following cuts—Figs. 20, 21, and 22. That shown in Fig. 20 was first introduced, and is

FIG. 20.

the kind which I have always used in conjunction with plates. That represented in Fig. 21 shows a crutch at each end, and the screws turning in opposite directions. This plan would, undoubtedly, be advantageous in the case of two teeth directly opposite each other, both of which required moving the same distance and offered the same resistance—conditions which are rarely found. While this pattern will evidently fulfill all the requirements of the former, I have

FIG. 21.

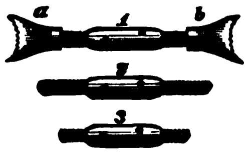


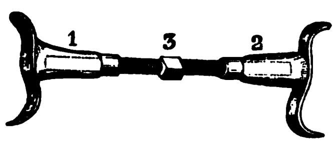
FIG. 22.

never used it in the special cases for which it seems to have been invented.

I never use jack-screws except in conjunction with a plate, for two reasons: First, I never find occasion to move equally the teeth upon which such a screw would rest; and, secondly, a vulcanite plate gives not only the facility of distributing and concentrating pressure at will, but the bearing of the vulcanite on the teeth is less injurious than the metal.

The screw in Fig. 22 is a later invention, and is substantially a combination of both the other forms, being an intended improvement upon the first pattern by adding a revolving crutch to the end of the screw.

FIG. 23.



In 1860 Dr. E. H. Angell, of San Francisco, communicated to the "Medical Press" his method of treating certain cases of irregularity. For widening the dental arch he employed a screw such as is represented in Fig. 23. The collars at the extremities were made of gold and lined with pure gold, so as not to be injurious to the enamel of the teeth. The portions marked 1 and 2 in the diagram are made of tubes with a screw-thread cut upon the inside; 3 represents the shaft of sixteen-carat gold, No. 13 Stubbs's gauge, made square at the middle to be readily turned with a wrench,

FIG. 24.

and the screw-threads upon the shaft turn in opposite directions. The wrench was made by cutting a slot in a silver dime, as shown in the next illustration. For moving teeth along the line of the arch he used a variation of the screw, as shown in Fig. 24. The application of this apparatus is shown in a report of one of his cases, to be found on p. 200.

This method of using screws is substantially the same as that which has latterly appeared in several numbers of the

FIG. 25.

"Dental Cosmos," under the ostentatious title of "Regulation made easy."

Fig. 25 shows another form of the application of screws to regulating, which was introduced by Dr. Farrar. These seem better adapted to the rotation of single teeth than anything else, and for that purpose will probably be found as useful as any other means.

WEDGES.

Wedges are also an important source of power. They are not new to the dentist, and have proved of great benefit to him in various ways; but it is doubtful if their value in treating irregularities has ever been realized, although they have often been resorted to, and results claimed for them which were mechanical impossibilities.

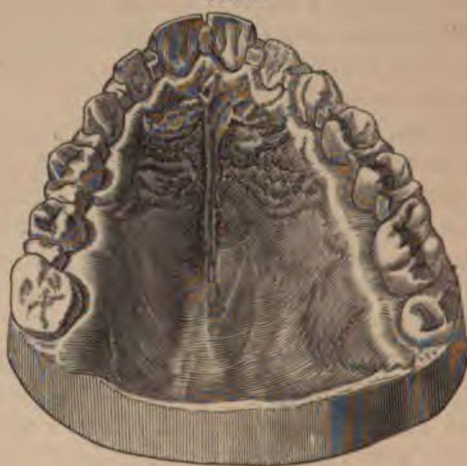
For instance, a dentist living in a distant city had a patient under treatment, where the six front teeth of the upper jaw shut within the lower teeth. He fitted accurately a rubber plate all over the roof of the mouth, covering the grinding surfaces of all the teeth behind the canines, and lying close against the inclined lingual surfaces of the offending six teeth. Against each of the front teeth he made a slot in the rubber plate, into which was inserted a wedge—the wedge of course impinging on the teeth, with the expectation of driving them forward. These wedges were changed daily and thicker ones inserted. This treatment was carried on for several weeks, when the patient, being obliged to visit New York, was referred to me. I found between the incisors and the plate behind considerable space, which, the young lady stated, represented the distance which the teeth had moved. Believing that it was an impossibility for teeth to move with just such an appliance, I removed all the wedges, and replacing the plate, found that the teeth had not moved a hair's breadth, but fell into the depressions of the plate as nicely as when it was first made.

In this case there was no recognition of the power of the inclined plane to oppose and overcome all that was expected of such a fixture. In similar cases, and by the proper adjustment of wedges, they can be made to do more in the same length of time than all screws, pulleys, levers, or inclined planes combined.

Such an application of wedges is illustrated in Fig. 26. The full report of the case will be found on page 127.

The principle is identical with the function of the keystone of an arch. Drive in the keystone or a wedge between each of the separate stones, and the arch is necessarily en-

Fig. 26.



larged, and will continue to be enlarged so long as a wider keystone is admissible, and there is a support which prevents the whole arch from tumbling in ruin to the center.

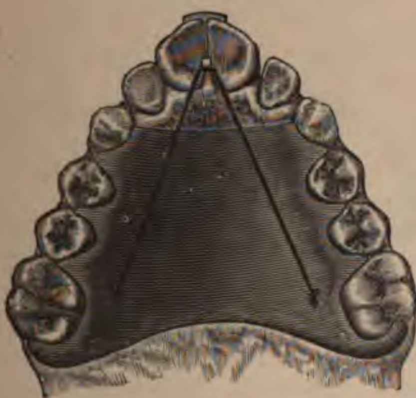
ELASTICS.

There is no mechanical force used in regulating teeth of such wide application as that derived from elasticity—that inherent property possessed by certain bodies of returning to their former shape when bent or strained.

The jack-screw can be regarded as first in importance only because it possesses greater power; but its application is limited. The force of elasticity is readily obtained and applied, and has been in use by mankind from the earliest dawn of the arts. This power has rendered effective alike the simplest and the most complex machinery. The bow of primitive warfare and the chronometer of civilization are equally dependent upon elasticity for their results; and, whether derived from the springing of metal or the resilience of rubber, it forms the most convenient and valuable aid in regulating teeth which is at our command.

Elastic ligatures cut from small rubber tubing can be applied in a multitude of cases. The dental arch may be widened or contracted, the teeth elongated, shortened, or made to rotate in their sockets, by their judicious use. It is but necessary to obtain a fixed point for the attachment of the ligature, and, with the other end stretched over the

FIG. 27.



offending tooth, the result is but a question of time. By a little ingenuity, a single ligature may be made to move several teeth into line, when they stand alternately, one without and one within the arch, and even to twist one or more in the sockets at the same time. One of the most useful applications of the ligature is in contracting the arch, as in cases where the incisors are too prominent. In some cases it may be only necessary to place a cap over the incisors, and stretch the ligature from the cap and secure it to the extreme back teeth. In most cases, however, it will prove less a cause of irritation to the gums along where it passes to adapt a plate over the roof of the mouth, extending behind the molars, and secure the posterior ends of the ligature to the plate rather than to the teeth.

An admirable illustration of what can be done in this way is shown by Fig. 27. All the teeth in this case were brought into a symmetrical curve, the front teeth being carried back and the sides expanded by this fixture alone, in the short space of seven weeks. A variation of such an appliance, but involving the same principle, is shown

Fig. 28.

in Fig. 28. The band across the face of the incisors was kept from slipping against the gums by hooks over the cutting edges of the teeth. The horseshoe-shaped slot in the plate shows a ready means of attaching the elastic, or it may be tied with thread, as indicated in the engraving.

To enlarge the arch to any extent by the use of elastic ligatures involves a point of attachment external to the arch; and, as this can only be done by a fixture under the lip or cheek, it is not so desirable a method as the use of a jack-screw or wedges. Elastic ligatures are invaluable, however, in conjunction with a retaining plate, to gently hold the teeth in their newly acquired positions.

The following engravings will illustrate some of the applications of elasticity.

Fig. 29 shows a combination of vulcanite and gold wire for bringing into line certain irregular teeth upon the lower jaw.

It was a former practice, in a case like this, to use the wire band independent of the plate, the ends being tied with silk or twine ligatures to the molar or bicuspid teeth; but experience showed that the ligatures were apt to irritate the gums, besides giving much trouble whenever the fixture was removed for cleansing, by the difficulty of re-tying; consequently the wire was carried over the teeth, selecting such a gap when the jaws were closed as was most favorable,

FIG. 29.

and the ends of the wire anchored in vulcanite. In this way perfect facility in removing and replacing was obtained.

Another advantage derived from fixing the wire in a vulcanite frame is the steadiness with which the wire is kept in relation to the teeth.

In drawing teeth toward a wire, rubber elastics exert a constant tendency to force the wire into some position where the elastics will not remain on the teeth, particularly the incisors and canines. There is often apparently but one position in which the wire can be made to act as the anchorage for the elastics, and this position can not always be obtained where the wire is only sustained by tying the ends to adjacent teeth. It will therefore be found to be far less trouble in the end, to both operator and patient, to have the wire secured to a vulcanite frame, carefully adjusted to a position which will exert the most efficiency.

Two methods of attachment for the elastics are indicated in the engraving: with those on the right a single band of the rubber passes over the tooth; those on the left show rings cut from this same size tubing, but being doubled, and both ends of the loop being carried over the tooth, the power is much increased.

Fig. 30 shows another method of attachment for elastic rings. This fixture was used in a case where the canine

Fig. 30.

teeth on the lower jaw stood outside the line, and the arch behind was somewhat narrowed. Both the first permanent molars had been removed because of decay, and the appliance here represented drew the canines into position and widened the arch. Hooks of gold wire were inserted in the vulcanite to attach the elastic bands more readily, and waxed silk or linen twine drew the bands forward and inside of the bicuspids, and tied them to the canines; thus the resilience of the rubber, from being attached to the plate in the position here indicated, was made to perform contrary movements of the teeth.

Fig. 31 illustrates other forms of attachment, as also a moderate degree of elasticity to be obtained from the shrinkage of linen fiber when wet.

It is frequently the case that the rapidity of movement obtained from rubber endangers the vitality of the tooth. More harm would be likely to follow the abandonment of pressure than its continuance, but it is wiser to reduce the strain to the minimum until tone has returned to the tissues. In such cases a piece of linen twine in place of the rubber,

Fig. 31.

tied tightly, will retain all the advancement and add somewhat gently to it. In fact, in the earlier days of treating irregularities, and before the introduction of rubber, this kind of ligature was much depended upon.

Fig. 32 shows other attachments of elastic under peculiar circumstances. This fixture was made to correct a bad arrangement of the four inferior incisors, and prior to the shedding of either the molars or the canines. The regulating of the incisors necessitated attachments of a firmer character than could be obtained from the loosening temporary teeth, besides the danger of removing the canines prematurely if strain was applied to them. Consequently the apparatus was made with wire, passing over the arch between the canines and temporary molars, terminating in hooks, as seen in the illustration, marked A A. The elastic ligature could thus have an independent attachment outside as well as within the arch, and movements in almost any direction could be obtained.

FIG. 32.

Such fixtures possess the decided advantage of being managed by the patient. Any intelligent child could remove and replace such appliances for cleansing purposes, and avoid unnecessary visits to the dentist.

INCLINED PLANES.

The inclined plane was one of the first mechanical forces adopted for regulating teeth, and was much recommended in the earlier text-books. Its application is probably well known. It consists simply of a plate adapted to the jaw, opposing by a sliding surface the offending teeth. For example: The incisors of the upper jaw may be shutting inside the lower teeth. To correct the deformity, an inclined plane may be made of any of the materials which are used as a base for artificial teeth, accurately adapted to the incisors of the lower jaw, with a process extending upward and backward so that it shall impinge upon the lingual surfaces of the offending superior incisors at every occlusion of the jaws.

Such an appliance is shown in Fig. 33, letter A. The objections to this mode as a sole reliance are many. It will be observed that there can be no movement expected of the misplaced teeth unless there is a forcible occlusion of the jaws, the result being that it almost always defeats its own objects; even when a movement takes place, it is only after a tedious and prolonged wearing of the fixture. The teeth will not be held impinging on the incline except by a constant effort of the will. The length of time required is also a serious objection. The masticating teeth, being held apart for a long time, will be pretty certain to elongate, and the proper articulation of the teeth be destroyed. To avoid this, it has been recommended to build up blocks or gags on the molar teeth which can be used in mastication. These objections, among others, condemn the principle as unreliable for general use, but as an accessory to other fixtures it may often prove a valuable adjunct.

FIG. 33.

In Fig. 33, letters A and B show a combination of an inclined plane with elastic ligatures, which was used to correct an irregularity of both upper and lower incisors, and the same apparatus was used as a retaining plate when the change in position was completed. The case was one where the superior incisors shut within the inferior ones in the mouth of a lad of fourteen. The fault was in both jaws. The lower teeth were too prominent and the upper ones too retreating. Advancing the upper ones until they covered the lower ones would have made the mouth too full, and the reverse would have been the result if the lower ones had been retracted behind the upper ones. Both sets being at fault, both were operated upon. The fixture was made to be worn on the lower teeth, and it will be observed that the incline seems to stand unnecessarily forward of the receptacle for the lower teeth. When first adjusted, the lower incisors were flush with the front edge of the incline, and the upper incisors caught on the upper front surface. The fixture was cut away freely behind the lower incisors, to permit of the inward movement, and a narrow gold band was carried across the front as seen in the engraving, letter B. Elastic straps were drawn between the teeth connecting the two, and the lower teeth were drawn back simultaneously with the advancing movement of the upper ones.

Fig. 34.

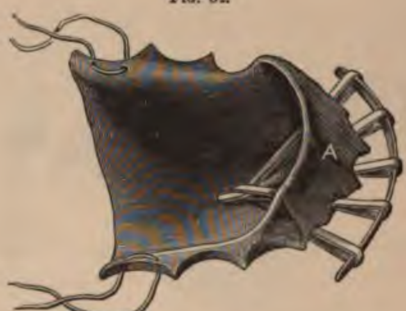


Fig. 34 shows another application of an inclined plane somewhat out of the ordinary course.

It was adapted to the inside of the superior dental arch, and the inclined surface marked A projected below and caught the inferior incisors.

The object was, not to protrude the lower teeth, but to change or jump the bite in the case of an excessively retreating lower jaw.

In the engraving the appliance is shown bottom up, to exhibit more clearly the attachment of some elastic ligatures which were caught on a hook in the roof of the plate, and were drawn out through corresponding openings, and connected with a gold bar worn across the front of the superior incisors to reduce their prominence.

The fixture was worn constantly, and in a few months produced the desired result. The objection urged against the use of an incline, because the time required had a tendency to alter the articulation of the teeth, was in this case an argument in its favor, and an advantage, because a new articulation was desired, and the incline, as adapted, offered no opposition to the antagonism of the teeth.

The principle of the inclined plane is always operating in the mouth, and may often be taken advantage of beneficially, while at other times it will tax our ingenuity to the utmost to overcome its powerful influence. In the case of the superior incisors shutting within the lower, after they have been brought forward so as to barely catch over the lower ones, then the principle of the inclined plane becomes available in completing the operation.

The points of the lower teeth, catching within the upper ones, strike their natural inclined surfaces, and nature may be relied upon for the rest.

In moving the bicuspid teeth of the upper jaw, either outward or backward, all that is accomplished by fixtures may be entirely overcome by the articulation of the lower teeth forming an inclined plane, and thus acting upon the upper ones to return them to their former places.

Levers do not come into such universal application as do some other powers; the principal objection being, that the limited space of the mouth does not permit their unrestricted movement.

Levers may be used to advantage in revolving teeth in their sockets; and for this purpose a band around the tooth is necessary, which will not slip, and the lever may be attached to the band. Force may be brought against the long arm of the lever by ligatures connected with convenient teeth. Such an appliance will pretty surely accomplish the result, but it can generally be obtained with a less cumbrous fixture.

Levers may often be advantageously used on the outside of the arch, to press gently against some offending tooth, and thus drive it into its desired position.

Such an apparatus is shown in Fig. 35. The lever, marked D, was made of moderately stiff gold wire, anchored in a vulcanite plate in a case where the first permanent molars had been extracted. The lever in this instance was required quite as much to get an attachment for elastic ligatures as to press in the outstanding canine. If the canine had been the only tooth out of place, it could readily have been brought in with a strap attached to the vulcanite; but several of the incisors needed moving and twisting. By getting an attachment at the end of the lever, a variety of work could be

FIG. 35.

accomplished, according to the connection with the vulcanite. For example: If the elastic were brought between the two centrals and tied at A, the action would tend to move out one tooth and depress the other. If the point of attachment were changed to B, the influence would be changed; and so again if transferred to C.

In like manner, if carried between the lateral and central or lateral and canine, there would be a difference in the force exerted according to the point of attachment.

Fig. 36 illustrates a method of reducing one or more teeth to a regular line by means of a wire or bow going around the outside, and acting partly as a lever and partly by the force of elasticity. The engraving sufficiently explains the action. The plate is of vulcanite, and an elastic loop acts to contract the circle by drawing the ends of the wire together. Such an appliance would act only on the teeth, but in the following illustration, Fig. 37, a similar

FIG. 36.

principle is used in a case of maxillary fissure connected with a fissure of the palate.

There was a wide gap between the lateral incisor and the

FIG. 37.

canine tooth, and the opening extended through the alveolar arch and into the nasal passage.

It was desired to bring the maxillæ into contact, and a fixture like the last would only act upon the teeth, tending to give them a wrong inclination. This fixture was made to embrace the gum as well as the teeth with the wire running through the length of the vulcanite to give both stability, and the terminal hooks were drawn toward each other when *in situ*, with silver wire wound around and twisted with a pair of pliers. In the process of twisting, the gap was seen to perceptibly close and ultimately came together and united.

The application of these principles to the movement of teeth is one of the most responsible duties the dentist is called upon to perform.

Each and every one of these mechanical powers can be made to do our bidding; and, equally, each one of them may become a formidable engine of disaster.

When applied in the mouth they should have constant watchfulness and care. Not one of them but in the hands of empirics would cause the destruction of those valuable organs they can be made to conserve.

To any one who has become deeply interested by experience with these cases, there is a fascination about them which will lead him to new experiments in the treatment of almost every case.

In fact, success depends quite as much on ready invention of means to meet any emergency as upon the exercise of any knowledge, or the use of any appliances already proved.

CHAPTER VI.

IMPRESSIONS AND MODELS.

IN all complicated cases of irregularity, impressions and models are a preliminary necessity in making suitable appliances for correction; and in a majority of cases correct models of both upper and lower jaws, properly articulated, are a valuable aid in making a diagnosis of the case. The positions of the teeth, within or without the line, their inclination, rotation, and articulation, can be much more closely studied from models than in the mouth. Often it will be seen that an opinion formed upon the observation of the living structures may be an erroneous one when the models are closely studied.

The probable effect of the change of position in the side teeth can not always be prognosticated by looking at them in the mouth; but by observing accurately how they articulate in a model, and carefully noting the inclination of the occluding surfaces and the tendency of the same surfaces if the proposed change were made, a much better opinion can be formed of the propriety of movement. Nothing is more injudicious than the moving of teeth into a position which can not be maintained by the articulation of the opposing jaw; and nothing is more powerful in carrying moved teeth back to their former state than the continued action of inclined surfaces in ordinary mastication, favoring such return.

A proper knowledge of the case requires models and impressions, and such models are better taken in plaster of Paris than in any other known substance. While the merits of plaster are generally conceded, there is also a feeling that it is especially or only adapted to mouths denuded of teeth, and that its use where teeth are scattered or straggled is inapplicable. Experience proves the reverse of this to be the fact. Plastic substances, such as wax, gutta-percha, etc., are only adapted to simple surfaces; and in no case where there are intricate, devious, or tortuous details can they be relied upon. Their very nature—namely, their plasticity—is what condemns them; and the opposite characteristics of plaster—namely, hard, rigid, unyielding, brittle—are those which make it peculiarly applicable for impressions in all difficult cases. That it will adapt itself accurately to all the details of form and irregularity, and will break with a clean, sharp, well-defined fracture on removal, are the peculiar qualities which stamp its superiority.

Therefore it is that the most difficult cases are those which require plaster, and in the more simple ones there is nothing as a rule to make plastic substances a necessity.

An objection has been made to plaster on account of the difficulties attending its use; but, with an experience far less than is required to become proficient in most skillful manipulations, it will be found the most simple and accommodating of substances. This false notion has led to innumerable inventions of steps preliminary to the use of the plaster. A variety of cups or trays have been constructed especially designed for plaster, but the proper use of the material does not justify any such especial inventions. The common form of tray made of britannia, which can be changed in shape somewhat by bending, equally applicable for wax, is the most simple as well as the best that has been introduced for taking impressions of all cases except those of most extraordinary oral deformities. Neither is the preliminary operation of taking an impression in wax, cutting out a portion of the wax and supplementing with plaster, or any other preliminary device, at all necessary. A simple cup of an approximate form, and only large enough to inclose the parts from which an impression is required, is all that is necessary. To put the plaster in such a tray, carry it steadily to its place, and remove it at the proper moment, constitutes the whole proceeding.

But while the process is a very direct and a very simple one, success will come only from a careful attention to the details. The plaster must be fine and strong, and set with moderate rapidity. The so-called "dentists' plaster" in the market has not proved in the author's experience to possess any advantages. The quality known among the manufacturers as "superfine" is far preferable. When in proper condition—that is, where it has not become deteriorated by long exposure to a damp atmosphere—it possesses all the desirable qualities for impressions, models, and general use. For ordinary use it sets with all the rapidity that proper manipulation will permit, while this property can be much accelerated by the addition of a little salt.

The details of taking an impression of a case of irregularity can be best met in substantially the following manner:

Select a cup which shall just inclose all the teeth required to be shown, and bend it to the general conformation of the dental arch. If it is an old cup which has been often used, it is preferable, as the roughened surface facilitates adherence of the plaster; if a new one, the inner surface should be made quite rough, so that the cup will not be liable to come away, leaving the plaster in the mouth.

A common stoneware coffee-cup is the most suitable vessel for mixing the plaster in, and a small table-knife the most suitable instrument. Fill the cup about one third full of tepid water (tepid water, only because it is pleasanter to the mouth; not hot water, because that affects the time of setting), and throw in a pinch of salt, the quantity necessary being determined by a little experience in working that particular quality of plaster. Shake into the water all the plaster that will readily sink under the surface, stir the mass until it is observed that it is becoming stiffer, and place it in the tray as soon as it is stiff enough not to run out. Avoid placing too much in the tray. Pile it up more particularly in the center for an upper jaw; the sides will take care of themselves. Carry it gently and steadily to its place, holding it firmly, with the left hand passed around the head and the fingers supporting and sustaining the tray, while the right hand is left free to note the process of crystallization going on in the cup. Stir up the remaining plaster in the cup into an irregular form, and test the solidity of the mass by trying those forms. Keep the plaster in the mouth until that remaining in the cup will fracture under trial. If under pressure the form mashes, delay; but the moment it will fracture, remove the impression from the mouth. If the case be an intricate one, it will be found broken into many fragments, and the remains sticking to the teeth in various places. These fragments can now be removed at leisure.

In the restoration of the impression from these pieces there will be found no more difficulty than in putting together a dissected map of a continent. By no possible contingency is it likely that a fragment can be misplaced. These pieces can be retained in place by a little melted wax, rosin, shellac, or any other convenient substance, dropped upon the outside of the fracture, avoiding anything upon the surface to be represented in the model, as its perfection of form would be thereby destroyed.

Much of the success in taking a difficult impression depends upon the *morale* existing between the patient and operator. It is not desirable that the patient be impressed with any idea of the importance of the proceeding, nor that any coöperation on his part other than submission be required. On the part of the operator there should be that quiet demeanor, that freedom from nervousness and excitability, which inspires confidence in the patient and betokens a mastery of the manipulations. Much of the failure in operations of this kind has resulted from a magnified fear of the patient that a formidable operation was to be undertaken, attended with choking and much other suffering, and requiring all his self-control. To dissipate such alarm by quiet words and demeanor is the first step to success. If the patient manifests any symptom of gagging or choking, let the head be pitched well forward, and the request made to breathe through the nose, when all unpleasant symptoms will be likely to pass.

In taking an impression of the lower teeth, the same principles are to be followed. The plaster when ready for introduction to the mouth will be found stiff enough to remain in the tray while it is carried to the mouth and deftly turned bottom upward and inserted. In other respects the procedure will be the same as for the upper jaw.

As illustrating the capabilities of plaster for impressions of somewhat inaccessible places, the following occurred in my practice some years ago: A distinguished surgeon of this city was treating a patient where the posterior border of the soft palate had united with the wall of the pharynx, closing entirely the passage to the nares, and precluding all respiration through the nose. He had dissected off the palate, but found great difficulty in keeping it away so as to prevent reunion. In this emergency he conceived the idea of an elastic rubber chimney adapted to the posterior nares, and which could be drawn in by being compressed and passing through the new-made opening behind the palate. The expansion, it was calculated, would hold off the palate, while the opening through would permit a free passage of air. I was applied to, and immediately saw the necessity of acquiring some knowledge of the exact form of the cavity above the opening. The passage had contracted to the size of the little finger, while the cavity above must be much larger. An impression of that cavity was obtained in the following manner: a stout piece of twine was passed with a bougie through one of the nostrils, and carried back until it appeared below the palate; it was then seized and brought out of the mouth, and the ends were tied. We then had a revolving band to which was secured a small piece of compressed sponge, as large as would pass the opening. This compressed sponge was then dipped in a thin mixture of plaster, and the cord drawn out of the nostrils until the sponge passed into the posterior nares. It was left there until the plaster had hardened, when by a reverse action of the cord it was withdrawn, the elasticity of the velum permitting it to come away. In this manner a most accurate impression of the posterior nares followed the expansion of the compressed sponge and the fixedness of the setting plaster. From this, of course, an accurate model of the parts was obtainable. As a further illustration of the adaptabilities of plaster for impressions the reader is referred to the details of a case described on pages 322 and 333.

To obtain the finest casting from a plaster impression requires always that the impression should be soaked full of water, thus driving out all air and preventing all porosity of surface in the cast. A lather of soap spread over the surface of the impression and then well washed off, is the best and only treatment the impression requires to give the finest cast. When the plaster is introduced, the first should be in a small quantity and gently insinuated into all the intricacies; otherwise a globule of air may be covered in the cusp of a tooth and result in a defect. To facilitate the separation of the cast from the impression, it is desirable that the two masses be of different colors. The merest trifle of some pigment thrown into the cup when the plaster is mixing for either is sufficient to make a contrast, the other being white. One of the most convenient pigments for this purpose, as well as one which gives pleasing color, is Venetian red or Spanish brown; and, being of little commercial value, its cost is of no consequence.

In the treatment of any considerable case of irregularity even when confined to the upper jaw, it is preferable to obtain impressions of both jaws, and make a study of the case from articulated models. Thus only can it be decided which of the mechanical powers or what combination of them will be most likely to produce the result. From a study of the models, in conjunction with observations of the physiognomy, a more definite conclusion can be arrived at as to the wisdom of extracting any teeth. In doubtful cases I have sometimes cut off the teeth from the plaster model, dispensing with one or more, and, rearranging the remainder, have thus formed a better idea of the probable result of extraction and a movement of the natural teeth.

In some instances this has been the only method by which I could determine with any degree of certainty what would be the result of my interference. I would therefore recommend, especially to young practitioners, that this plan be pursued in all cases of doubt.

This course is particularly applicable to such cases as are described on pages 154 and 156. In certain instances in my own practice it has been with much gratification that I have seen the natural teeth assume, under treatment, the exact position of which the altered plaster model was a type.

CHAPTER VII.

IRREGULARITIES.—CASES FROM PRACTICE.

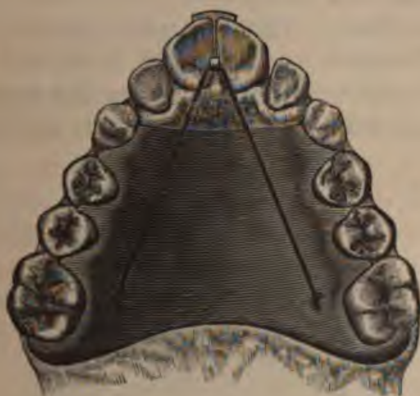
THE case here illustrated is that of a miss twelve years of age. The second permanent molars had not erupted. The canines had erupted, but had not attained their full growth. The patient's stature was equal to the average of her age, and there was no want of symmetry to indicate a tardy or defective development of the maxillæ. The superior central inci-

FIG. 38.

sors were a full half inch in advance of the inferiors at the mesial line. Fig. 38 shows this relation.

The treatment consisted of a plate of vulcanite adapted to the roof of the mouth, as seen in Fig. 39. A hook of gold was inserted in the plate against each molar, and a little T-shaped catch was made of gold to pass between the centrals. Before introducing the plate, a rubber ring cut from tubing was secured to one of the hooks at the back of the plate, passed through a loop made in the stem of the T, and caught upon the hook on the opposite side. The plate was then adjusted to the roof of the mouth, and the T brought forward; its stem, being quite thin, was passed between the centrals,

FIG. 39.

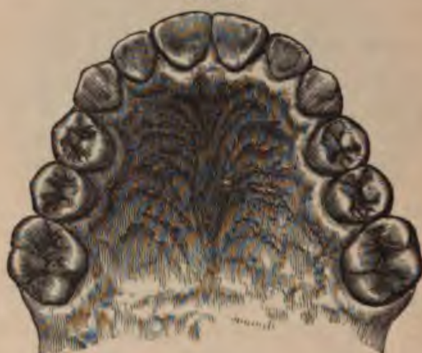


and the cross-bar caught on their labial surfaces, as shown in Fig. 39. This was the only treatment the case received, and in seven weeks the result was as is shown in Fig. 40. The incisor teeth were brought back in contact with those of the inferior jaw, and the contrast in the form of the dental arch is strikingly shown on comparison of Figs. 39 and 40. At the end of the period above stated, a simple retaining plate was introduced, resting against the palatal surfaces of the incisors, which were held in firm contact with it by a slight rubber ligature. This retaining plate was worn a number of months, after which it was abandoned, and the teeth remained stationary in their newly acquired position.

A natural inquiry follows as to what became of the lower teeth during this process. The answer is, that the bicuspids and molars both articulated well with their antagonists before the treatment, and this articulation was not interfered with so rapidly nor so extensively but that the lower teeth ultimately followed into a new position by mere force of occlusion; and, by the time the retaining plate was abandoned, both dental arches had assumed a new and permanent shape.

This case illustrates how great a work can be accomplished by very simple means, and yet this kind of an appliance might not be of any benefit in any other case except one exactly like the above. This case would naturally be termed one of a "V-shaped maxilla"; but it was not a V-shaped maxilla. I doubt very much if the maxillæ were concerned at all in the disturbance. I came to this conclusion before

FIG. 40.



commencing treatment; but, even if I had not, I think the sequel proved that it was a deformity entirely independent of the maxillæ, and confined to the alveolar and dental arches. It was a V-shaped or triangular dental arch—an arch in which the sides from the base to the center were not curved as they should be, but nearly on a straight line. I believe, therefore, that the apices of the roots were in the maxillæ upon their normal curved line; the crowns of the incisors thrown beyond the line, and the side teeth drawn within it. Had it been otherwise, I do not believe that force alone, on the center, like pressure made on the keystone of an arch, would have produced the desired bulging at the sides. An essential element of the treatment, however, was the plate across the roof, which effectually prevented any tendency for the arch to collapse while the pressure was exerted.

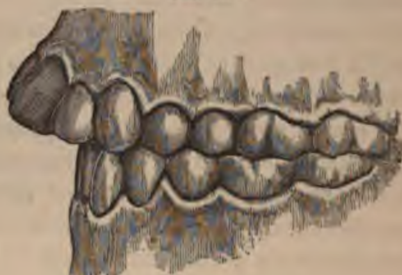
The term "V-shaped maxilla" is very likely to be misapplied, and is an unfortunate term in any case. In those writings where it has attracted the most attention, it does not seem to be a "V"-shaped maxilla which was under discussion, but rather a saddle-shaped palatine arch—one in which the sides of the dental arch presented an appearance of having been pinched together, and in which the triangular form of the V was not applicable to either the dental arch, the palatine arch, or the maxillæ. This criticism is made because the case under discussion would be classed by many under that general term, and its origin most likely referable to the same cause.

As to its cause, I have no knowledge sufficient to prove its hereditary character. I do not believe it to have been the result of "thumb-sucking" nor "fruitless sucking" of any kind. It was not associated with "enlarged tonsils," nor did the patient habitually keep the mouth open for breathing, and thus (as it has been claimed) have the sides of the arch unduly pressed upon.

Mr. Tomes has advanced the latter hypothesis for similar cases, but it does not offer to my mind a sufficient explanation, as I should regard the retracting power of the orbicularis, and all the other muscles merging in it, as equal in their influence over the positions of the teeth to those muscles acting more posteriorly. With a contracting muscular power distributed all around the circumference of the dental arch, I can not see how, as the result of that power, the arch should sink in at its sides and bulge forward.

The following case presents an appearance similar to the one just described, but which, if it had been treated by the same means only, would have ended in failure. The patient was a young lady about seventeen years of age. Fig. 41 shows the profile view of both jaws, with the teeth in contact and the advanced position of the superior incisors, to-

FIG. 41.



gether with the articulation of the bicuspids and molars within those of the lower jaw. Fig. 42 exhibits the pointed character of the dental arch, and the irregularity in the position of the teeth along the line. This twisted, pinched, and

FIG. 42.

tipped-up condition of the incisors, but especially the centrals, gave a peculiar expression to the upper lip, distorting the facial profile, and destroying the symmetry of what was otherwise a more than usually intelligent and comely face.

A comparison of Fig. 42 with Fig. 39 will be necessary to a full understanding of the different treatment demanded. In the former case the line from the proximal edges of the central incisors to the posterior teeth on each side is nearly straight; the variation from a straight line is a slight but regular curve outward. The teeth stand nearly in contact with each other; so nearly, that within a very few days after pressure was applied they all met. The bearing of the teeth upon each other was then practically the same as would be that of the separate stones forming an arch, and any change of shape in the arch, as the result of pressure upon one point, must be in an outward direction.

A reference now to Fig. 42 will disclose the difference. All of the teeth anterior to the molars are so related to each other that pressure on one point would cause the arch to collapse. Even if a plate had bridged the palate and come in contact with the teeth at the sides, so as to prevent a collapse, no force upon the center as they now stand would have carried those teeth outward. A fixture operating like the T on page 97 would not have affected the bicuspids and molars, but would have drawn the middle incisors toward the center in the same twisted condition, and would have moved the laterals and canines irregularly apart. The widening of the arch, therefore, which is of primary importance, must be effected by other means.

The correction of the deformity necessitated three separate stages and three distinct operations, as follows: First, the widening of the arch; second, the twisting of the central incisors; and, third, the reduction of the V to a proper curve.

The widening was produced by a jack-screw, that most effective of all known agencies wherever it is applicable. Its mode of adjustment is very fairly shown in Fig. 42. A plate of vulcanite was made as there represented, so thin and elastic along the center that it would straighten under moderate force, and so stiff where it came in contact with the teeth that it would not yield. The attachment of the jack-screw is made after the vulcanite plate is finished, and is readily accomplished by carefully cutting a little mortise in the plate on one side, and allowing the point of the screw to rest in a pit on the opposite side. Care must be exercised that the mortise be so nicely cut as to prevent that end of the screw from twisting, and also that neither of the holes passes through the plate. The power of the screw may be distributed *ad libitum* to different points, and in a greater or less degree, according to its location in the plate. In the present instance it was desirable to move the molar teeth but slightly, the first bicuspids considerably, and the second bicuspids on a line with the others. The screw was placed against the first bicuspids, or rather against the gum above the bicuspids; the principal object of so placing it was to give as much freedom to the tongue as convenient. It was applied on the 19th of April, and the screw turned until a firm pressure was felt. Slight turns of the screw were made daily or oftener, by the patient herself, for a period of twelve days, when it was found that the first bicuspids on each side had each moved more than half their diameters, and that all the teeth on both sides were articulating outside their corresponding ones of the lower jaw. This increase of width is very well shown in Fig. 43, although the vulcanite plate, as here described, came in contact only with the bicuspids and molars, and the jack-screw operated directly upon those teeth. Nevertheless the six front teeth were affected by the movement, and the canines were wider apart as the result of the treatment. This was owing undoubtedly to the position of the screw being so high upon the plate that the surrounding processes, as well as the teeth, were involved in the movement. During this period the plate and screw were worn night and day, but were removed daily for cleansing. There was very little soreness—none to cause complaint by the patient, and not enough to seriously interfere with mastication.

On the 2d day of May, thirteen days after its adjustment, the teeth at the sides being in the position desired, the screw was removed and the second stage of the treatment was commenced, which was the twisting of the central incisors and disengaging them from the lock and overlap of the laterals. This apparently trifling operation is often one of the most difficult to accomplish. An almost infinite variety of methods have been resorted to with more or less success, and the same method often in what seemed the same presentation, but with a very different result. In this instance a

FIG. 43.

vulcanite plate was required to retain the teeth in their spread condition, and its presence was made available for attachments for elastic ligatures. The plate was adapted to the palatal surfaces of all the teeth, as seen in Fig. 43. A little hook or catch of gold wire was inserted opposite the canine teeth, and a little staple or loop of the same wire at the apex of the plate between the centrals. Previous to insertion and adaptation, a ring of rubber cut from tubing was caught over one hook, passed through the loop at the apex, and caught on to the other hook. The plate was then introduced into the mouth, and the elastic strap drawn over each lateral incisor, as seen in the engraving. A little reflection will recognize the philosophy of its action. The tendency of the elastic ligature to contract to a straight line operates only on the inverted corners of the centrals. Its action would be equally upon the laterals, were it not that they are in contact with the plate and can not be displaced. The real and only action, therefore, is between the outer surface of the lateral and the gold loop at the apex. The tendency of the rubber to straighten between these two points twists and throws out the inverted edge of the centrals. It accomplished the desired work, but very slowly as compared with the preceding movement; for it was not until the 24th of June, a period of more than seven weeks, that the third and last stage was entered upon.

In passing, let me remark that there was no effort made in this case to produce a given result in the shortest possible time consistent with safety. A great work had already been accomplished in a limited time in the widening of the alveolar arch. That condition was being sustained by the plate, and becoming settled and firm. It was better, when the time was not limited, to take the next step in conjunction with that retaining plate, and by a slower process, than to adopt a much more rapid one, which would involve a more complex appliance and more constant attention on the part of the operator.

The form of the arch when the third stage of treatment was entered upon was much the same as that shown in Fig. 39; that is, a V-shaped arch with the teeth regularly placed along the line, each side the middle; and the reduction of this V-shape to a proper curve was brought about by the same kind of an appliance. The third plate answered the same purpose as the second in retaining the side teeth in their widened position, and differed from the second in bearing so upon the central incisors as to prevent their returning to their former twisted position, and in having attached to it catches, ligature, and T, precisely the same as shown in

Fig. 39. There is, however, this difference to be borne in mind: When it was applied, the vulcanite plate came in contact with the lingual surfaces of the front teeth, and was cut away from time to time as the teeth were brought in contact with it. This course was adopted for two reasons: First, the former condition of the front teeth being twisted, there was danger, if left too free, of returning to that position, and thus destroying the lateral pressure upon the adjoining teeth; and, second, the summer vacation came on, and the patient could be seldom seen. For this last reason the reduction

FIG. 44.

progressed slowly, and this fixture was used for five months, accomplishing the double purpose of carrying back the teeth against the plate, and retaining them there until the plate was still further cut away.

The desired curve being attained, the final retaining plate, as seen in Fig. 44, was substituted. Other forms of a retaining plate would have secured the same results, but this one was adopted because of its simplicity as well as effectiveness. It was a simple plate of vulcanite with a small gold wire imbedded in it, and passing to the outside of the six front teeth, through a small gap between the cusps of the canine and bicuspid on each side. If the articulation of the teeth of both jaws had been such, on occlusion, as to shut up this gap, then this kind of a retaining plate could not have been used.

There were many points in connection with the above-described case, of the utmost interest to those engaged in treating irregularities. They involve the origin of the deformity and the æsthetic results obtained by the treatment. I believe now that it would have been better to extract one tooth from each side of the mouth; but these matters are referred to elsewhere.

The following case is introduced in connection with the one last described, because it involves points of unusual interest; including the origin of the deformity, difference in the aspect, and difference in the method of correction. The patient was an elder sister of the preceding. The points of similarity in the two cases were, that the incisor teeth projected and the palatine arch was narrow; but the shape of the dental or alveolar arch was entirely different.

Fig. 45.

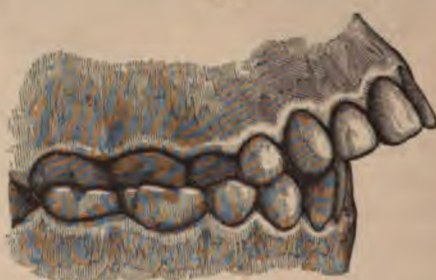


Fig. 45 shows the profile view—the incisors tipped up and projecting, one central lapping over the other, and all the teeth back of the canines articulating inside the corresponding lower ones. Fig 46, when compared with Fig. 42, shows how the arch differed in form from that of the younger sister. The effect upon the facial expression was as unlike as was the form of the jaws. In the younger sister the upper lip was pinched, and pushed forward in the center; in the present case, of the elder, the whole breadth of the upper lip was advanced and decidedly curled up, the teeth being nearly always exposed. Evidently the first æsthetic consideration was the reduction of this prominent dental arch; and, as the teeth were all in close contact, this could only be done by the removal of some of the teeth, or by expanding the palatine

FIG. 46.

arch. Practically, then, the widening at the sides became the first step in the process of correction.

A vulcanite plate and a jack-screw, such as described on page 102, and here shown in Fig. 46, was introduced. It differed from the afore-mentioned one in some respects, as follows: The second molars were so wide apart already that it was desirable to avoid spreading them. The vulcanite plate therefore clasped and embraced them. The pressure of the jack-screw was desired equally against the two bicuspids and the first molar on each side; it was therefore placed midway, i. e., above and against the second bicuspid; and to avoid the second molar being influenced by it, the plate was sawed down with a watch-spring saw nearly to the middle just behind the first molar, as seen in the engraving. This fixture was adjusted on the 26th of February and worn for thirty days, the screw being tightened from day to day by the patient; but she presented herself at the office frequently for inspection.

Fig. 47.

During this process it became evident that the continuance of this expansion would create a deformity of more importance than the first one. The movement of the side teeth developed the fact unquestionably that the apices of their roots were based upon a maxilla so narrow that the further widening of the arch would have presented the palatine surface of the upper teeth to the grinding surface of the lower ones. The divergence of the crowns was such that had the expansion been continued until the prominence in front could be reduced, it would have broken up the articulation of the teeth, thrown the jaws wider apart, and increased the gap between the upper and lower incisors. The width already gained was equal to more than half the diameter of the teeth operated upon; but, as it was far from sufficient to allow the front teeth to come back, there was but one alternative, namely, the extraction of a tooth on each side.

As the patient had reached maturity, and the teeth were all equally sound, the removal of the first bicuspid was decided upon as simplifying materially the subsequent steps. On the 3d of April these teeth were extracted and a new regulating plate adjusted, which is shown in Fig. 47. This appliance is not unlike the retaining plate made for the sister, and described on page 105. Its object being the reduction of the six front teeth, it effected that result as follows:

The plate was accurately adjusted to fit and catch between the bicuspids and molars. The gold wire in front was elastic and springy. It was bent so as to impinge upon the incisors, then caught in front of them, pulled back, and sprung into its place. As fast as the reduction was accomplished, the wire was bent at the sides where the teeth had been extracted and also contracted. So far as any variety of fixture was concerned, this, in fact, completed the treatment. This same appliance, or one like it to all intents and purposes, became the retaining plate, which was worn from one to two years.

Fig. 48 shows the form of the arch at the conclusion. It was rounded very symmetrically, and the space formerly occupied by the first bicuspids was nearly closed up. The third molars made their appearance. The articulation with the lower teeth is good, and not likely to break up the present arrangement.

While it was, without doubt, quite possible to have so enlarged the arch as to admit the full number of teeth into a symmetrical line, I am fully satisfied that it would have created a deformity equal to the one I was reducing.

One point in this case of considerable importance was the apparent want of correspondence in the size of the superior and inferior maxillæ. It will be borne in mind that any attempt to widen the palatine arch sufficient for the cusps of the upper teeth to articulate naturally outside the cusps of the lower ones would have ended in failure. From this it may be inferred that the superior maxilla was too narrow and the inferior too wide for such a correspondence; but a careful observation of the external features did not disclose

Fig. 48.

any discrepancy. Had it been in reality a deformity of the jawbones, there would have been a want of symmetry in the face; but the face was regular in its outline, with no evidence of pinching across the middle, nor of undue width at its base. The want of correspondence was therefore due entirely to the dental development. The dental arch of the lower jaw was of unusual width, and this was owing, in all probability, partly to the malocclusion of the upper teeth, and partly to causes to be mentioned hereafter. The false articulation in this case operated not only on the upper ones, so as to narrow the arch, but also in a reverse direction on the lower arch, to widen it. There is no doubt but that a true articulation of both jaws could have been attained by narrowing the lower dental arch, but this was not altogether feasible, nor did the surrounding circumstances justify an attempt.

An inquiry into the origin of the irregular dental development of these sisters convinces me that the primary disposition, so far as they were concerned, was hereditary. I saw no evidence of this, however, in either of the parents, whose teeth were well developed and regular, and had no suspicion of the inherited character until after the regulation was accomplished, when I met a sister of the mother, and was impressed not only with a strong general likeness to her nieces, but with a dental irregularity of the same general character, viz., narrow upper jaw and protruding incisors; in fact, the expression of the mouth was identical with that of one of the young ladies before treatment. But this discovery did not account for the marked differences in the dental arrangement of the sisters.

A further inquiry revealed the fact that the elder sister (Figs. 45, 46) was an immoderate thumb-sucker during all the earlier years of her life; in fact, according to her own statement, continuing the practice until after she was ten years of age; while the younger one had never contracted such a habit. With this knowledge the solution of the problem was not difficult. A tendency to a contraction across the palatine arch was hereditary; the protrusion of the incisors was the result of that contraction, and also hereditary. The younger sister had preserved that inherited character, modified only by accidental circumstances, during the eruption and growth of the teeth. But the thumb-sucking habit of the elder sister had changed entirely the inherited form. The constant presence of the thumb had retained the advanced position of the centrals, and had also brought forward and rounded out all the six front teeth, while at the same time this influence upon the lower jaw would have been likely to force back the front teeth and expand the sides. It was thus, in all probability, both the malocclusion and the thumb-sucking which produced the unusual width of the inferior dental arch.

It has been asserted by some observers that these narrow dental arches are the result of enlarged tonsils, compelling a constantly opened mouth for respiration; but in neither of these cases was there any enlargement of the tonsils, nor any unusual tendency to keeping the mouth open.

It has also been maintained that these same V-shaped or pinched arches are associated with abnormally high palatine vaults, and that the same characteristics are peculiar to congenital idiots; but there is not the least evidence of a mental development below the average in either of the cases under consideration, but rather the contrary—an intelligence and refinement belonging only to the higher classes of society.

Nor have I ever seen any evidence that this class of cases have a congenital origin in any other sense than the inherited tendency. There is certainly no evidence of such deformity prior to the eruption of the second set. I have examined a large number of children in looking for a pinched or contracted dental arch, and, unless associated with some other deformity, have never seen one. I have no reason, therefore, for believing that any considerable percentage of these cases which come to notice later in life have a congenital origin. I was confirmed in this view by an examination into the condition of two younger brothers of the two sisters whose cases we have been considering.

Fig. 49 shows the upper jaw of the elder of the brothers, then eleven years of age. Both deciduous molars on the left side remained; on the right side one had been removed, and the first bicuspid was emerging from the gum; the second deciduous molar remained. The incisors, as seen in the cast, were permanent, and the canines were developing normally, one of them being through the gum, and the other nearly so. The reader will observe that the incisors had already assumed the V-shape which characterized those of the sisters! They were half an inch in advance of the incisors of the lower jaw. As will be seen, there is no want of space shown as an explanation of their prominence; there is room enough in the arch for all the teeth that are there or are coming; nevertheless, the arch is abnormally shaped, and will require sooner or later appliances for its reduction. The lad has never contracted the thumb-sucking habit, and his mental and physical development are good. If the assumption were correct in regard to the inherited origin of the deformity in the two elder

FIG. 49.

sisters, we need look no further for the cause of a like arrangement in the teeth of the brother. Reflection would also lead us to expect such a development in other members of the same family, on arriving at the proper age. But an examination of the mouth of another sister, now about fourteen years of age, shows a perfectly regular and symmetrical dental arch. A younger boy of about six years shows only the deciduous teeth and permanent molars of that age, and all regularly developed, with no symptoms of a tendency to a contraction of the arch to a V-shape.

From these observations, as well as others, I come to the conclusion that an irregular dental development can not be prognosticated, even with a strong hereditary tendency, and particularly that form which assumes the V-shape. Neither is this shape any evidence of idiocy or of any tendency to idiocy in that individual.

In this connection I am impressed with the untenable ground taken by Dr. Barker at a meeting of the Alumni of the Pennsylvania College of Dental Surgery, as reported in the "Dental Cosmos" for May, 1874: "Dr. Barker brought before the association a patient who had a strong hereditary tendency to a large projecting superior maxilla, and he said: 'This tendency I overcame by extracting two perfectly sound six-year molars. There would be no such thing as irregularity if the dentist could get the child young enough.'"

Professor Truman asked, "Was the protrusion mentioned an existing fact, or was it only anticipated?"

Dr. Barker replies that the tendency was anticipated, and Professor Truman most justly adds: "As there was no irregularity to treat in this case, I can not discover any justifiable reason for the removal of the first permanent molars. In this patient the articulation of the anterior teeth is perfect, while the proper articulation of the bicuspids has been destroyed by the extraction. The masticating surfaces of these teeth strike directly upon each other, producing, in my judgment, a serious irregularity."

These observations of Professor Truman on the results of an attempt to correct a protruding jaw which had not yet developed, together with the impossibility of foretelling what will be the results of an hereditary tendency, show the folly of any such experiments. In the case of the family referred to in this chapter, two daughters developed narrow arches and protruding jaws through an hereditary taint; the third child was passed entirely; the fourth is unquestionably following abnormally; and the fifth is too young to form a decision as to the permanent teeth.

Figs. 50 and 51 show the models of a case I have now under treatment. The patient is of German birth, fifteen

FIG. 50.

years of age, and above the average in height. She is fair of face and comely in appearance, and there is no external indication of the internal deformity. The natural contour of the cheeks is not disturbed. It is evidently confined to the alve-

FIG. 51.

olar processes and the teeth. I have seen other members of the family, and as yet discover no signs of hereditary transmission. It is not associated with enlarged tonsils; the tonsils are not quite up to the average size. In intelligence she is equal if not superior to the average of the class in society to which she belongs.

The teeth, it will be observed, are very irregularly placed; the second deciduous molars are remaining, and the second bicuspids have not erupted in the upper jaw. I think the palatine arch is the narrowest that I ever saw in an adult, not otherwise deformed. The width between the remaining deciduous molars across the arch is exactly one half inch, while in length the jaw would indicate a size above the average. The lower jaw articulates with the upper, but in such a way as to leave more room for the tongue below than above.

I propose to widen these jaws to the extent that harmony with the other features demands, and to that end have extracted the deciduous molar of the right side, and inserted a vulcanite plate with a jackscrew reaching from side to side, as illustrated in former chapters. The progress thus far has been both rapid and satisfactory, but no attempt is being made to accomplish it against time.

The following description of a case of V-shaped contracted maxilla, in which there was a wide separation between the upper and lower front teeth, was communicated by Mr. Charles S. Tomes, of London:*

"Mouths in which the back teeth alone antagonize, and the upper and lower front teeth fall short of meeting one another, are not very uncommon; though, inasmuch as this deformity is often regarded as irremediable, or as necessitating a course of treatment so protracted as to be practically prohibited, this case may possess some interest on account of its having been brought to a successful issue within a very moderate period. Before the patient came under my care an attempt had been made to correct the irregularity of the upper teeth among themselves with some degree of success,

* "Monthly Review of Dental Surgery."

as I learn, from a model taken at the outset, that originally the lateral incisors stood within and the canines outside the line of the other teeth. With the view, I suppose, of allowing the canines to fall in, the first upper bicuspids had been extracted on each side—a plan of treatment which, in the long run, led to unfortunate results; for although the canines assumed a position of comparative regularity as far as the teeth on either side of them were concerned, they did so at the expense of sinking in altogether inside the arch of the lower teeth.

"When first seen by me the characteristics of the mouth were as follows: The upper jaw presented the ordinary form of a V-shaped maxilla, the central incisors meeting one another at an angle, their mesial edges being greatly everted and overlapping one another, and the palate being excessively deep and narrow. When the mouth was closed to the utmost extent possible, a gap of $\frac{4}{16}$ of an inch intervened between the edges of the upper and lower central incisors, of $\frac{3}{16}$ between the right laterals and the canines, and of $\frac{2}{16}$ between the left laterals, while the left canines occupied a position (relatively to one another) too irregular to admit of exact measurement. Behind the canines the upper and lower teeth came in contact with one another, but their disposition was very irregular. Thus the second upper bicuspid (the first having been previously removed, as has been already mentioned) bit inside the corresponding lower tooth; while of all the teeth in the upper jaw the second molars were the only ones which preserved their normal relations by biting outside the corresponding lower teeth. It was therefore necessary to move outward the central and lateral incisors, the canines, and the second bicuspids on both sides.

"The first stage in the treatment was to expand the arch of the upper teeth, so that they would, had it been possible to close the mouth fully, have passed outside the lower teeth. The first upper molars, being excessively carious, and often painful, were extracted, and a vulcanite plate was then inserted, which forced the bicuspids outward by means of wooden wedges, while at the same time it disengaged them from the cusps of the lower teeth by means of gold caps fitted over the second molars so as to prop the mouth open. It should be added that the removal of the first molars did not enable the front teeth to be approximated any more closely than before.

Fig. 52.

Model of the mouth before the treatment was commenced.

"As soon as the bicuspids had passed out, so as to bite outside the lower teeth, this plate was abandoned in favor of one with a stout gold wire passing outside the incisors, canines, and bicuspids, and being attached to the vulcanite plate in the spaces left by the extraction of the first molars. To this band, which had been rendered elastic by hammering, the central and lateral incisors and canines of both sides were firmly attached by silk ligatures, the band being pressed inward toward the teeth by the finger of an assistant, while each ligature was being tied.* The effect of this was to

* "Were another similar case to present itself, I should adopt a modification of this plan, shown to me by my friend Mr. S. J. Hutchinson. In place of attaching the belt to the band by ligature of silk, an elastic band is passed behind the neck of the tooth, brought forward and passed round the gold band, then backward again, passing once more on either side of the tooth acted on, and the ring then secured by being hooked over a small stud on the vulcanite, immediately behind the neck of the tooth."

draw the teeth outward rapidly, and to make the front of the arch rounded in the place of having the angular form characteristic of the V-shaped jaw, so that the upper teeth assumed a perfectly regular position among themselves.

"As soon as the upper teeth had been drawn outward so that the arch was wide enough to allow of their passing outside the lower teeth, pressure was brought to bear in order to close the front part of the mouth by means of a simple arrangement of elastic bands. A circular air-cushion was

FIG. 53.

Apparatus used to draw the jaws together. The band passing over the top of the head is placed too far back in the woodcut.

adapted to the chin and connected by strong pieces of elastic with a cloth band passing over the top of the head; the whole was kept in place by two pairs of ribbons which were tied at the back of the head. At first some little trouble was experienced, owing to the skin of the chin becoming tender under the heavy pressure; but this was combated by the use of spirit lotions, and by putting slightly oiled lint between the air-pad and the skin. This apparatus was worn constantly at night, and also during a considerable part of the day, the teeth being kept from falling back into their former positions by a light retaining plate. At the time when this apparatus was first adjusted the only teeth which came into contact were the upper and lower second molars and second bicuspids.

"For a few weeks no very marked effect was produced save slight pain in the region of the temporo-maxillary articulation; but after that the gap between the upper and lower incisors diminished each week by an amount that could be measured, and at the expiration of six months from the commencement of treatment (the elastic bandage having been worn for about four months), not only had the gap entirely closed, but the upper central incisors had been made to over-

FIG. 54.

Model of the mouth after the lapse of six months.

lap the lower to the extent of $\frac{1}{16}$ of an inch, while, as may be seen in Fig. 54, the laterals and the canines also overlap and antagonize. It will be noticed that the closure is more perfect on the left than on the right side, on which latter the gap was originally much the widest; and as the apparatus has now been worn more or less for an additional three months without effecting any further appreciable change, it is probable that this will not be rectified. Not only has the patient's appearance been very greatly improved by the closure of the mouth, but the power of mastication, which before treatment was necessarily very imperfect, has been most materially improved.

"The patient's age (seventeen), the number of teeth which had to be moved, and the extent of the deformity, combined to render the prospect of success remote, and it was only at her own urgent desire that I undertook to treat the case at all, feeling very doubtful of its ultimate issue; while the success which has attended the treatment is mainly due to the indomitable perseverance of the patient herself, who fully understood what was being attempted at each particular time, and furthered my endeavors in every way.

"A point of much interest which arises in considering this case is, was the closure of the front teeth effected by an elongation of the ascending ramus of the jaw, or by the antagonizing teeth (i. e., the bicuspid and second molars) being depressed, and, so to speak, forced down farther into their sockets? I am inclined to think that the latter is the true explanation, for not only did these teeth become tender during the treatment, but the rapidity with which the closure was effected when once it had commenced (each week showing a very sensible improvement) almost precludes the possibility of its having been due to elongation of the rami, which must necessarily have been a slow process."

In carefully reading the foregoing description, I am in doubt about there having been a deformity of the maxilla. Mr. Tomes calls it a "*V-shaped contracted maxilla*," but gives no evidence that the *maxilla* was in any way contracted. The changes resulting from the extraction of the first upper bicuspids are only alveolar changes. If it were a contracted maxilla, the spreading of the crowns of the teeth at that age would have probably resulted as in the case of my own, described on p. 108. I am inclined to think that the contraction was confined entirely to the dental and alveolar arches, and Mr. Tomes's closing sentence leads me also to the further opinion that the maxillæ were not affected at all by the treatment.

The following drawings are from models of a dental arch in the mouth of a miss thirteen years of age. An examination of the cast taken before any treatment was commenced (see Fig. 55) shows a pointed arch, which should not be confounded with the *protruding arch* of an upper jaw, in which the six front teeth all stand forward on a broad and flattened curve. It has been supposed that the type shown in this model is the result of thumb-sucking, or some other like and equally pernicious habit, but it is a misapprehension of the facts. I have never seen a case of thumb-sucking that produced the V-shaped arch, and the case de-

FIG. 55.

scribed on p. 106 shows an example of undoubted hereditary tendency to a V-shape, but which the habit of thumb-sucking obliterated, and instead thereof the anterior portion of the arch was widened and correspondingly flattened, while the sides, being held by the articulation of the lower teeth, remained unchanged. In the present case the deformity of the upper jaw was not in itself nearly so pronounced as in many other cases, but the effect produced upon the external features was very marked. In Fig. 56 is seen the profile of both jaws with the articulation of the teeth. So great a discrepancy between the incisors of the upper jaw and the incisors of the lower jaw in the mouth of a child whose features were otherwise regular, produced an incongruity amounting to marked deformity. A study of the profile did not show that the upper lip was so much in advance of a regular outline as that the lower lip, chin, and lower jaw were all receding and seemingly out of place. Nevertheless, the occlusion of the teeth showed that their grinding surfaces articulated admirably with their antagonistic neighbors.

The dental arch of the lower jaw was well formed, was not contracted at the sides, but was round and of normal

Fig. 56.

development, and in this respect was unlike any lower jaw that I remember to have seen associated with a pinched upper arch where the grinding surfaces articulated so accurately. In all cases which I have heretofore observed of a well-shaped lower arch associated with a pointed upper one, the articulation was not good; the lower bicuspids and molars articulated outside the cusps of their superior antagonists. I was puzzled over this anomalous state until the plaster models were made (as represented in Fig. 56), when, with a better opportunity of studying the articulation, I discovered that the lower teeth were articulating one tooth behind their normal place in the upper jaw; that is, the first bicuspid of the lower jaw was shutting between the bicuspids of the upper jaw, while in all cases normal occlusion requires that the lower bicuspids should shut in advance of their correspondents above. In the plaster models I was able to see the perfection of articulation in this state of malocclusion, and also to see that the movement to shut the lower jaw farther forward showed the upper jaw too narrow to receive it. Thus was obtained a clear insight into the *cause* of the deformity.

The tendency to a pointed arch was inherited from the child's father, but with him it was of so slight a character as not to amount to a deformity. This peculiarity was more marked in the child, for, as I have elsewhere shown, the causes which produce an irregularity in development will, if transmitted, exaggerate the peculiarity. And so in this case the V-shape of the upper jaw was more marked in the child than in the father, but not sufficient to produce such a deformity of external feature if the lower jaw had persisted in shutting forward in its normal place, and of course outside in the bicuspid and molar region, as in most other similar cases.

The remedy evidently lay in the widening of the upper jaw until the lower would be received in its forward and natural place; and resolved itself, therefore, into three elements, viz.: widening the upper arch so that the lower teeth could not articulate as they had been accustomed to; secondly, compelling a new articulation in an advanced position (this action I have called in other places "*jumping the bite*"); and, thirdly, flattening the pointed and projecting appearance of the incisors.

The appliance used was of the simplest possible character, and is shown in Fig. 57. It was a thin plate of vulcanite covering the roof of the mouth, fitting closely to the necks of all the teeth except the central incisors, and sprung into place. Two slots, as seen in the engraving, were cut through the plate as a convenient means of attaching two rubber rings cut from small elastic tubing. A piece of stout thread was passed through both rubber rings; the plate was introduced in the mouth, and the thread drawn forward between the central incisors and tied over a little cross-bar lying horizontally about the middle of the crowns, at their proximal edges; this cross-bar was the unburned end of a match-stick, and less than an eighth of an inch long. The engraving shows the rubber rings only under about half tension; in use they were drawn clear up to the lingual surfaces of the centrals, but of course the tension depended much upon the size of the rubber tubing and the strength of the rubber. At the time of the introduction of this appliance I inserted thin wedges of rubber between the teeth on each side in the

FIG. 57.

three spaces between the canine and molar. How much these wedges contributed to the correction of the deformity I am uncertain, as after two or three days I became fearful that they might operate disadvantageously, and removed them. The sole appliance, then, depended upon for correction, was the vulcanite plate, as seen in Fig. 57.

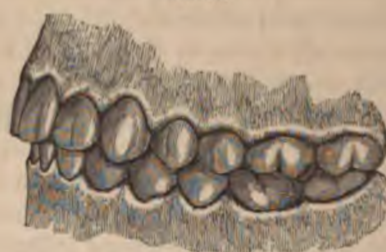
Two weeks from the same hour at which I attached the apparatus I took the casts which are represented in Figs. 58 and 59. At the end of another week I introduced the final retaining plate, and pronounced my work at an end. The articulation of the lower teeth in their new-found places was nearly as perfect as in the former condition, and in process of time will, by accommodation, become quite so. It is now impossible for the teeth to shut in their former and abnormal places. It needs no words to describe the change in the external features; the casts shown in the engravings suf-

Fig. 58.

ficiently indicate how the profile was changed within three weeks, from a marked deformity to an equally marked and pleasing regularity.

To an unreflecting mind the results accomplished by so simple an appliance may seem incomprehensible, but they

Fig. 59.



are the logical sequence of the application of well-known laws. The power here applied to the median line was of the same character as the placing of a load of sufficient weight upon an arch to crush it. As the arch flattens in the center under the weight, it must bulge at the sides until the whole collapses in ruin. But before the *disorganization* of our dental arch arrives, we apply our retaining plate, which in this case was like the regulating plate, but with the rings nearer to the front, which were drawn over each central, simply to hold them from springing forward, and all the other teeth were locked by them.

On the 19th of January, 1871, the treatment of the following-described case of irregularity was commenced:

The patient was a young lady fourteen years of age. The occlusion of the jaws showed that the entire row of

FIG. 60.

lower teeth shut outside the upper ones. This is fairly represented in Fig. 60. The external features showed—1. That the lower jaw was not too large, being neither too wide nor too long. This determination was easily arrived at by a comparison of the extreme lower part of the face with the upper part of the face and head. 2. The same course of reasoning showed that, relatively, the upper alveolar border and row of teeth were contracted so much as to produce limited external deformity. To a casual observer, the chin and lower lip were too full. To a more accurate observer, the upper lip, cheeks, and nose were depressed. I suggested that immediate attention would correct what otherwise would become an increasing deformity through life.

The casts represented in Fig. 60 were taken, and the first fixture applied, as before stated, January 19th. Six days

FIG. 61.

afterward the incisor teeth of the upper jaw were overlapping the lower incisors. On that same day, namely, January 25th, I gave a clinic, under the auspices of the District Dental Society of New York, on the subject of "Treatment of Irregularities," and took an impression and made a cast of this case, exhibiting it there as a part of my demonstration, to prove the rapidity with which teeth could safely be moved into certain positions.

Within twenty days from the time the power was first applied to the teeth, the entire upper row was articulating outside of the lower ones, substantially as shown in Fig. 61.

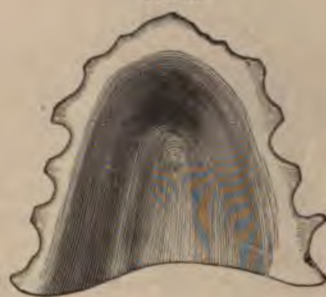
A retaining plate was adapted to the upper jaw, such as is shown in Fig. 62, which was worn, with some unimportant modifications, for several months. The result was a most marked change in the profile, and in the relation of the external features. The individual features being naturally well formed and symmetrical, the change in their relations produced a face of more than usual beauty.

The treatment consisted solely of wedges inserted between the teeth, as shown in Fig. 62, in conjunction with

FIG. 62.

the retaining plate, Fig. 63. Wedges were inserted between *all* the teeth, as shown in Fig. 62, and worn from the first. These wedges were of elastic rubber, and used of such thickness only as would exert a gentle pressure. The retaining plate answered a twofold purpose: it kept the teeth from the possible contingency of any one of them moving toward the center of the mouth; and, secondly—which was of equal importance—points of the retaining plate were allowed to pass between all the teeth, which kept each wedge from slipping up into and irritating the gum. The patient was watched daily so long as the wedges were acting. When by reason of their want of thickness they ceased to act, new ones, but slightly thicker, were substituted. There was no more discomfort to the patient undergoing this process than is commonly experienced in the wedging of one or two teeth in the mouth for the purpose of getting space for filling. There was no soreness which called out complaint from the patient. There was no favoring diet, nor was there any provision made for masticating while the teeth were in transit. The teeth in their new position and articulation, as seen in Fig. 61, have remained stationary now for a period of eight years.

FIG. 63.



Not only is the external face improved, but a longevity is guaranteed to these teeth by their isolation which could not have been obtained by any other means.

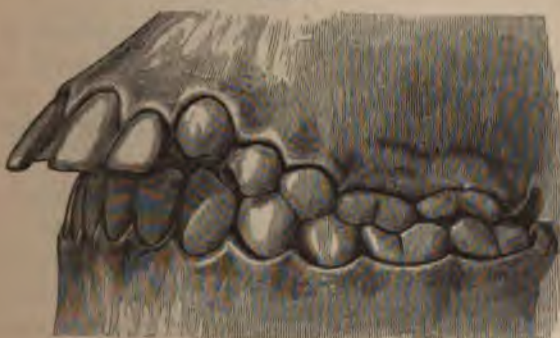
The foregoing account is not designed to prove what is sometimes possible, or what trials nature may undergo and still survive; but it is set forth as an illustration of a principle in the treatment of irregularities which has never before been published.* In the above there is nothing but a recognition of pure *mechanical* principles in dental practice. The wedge is a mechanical power. Its application here is identical with its use by the architect as a keystone in building his arch. Its action and results are the same as if the hoops of

* First published in the "Dental Cosmos," January, 1872.

a barrel were loosened and a wedge driven between each stave. The circumference of the barrel would enlarge so long as the staves were prevented from twisting, in which case the whole thing would collapse into a wreck.

In 1861 my attention was called to the mouth of a child nine years of age, whose teeth were erupting and growing unlike those of other members of her family. The father and mother both had regular dentures. The mother in particular had a most intelligent face, with regular, handsome features, and large, beautiful teeth. An older sister had fully

FIG. 64.



developed teeth in both jaws, all regular, and of the type of the mother. In the child the incisors were protruding, and the whole upper jaw gave the appearance of being excessively large. (See Fig. 64.) The teeth of the lower jaw were normal. I could see no reason for this peculiarity. It was not inherited from either father or mother, nor from the grandmother, whom I also saw, nor did they know of a like deformity in any of the relatives. It was not the result of thumb-sucking, nor, so far as I could learn, of any other evil habit.

I did nothing at the time, thinking it possible that the action of the upper lip might have a tendency to depress them as they advanced. I watched the case for four years before I decided to act. During this time they had continued to grow worse, and were throwing out the upper lip so that it was with much difficulty that the lips could be brought together and the mouth closed. The surrounding features were developing after the symmetry of the mother's. The permanent teeth of that age (thirteen) had all made their appearance, and the mouth was deformed without hope of improvement in the course of nature. The teeth behind the canines were all in contact and articulated well with those of the lower jaw, but the incisors were spread and straggled, and the crowns had the appearance of being of extraordinary length.

As interference need be no longer postponed, I made a frame of gold, covering the cutting edges of the incisors and lapping on to the canines, and a plate of vulcanite adapted to the roof of the mouth, such as described in former chapters, and cut away in front to provide for the retrocession of those teeth. Ligatures cut from rubber tubing were attached to the posterior part of the vulcanite plate, one on each side, and drawn forward and caught on projecting spurs of the gold frame. This apparatus, which can be easily understood from the description, was worn for a short time, when two discoveries were made: First, the arch in front was by this means contracted until the teeth came in contact, but was not sufficiently reduced. With the teeth all now in close contact, there was no hope of further reduction without the removal of a tooth, and the first bicuspid on each side was consequently extracted. Secondly, the backward movement showed an apparent elongation of the incisors. I do not think it was an actual elongation, but an appearance arising from crowns of an already extraordinary length becoming more perceptible as they came into a vertical line. It became evident that any further pressure in the same direction would eventually carry the teeth down so as to touch the gum of the lower jaw, thus completely hiding the lower incisors and producing a deformity but little preferable to the first.

In this emergency I conceived the attempt to shorten the crowns of the upper teeth by driving them up into the jaw.

I continued the apparatus as before described within the mouth, and added to the gold frame a stud or post about half an inch in length, soldered to it opposite the canines, and coming out of each corner of the mouth. This apparatus,

FIG. 65.

when in position, is shown in Fig. 65. The arms extending upward, passing outside the cheeks, were made of strips of brass, and were connected by elastic ligatures with a skull-cap, as shown in Fig. 66. This skull-cap was made of leather, and the whole apparatus was very easily applied as follows: The vulcanite plate was inserted in the mouth, and the rubber ligatures brought forward and caught as before described, the skull-cap placed on the head, and strong elastic straps were caught over buttons or hooks on the cap, and like buttons or hooks on the cheek-arms. The action will be understood by observing Fig. 66. The outside pres-

10

sure was forcing the teeth up into the jaw, while the pressure inside was carrying them in a direct line backward. This apparatus did not interfere with the comfort of the patient in any respect other than the appearance, and was worn constantly for a period of three months; after that, during the night, and somewhat during the day, for an additional two months. The result was, that the six front teeth were carried back so that the canines came in contact with the second bicuspids, and the incisors were driven up into their sockets

FIG. 66.

one fourth of the length of their crowns, and the family expression of the mouth and face restored. The result is shown in Fig. 67.

So far as I am aware, this was the first effort ever made to shorten teeth by retracting them within the jaw where they had become elongated through natural or developmental causes. This occurred in 1866, and was reported at the May meeting in that year of the New York Dental Society, and published in the "Dental Cosmos."

The success in this case involved absorption of the walls of the socket, and is not to be confounded with some cases which I have seen since reported, where a tooth had become elongated by accident (as, for instance, the presence of a rubber ring around the neck of the tooth), and pressure was used to restore it. In the latter case it is probable that neither deposition nor absorption of bone took place.

My attention was recently called to an instance in Dr. Thayer's practice, in Brooklyn, where the pathological condition was like my own case. In regulating several upper teeth

FIG. 67.

for a young lady, he had occasion to turn one of the central incisors. After the teeth were all brought into line he made a retaining plate with a band in front. The patient neglected to report herself, and went out of town, being gone for several weeks; during which time the bearing upon the afore-mentioned incisor became such as to drive it up into the jaw, and when discovered by Dr. Thayer was shorter by one half the length of the crown than its adjacent neighbors.

Fidelity to history requires that I should report the disastrous results that followed neglect and inattention to my instructions in the case above described and illustrated. Immediately on obtaining the desired results in appearance, I made and applied a retaining plate, which, if worn, would keep the teeth in their newly acquired positions. Being over-persuaded, I foolishly gave my consent to an immediate trip to Europe, the patient to return to me in four months. My parting instructions were that the retaining plate must be worn constantly. On board ship the plate was removed during sea-sickness, and no attempt made to replace it until they arrived on the other side the Atlantic, when it was found that it could not be inserted, the teeth having changed position. A number of weeks elapsed before any one was consulted, and in the mean time they had gone all astray. A year and a half afterward the patient returned to this country, and reported herself to me. The teeth were then, if anything, more disorderly than before I made any attempt with them; and I declined to further interfere, partly from discouragement, and partly from a doubt as to the expediency of breaking up the structures a second time, and at this more advanced age. And the last condition of that patient was worse than the first.

In April, 1878, Dr. George S. Allan brought a little girl to me for consultation in regard to a marked protrusion of the lower jaw. The deformity was entirely in the under jaw, which, as usual in such cases of abnormal width, projected so that the lower arch extended outside the upper throughout its whole circuit. As the irregularity appertained to the jaw itself, and not to the arrangement of the teeth, it was decided to operate upon the jaw alone, and to bring about a correct articulation of the teeth as a sequence. At a meeting of the Odontological Society of New York in November following, Dr. Allan reported the progress of this case, from which I quote as follows:

"My first plan was to construct two dental splints or plates of rubber, one each for the upper and lower jaws, having a protuberance on each in the nature of an inclined plane, which would act, during closure of the jaws, to force the lower one backward. But I did not persevere in this direction, for I soon found that it would be of little use. Then, directing the child to continue wearing the upper plate, I set to work to make an apparatus that would pull the lower jaw back, keeping the upper splint alone in place. As you will see from the photograph taken at the time she was wearing this apparatus, it consists of two parts. For the lower part I made a brass plate to fit the chin, having arms

FIG. 68.

with hooked ends reaching to a point just below the point of the chin. These arms were arranged in such a way that the distance between them could be altered at will by simply pressing them apart or together. The upper part consisted of a simple network going over the head and having two hooks on each side, one hook being above and the other below the ear. When this apparatus was completed and in use, there were four ligatures of ordinary elastic rubber, pulling in such a way as to force the lower jaw almost directly backward. I relied upon the elastics attached to the lower arms to do the main work. The upper elastics were simply used to keep the mouth closed so that the lower elastics would not pull it open, the upper elastics being made just strong enough so that the child, in the natural operations of eating and talking, would not have to strain the muscles of the mouth to keep the jaw open. The work proceeded very rapidly, much more so than I had expected, so that at the end of two months, instead of six (as I had told the mother of the child it would take), the irregularity was almost entirely cured. At about the end of the first month there came a stop, and for two weeks I could not get the jaw to move one particle, which puzzled me very much. The mother said the child wore the apparatus regularly, day and night, and she knew of no reason why the work should not go on. I had the child brought down to the office in the morning, and kept her there all day watching her; and I found that when she was busy at reading or play she would push the network on the head back so that the elastics did not pull. Thus that puzzle was solved. I then directed the mother to watch her carefully, and keep the band of the network well on the forehead, and also more carefully directed the young miss herself, and warned her that she would lose all that had been done if she was not more careful in the future. After this the work went on steadily to completion. In a little over two months the under teeth were completely inside of the upper. The cast I hold in my hand represents the condition of the teeth when I commenced operations, and this one shows the condition of the teeth at the present time. In my absence during the summer the child wore the elastics only during the night, and on my return I found that the jaw had pushed out a very little, not enough to throw the upper teeth within the lower teeth as formerly, but so that the left upper incisor was just touching the tip of the lower one. I had the apparatus reapplied, and this slight relapse soon disappeared. I see no reason why, in all such cases, either this or similar methods of procedure should not be adopted. If taken at this age, or even when the child is older, I can not see why success should not attend the efforts of the dentist. I was puzzled at first to understand how I had obtained so great an amount of recession in the lower jaw; but on carefully examining the skull and position of the parts at the child's age, the proper solution of the problem soon presented itself. The jaw at that period of life is completely developed and hardened. When a child is one year old the union between the two lateral halves of the jaw takes place, and at eight years the jaw is solid. Consequently any efforts that may be made will not affect the jawbone itself. The only way in which the change can be made is by pushing back the condyles of the jaw into the glenoid cavity. Allow me just here to show you the skull of a child about five years of age. The articulation between the glenoid cavity and the condyle is peculiar, in that there is a double synovial membrane between which there is a cartilaginous bursa. This cartilage gives way and absorption takes place at the posterior side of the condyles, with filling in of the anterior, so that the whole operation consists in pushing the condyles of the lower jaw into the glenoid cavity of the temporal bone. Until the articulation has again receded by the natural protrusion of the teeth, I suppose the child will have to wear the apparatus more or less. I had it taken off to bring here this evening. I should certainly in any similar case presented hereafter, even at twelve or thirteen years of age, before attempting any other procedure, try this first and thoroughly."

Fig. 69 shows the arrangement and articulation of the teeth of a miss of about fifteen years, as she was presented to me. It will be observed that both lower canines shut outside the upper lateral incisors. So also does the right lower central close outside the upper central. All the six front teeth of both upper and lower jaws were in an irregular condition, the lower ones being more marked.

A brief history of the case showed that at some former period the superior incisors were all shutting inside the lower ones, and the patient, then living in a distant city, had been under treatment and the superior arch expanded until the present condition was reached. During this process the plate used in the expansion of the arch was made to cover the grinding surfaces of the upper teeth, and mastication went on between the lower teeth and this plate. When the patient fell into my hands, there was a retaining plate on the upper jaw, which in like manner covered the grinding sur-

FIG. 69.

faces of the teeth. I have always publicly and in practice disapproved of such a *gag*, as not only unnecessary but productive of positive harm. This case illustrates the harm, for when I removed that plate it showed that the normal articulation of the teeth had so long been interfered with that the teeth would now touch only in a few points, these points being the extreme molars and the incisors, which were the only teeth that were free to develop, not being held back by the plate. When this so-called retaining plate was out of the mouth and the jaws in contact, there were spaces at the sides where the teeth did not meet each other by nearly a sixteenth of an inch.

There comes now a diagnosis of the case which can not be made from a study of models, but requires a personal examination of the patient. The model does not indicate any peculiar or unnatural pitch to the superior incisors, but a cursory observation of the patient's face on opening the mouth showed that the apices of the roots of the superior incisors were based on a contracted circle, and that any further marked expansion of the arch and advancement of the crowns would give a bad pitch to those teeth and a disagreeable expression to the mouth. Furthermore, the upper arch was already well developed. It was of normal breadth, and large enough in its circle to admit all the teeth into line. This was sufficient ground for abstaining from any further efforts at the enlargement of the upper jaw.

FIG. 70.

Turning now to the lower jaw, we find it of breadth equal to the upper, but the teeth jumbled in front and crowded out of line. And just here develop the necessity and the wisdom of extraction. As a fact in science, all these teeth of the lower jaw can unquestionably be brought into line by an expansion of the arch; and it would be equally a fact that, if it were done, the deformity of the mouth would be increased, as an enlargement sufficient for that purpose would place all the lower front teeth outside the upper ones. No further expansion of the upper arch could be effected without spoiling the expression of the mouth.

There remained but one alternative, viz., the reduction in size of the lower arch. I extracted the right lower incisor, leaving, of course, but three teeth between the canines,

FIG. 71.

and applied immediately the fixture shown in Fig. 70. It was a very simple plate of vulcanite, with three rings of elastic tubing attached to it, and when *in situ* one ring was stretched over the remaining central incisor and the others

FIG. 72.

over the canines. The plate was cut away behind these three teeth to permit of their falling back under the strain. The position assumed by the elastics is shown in Fig. 71.

At the same time a fixture, as shown in Fig. 72, was adapted to the upper jaw to lift out the left lateral incisor. When in position its work is that of an elastic ligature tied to the plate between the central incisors (see Fig. 71), then passed outside the central underneath the lateral, outside the canine, and tied to the plate between the canine and bicuspid. Such a fixture would inevitably draw in the canine and central at the same time that it was lifting out the lateral, did not the plate rest against them and thus prevent it. Within ten days the teeth of both jaws were in position, as shown in Fig. 73. The space caused by the removal of the lower central was entirely closed, and there was no leaning

FIG. 73.

of the teeth toward each other noticeable by an ordinary observer; and I doubt whether the absence of that tooth will ever be detected, except by the professional eye.

The following-described case of irregularity possesses some features in common with others which have been illustrated, but the causes and treatment are so different as to make the subject worthy a separate description:

Fig. 74 shows the cast of the teeth of a lad ten years of age. From a study of the casts, I should have been likely to come to the conclusion that the superior dental arch had been brought forward through some effort similar to thumb-sucking, and that the treatment demanded a reduction of the upper arch. The presence of the lad, and a study of the external features, showed that the upper teeth were but slightly at fault, and that the profile of the face was altered by a retreating lower alveolar and dental arch rather than a protruding upper one. The upper arch was broad and well formed; the lower was narrowed as well as depressed. The profile of the face was good except the lower lip, which was so sunken as to suggest the absence of teeth on the lower jaw, while the chin was not retreating and showed an harmonious relation to the other features.

Fig. 74.

The treatment was the adaptation of an appliance to each jaw; for, while there was no marked deformity of the upper jaw, nevertheless the pitch of the incisors would be improved by a slight reduction.

The fixture for the upper jaw is shown in Fig. 75, and consisted of a vulcanite plate, as here illustrated, with a rubber ring through which a stout thread was passed, and the elastic drawn forward to the lingual surfaces of the incisors. A bit of the stump of a match-stick a quarter of an inch long was laid horizontally across the two centrals, and the thread tied over the stick.

Upon the lower jaw there were not as yet any bicuspids or permanent canines; the only teeth here shown belonging to the permanent set are the four incisors and the first molars. The regulating fixture is shown in Fig. 76. The

FIG. 75.

vulcanite plate has gold spurs projecting between the incisors and canines. These spurs were inserted to keep the incisors from spreading on the line of the arch. Wedges of

FIG. 76.

elastic rubber were then inserted between each tooth, and between the teeth and the spurs. This operation drove the teeth forward in two weeks so that, with the reduction of the upper arch, which was simultaneously accomplished, the upper and lower incisors came in contact. The retaining plates for each jaw were similar to the regulating plates, only adapted to the changed positions of the teeth, and were continued in place for a number of months. The lower plate, as shown in Fig. 76, was made wider across the mouth than the cast would receive, and was sprung into its place. The tendency was to spread the arch, which it did, so that when the permanent teeth erupted they developed a broader arch than existed before, and one which corresponded better with the upper one.

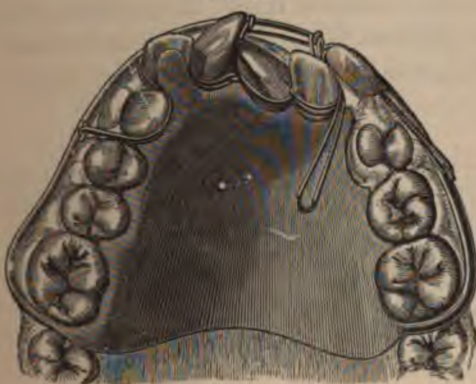
This case is but one of the many which show the necessity of a personal observation of the patient's external features as well as the mouth, in order to an intelligent treatment.

The case illustrated below was that of a boy thirteen years of age, concerning whom there was no other marked peculiarity, either mental or physical, than the irregularity in position of the teeth, and a somewhat retarded second dentition. Upon a careful observation of Fig. 77 it will be seen that the second temporary molar of the left side has not been shed, and that the crowns of the first bicuspid of the same side, and the canine of the right side, are imperfectly developed. The crown of the latter was pointing, and locked within the lower teeth on occlusion.

The articulation—which it is not deemed necessary to illustrate—showed all the teeth behind the six front ones to be in their proper places; but the canine of the right side and the central incisor of the left were locked within the lower teeth, and the others in varying positions of twisting and lapping, as is fully shown in both illustrations. The articulation also showed that the superior arch would bear sufficient enlargement to bring all the teeth into line, and without giving undue prominence to the upper lip.

The detail of changes required on the right side was to bring out the canine, twist the lateral incisor, twist and bring forward the central incisor; on the left, to twist and bring forward the central, bring forward the lateral, and reduce and carry back the canines. This was all effected with one appliance made of a vulcanite plate, as described in former cases, with a gold wire anchored in the plate and passing around the outside, as shown in the engravings. This, with the straps cut from rubber tubing, constituted the whole apparatus. To understand its workings, the illustrations will have to be closely observed.

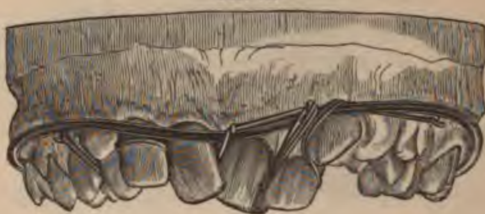
Fig. 77.



A semicircular slot is cut through the plate, forming a little tongue upon which is caught a ring of tubing; this is drawn between the lateral and canine, comes forward of the canine over the wire band, and is carried back and caught on a hook—a part of the band—opposite the bicuspids. The contraction of this ligature, it will be seen, will carry the canine back, and the pressure exerted by its being brought over the outside of the wire will tend to depress the tooth. The plate is carried up nearly to the canine, so as to protect the gum from being cut into by the rubber, which would happen without such provision. There are two hooks on the wire in front, opposite the central and lateral incisor, seen distinctly in Fig. 78. The lateral incisor of the left side is operated upon by a ring of smaller rubber tubing caught over it, and the one hook next the canine.

The left central, which needs twisting as well as bringing forward, has a rubber ring caught over both hooks. The action of this ring will bring the tooth bodily forward until it comes in contact with the wire. If, now, the ring were caught over but one hook, this would be the end of its action; but, being caught over both hooks, and they being properly placed, and wide apart, the contraction of the elastic will continue after the nearest point of the tooth has come in contact with the wire. This contraction can only exert itself between the hook next the canine and that side of the central, and twisting is the result.

Fig. 78.



The right central incisor, seen in Fig. 77, is a stubborn offender. In the model and in the mouth it was still more twisted than appears in either of the engravings. Its cutting edge was at nearly a right angle with the wire band. Its forward edge was not too prominent, and the wire band rested against it. I first attempted to twist it by the same arrangement of ligature as moved the other central, but it failed. It was too much twisted, and I could get no hold. I tied and retied ligatures in various ways, and of various kinds, but without effect, and ultimately resorted to the insertion of a peg on the lingual and crowning surface of the tooth near the gum. This peg, which unfortunately is also indifferently shown in Fig. 77, was made of pivot wood, and was about the size of the gold screws now used for the better retention of contour fillings. Had such a screw been at hand at the time, I should probably have used it, although a wooden peg is of equal service. With one elastic ring caught on this peg, on the inside of the right central incisor, a variety of movement was accomplished. As seen in the engravings, it passed from the wooden peg between the central and lateral, around in front of the lateral, back between the lateral and canine, around inside the canine next to the bicuspid, and then caught on a hook attached to the wire opposite that tooth. Its contractile movement would first twist the central; secondly, it would depress the lateral, and bring that within the arch, were it not for a branch or process of the plate coming forward and resting on its lingual surface, which supports it and prevents the reduction; thirdly, the canine is pulled bodily toward the wire band.

This system of plate, band, and ligatures regulated these teeth perfectly, and a retaining plate made in substantially the same way kept them in position until they became firm. The retaining plate was, of course, adapted to their advanced positions, and the wire, which at first formed a part of it, was afterward removed, as its only function was to hold the canine of the left side down to its place. The plate, minus the wire, was worn for a longer period, but only for a few weeks, as the articulation of the lower teeth was so admirable as to make a retaining plate unnecessary.

It must not be supposed that making and adapting such an apparatus as this was all that was done to regulate these teeth. While this is the appliance which was used, and these are the principles which governed its action, the application of those principles and the adaptation and retention of the fixture was a severe tax on one's ingenuity and perseverance. In the beginning, a variety of methods in the arrangement and attachment of ligatures were resorted to, some proving a success, and some ending in failure. The action of the elastic, which is caught in the center of the plate, and passes over the canine and wire, has an inevitable tendency to pull the wire down and throw the plate, wire, and straps all out of place. In this emergency a waxed floss or flax thread was passed around the neck of the right central, and the wire tied immovably to its position. As the canine became reduced this tendency decreased, the elastic ligature at the same time getting a better hold over the swell and around the neck of the canine. Again, at certain stages it seemed desirable to rest from active aggression upon some of the teeth while the work continued upon the others. Thus the left lateral incisor was becoming more tender than the rest, and exhibited symptoms of elongating; and it was favored by releasing all strain upon it and gently tying it to the band, to maintain what it had gained, and await its recovery.

Such a complication of abnormalities is very difficult of mastery. The inclination of the crowns, and the peculiar form which their roots may possess, serve often to make what may seem a simple case one of very difficult accomplishment; and the length of time that will be required can not be foretold, the experience in one case being but little criterion for another one similar in appearance. In this case the patient was in my hands for this purpose ten weeks and then discharged, the retaining plate only being required to be worn longer. The passage of the canine and central out of the lock of the lower jaw was accomplished within a few days.

There were no blocks built up on the lower jaw to open the articulation for that purpose. Indeed, in all the cases I have treated—and they have been many and constant for years—where some of the upper teeth were locked within the lower ones, I never made, in any instance, any apparatus to keep the jaws apart during such movement. I emphasize this fact, more because in a work from the pen of Mr. Salter, of London, a "gag," as he terms it, becomes an important and necessary adjunct in his treatment of such deformities; such an appliance being in my own experience a cumbersome and unnecessary affair. It is necessary only when the operation of moving the offending teeth is suffered to drag itself along through many weeks or months. In such cases, the molar and bicuspid teeth might elongate by being long kept from natural occlusion, and thus permanently destroy the articulation. Such cases I have seen, entailing great injury upon the patient; but the fault was not so much the failure to build a "gag" on the lower teeth as it was defective method of treatment of the upper teeth, making it a long and tedious process. With suitable methods and fixtures there need be but little time consumed in the passage of the teeth, so that their cutting edges can be caught outside the lower teeth; and from that moment the presence of the "gag" would be objectionable, and prior to that time unnecessary. No severe mastication will be performed or attempted upon tender teeth, and no masticatory force can subvert the constant action of properly applied elastic ligatures.

Fig. 79 illustrates a form of irregularity of frequent occurrence. This was in the mouth of a miss fourteen years of age. The central incisors were pointed; the laterals shut inside the lower teeth; the canines were very prominent, and the bicuspids slightly within the line of the lower arch. The effect was a serious disfigurement to a face otherwise very pretty. The lower jaw was well formed, the teeth regularly arranged, and none of them seriously decayed. The upper sixth-year molars were decayed, and the pulps exposed, which had given her some trouble; for this reason mainly they were extracted, the fact that the irregularity could be more easily corrected without them being a secondary consideration.

The regulation involved moving back the bicuspids, widening the arch, reducing the prominence of the canines, carrying out the laterals, and twisting the centrals. The whole was accomplished, and perfect symmetry and articulation with the lower teeth produced, in just eight weeks. All the movements above described were carried on simultaneously by the use of a vulcanite plate and elastics, as shown

FIG. 79.

in Fig. 80. A careful attention to the description will enable the reader to comprehend its multiplied action.

The strap B on each side was caught over the second bicuspid of the same side, and worn for two or three days.

FIG. 80.

The recent extraction of the molars behind enabled these teeth to yield readily; the same straps were then made to inclose both bicuspids of each side. Simultaneously the straps A A were each drawn forward on their respective sides and caught over the canine on that side. The bearing was along the regulating plate passing between the first bicuspid and the lateral incisor on each side. The bearing was such against the bicuspids that it moved them outward while the canines were being pulled inward and backward. Subsequently the straps B B were made to include the canines as well as the bicuspids within their power, and thus from two independent sources was pressure exerted. The straps C C were made to draw out the lateral incisors by passing between the canine and bicuspid around the outside of the canine, and caught over the lateral. This served also to assist in starting the canines, which are the most refractory of all the front teeth. Later on in the movement, when the canines and bicuspids had started back, the spurs of the plate to which the elastics C C are attached were cut off to get them out of the way of the retreating canines, and the straps B B were carried outside the canines and caught over the laterals. When the straps B B were pulling on the laterals, a single part of them was inside the bicuspids, and a single part outside, but over the canines they were doubled. The retrocession and the twisting of the centrals was easily accomplished by the straps and a cross-bar of wood, as shown in the central part of the fixture. During the movement there was difficulty in making the straps stay on the canines, until a waxed-silk ligature was tied about the neck of each above the thickest part, and the straps thus tied up to their places. The bearings of this appliance which antagonized all this force were around the second molar teeth, behind and against the alveolar arch of the front part of the mouth, and against the lateral incisors. In cutting off the tips of the plate at C C, it was still left to bear against the laterals, but the movement of the laterals was not due to this bearing of the plate, nor entirely to the action of the elastics.

The immediate result of all this pressure was to so change the places of the upper teeth that the articulation was broken up, and in a few days the lower teeth were able to catch behind the tips of the laterals, and they were in consequence rapidly driven forward. The action of the regular lower jaw thus contributed materially to correct the irregularity of the upper as soon as it was unlocked from the laterals. The retaining plate, which was worn for several months, was of vulcanite with a band around the outside, similar to Fig. 44.

The following case came into my hands soon after I had completed the one last described. It was the mouth of a lad about thirteen years of age. A comparison of Fig. 81 with

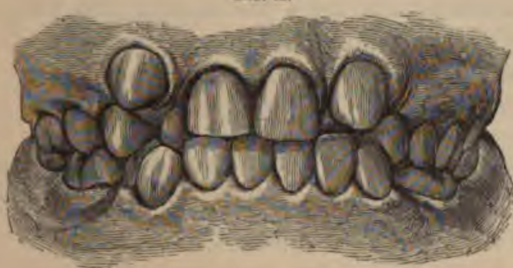
Fig. 81.

Fig. 79 shows a striking similarity; indeed, so much so that I had no hesitation in undertaking the treatment, with the encouragement that it would be completed in a few months at farthest. The lower jaw, however, was not in as favorable condition as in the former case.

Fig. 82, which represents a front view with the teeth closed, shows that one temporary molar remained on each side below, and all the front teeth were somewhat irregular. From a study of the case I felt justified in attempting to enlarge the upper arch enough to bring all the teeth into line, and to this end fitted a plate and jack-screw in the roof of the mouth. In connection with this, elastics were applied to the canines and laterals, on much the same principle as in Fig. 80. These were worn a few weeks, and until I became convinced that the expression of the mouth would be injuriously altered by any further widening.

Then arose the question of extraction, and as the results had been reached so easily in the former case, where the first permanent molars were extracted, those teeth in this case were removed. This afforded an opportunity to carry out the same plan of treatment as in that case, and that course was pursued for a few weeks with but little success.

FIG. 82.



Then came a series of experiments, in which screws, inclined planes, and plates with bands were an important element, of the details of which there is no record, but which continued for a year and a half before a result was reached equal to its prototype. In the mean time I had suffered all the mortification of anticipated failure.

At one stage of the proceeding, when there was a band around in front to which the laterals were tied by elastics to bring them forward, the laterals suddenly began to elongate, and within twenty-four hours had dropped half the length of their crowns. Indeed, except for the immediate removal of the elastics, I believe that they would have very soon dropped entirely out. To correct it, the cause was removed, and a new appliance immediately inserted which would tend to drive them back with every occlusion of the jaws. In the course of a few days they had recovered their former position, and finally were no longer than the adjoining teeth. These teeth have not been lost sight of, and there is no evidence that that elongation produced a disruption of the pulp. Before the conclusion of treatment I had the satisfaction of seeing the loss of the lower temporary molars, the eruption of the bicuspids, and a general improvement in the arrangement of the inferior arch resulting from occlusion.

One point is forcibly impressed upon us by the history of this case, viz., that, considering his sex and the aspect as presented in Fig. 82, it would have been far better to extract the lateral incisors and force the canines into the gap, especially in view of the fact that two comparatively sound teeth—the first molars—were sacrificed.

In Fig. 83 is seen an example of general disorder of both superior and inferior dentures, found in the mouth of a

FIG. 83.

lad about twelve years of age. Of every tooth, it might be said that it held an abnormal position, either within or without the circle, or above or below its proper plane; both alveolar arches were contracted, the teeth at the sides particularly pitching toward the center of the mouth. The upper sixth-year molars were decayed to mere shells, while the corresponding lower ones had been extracted, and the second or twelfth-year molars had tipped forward into their places. Against the first molar on the right side above was an abscess, and on the same side below was still remaining the temporary canine, while the permanent canine was standing outside.

The treatment consisted in the extraction of the temporary canine and each of the first molars; a plate and jack-screw for the upper jaw to widen the arch, followed by appliances on the general principles so abundantly illustrated in these pages. For the lower jaw a somewhat stiff plate was made of vulcanite for the inside of the arch, and sprung into its place; as the arch widened the plate was warmed and straightened and replaced. As the bicuspids of the side teeth were principally in fault, the lower arch was widened in a few weeks. During this time the irregular front teeth, including the malposed canine, were bound to it by elastics and brought into line. The retaining plates for both jaws were vulcanite, with a gold band in each anchored in the plate behind the bicuspids, and passing entirely around the fronts. The disturbance of the alveolar processes by extraction and by pressure set up an action which brought a correction of the abnormal plane, as shown in the engraving.

In the "Dental Cosmos" for January, 1870, Dr. McQuillen describes a case of irregularity which came under his treatment. The patient was a young lady of sixteen:

"On bringing the upper and lower teeth together, the right superior central incisor closed *inside* of the inferior central and *in front* of the inferior lateral, while the superior lateral was back of the inferior canine, and the left superior lateral inside of the inferior one, producing an articulation as shown in the accompanying illustration, Fig. 84. The irregularity in this case was so marked as to attract general attention, and the occlusion of the teeth, had it not been corrected, would have eventuated in a permanent and unsightly prominence of the lower jaw most destructive to the harmony of the features. In the course of two months, with a very simple, easily-constructed appliance, which could be readily adapted by the patient, the defective position of all the teeth was corrected, and a result obtained most gratifying to the patient, completely changing the appearance of the mouth, and greatly improving the expression of the face.

Fig. 84.

"The fixture employed consisted of a silver bar of the thickness of ordinary lower plate for artificial dentures, two inches in length by a quarter of an inch in width, perforated by four holes, and then, with a thin, flat file, cuts were made from the edge of the bar to these holes, making a fixture similar to the lower figure in the accompanying illustration, Fig. 85. India-rubber rings, cut from French tubing, were

Fig. 85.

readily passed over the bar (which rested on the front surface of the superior incisors) and around the deflected teeth. The constant, gradual contraction of the rubber drew the lateral incisors into their proper places in the arch. A bar of similar construction was also used in the lower jaw. After becoming familiar with the necessary manipulation, the application of the fixture was made entirely by the patient, thus relieving the operator of considerable trouble."

This method of securing the rubber rings to the metallic band was described by Dr. McQuillen in 1859, and is substantially the same as recommended by Mr. Tomes in his "System of Dental Surgery." Both gentlemen seem to have adopted this simple expedient and published their plan the same year.

Figs. 86 and 87 illustrate cases also from Dr. McQuillen's practice. "In Fig. 86 the lateral incisors of the lower jaw stood considerably within the arch. The patient, a little girl aged eight years, had the bar and rings described above applied, and at the expiration of a week or two the teeth were brought into line, and there held by a retaining plate until they became permanently fixed.

FIG. 86.

"In Fig. 87, it will be observed, the right superior central incisor is considerably outside of the arch. The patient from whom this cast was obtained, a lady aged thirty-five years, came under his care about three years ago. From childhood she had labored under the peculiar deformity called limber-jaw or under-hung, with all the lower front teeth striking outside of the upper, due to a preternatural elongation of the inferior maxilla. A short time before placing herself in his hands, by some means or other the right superior central incisor got outside of the lower teeth, and had gradually been driven farther and farther forward by the occlusion of the lower jaw, until it had become not only very prominent, but quite loose in the socket. As the age of the patient contraindicated any attempt at a radical reform of the original difficulty (the protrusion of the lower jaw), the only course that appeared to be justified was to get the incisor back to its former position, so that when the jaws were closed it would strike inside the lower teeth. This was accomplished by throwing an India-rubber ring round the incisor, and then stretching it over the crown of the first bicuspid of the same side. The contraction of the rubber in a few days drew it into place. To prevent the front teeth from striking during this period, silver caps were placed on the molars."

FIG. 87.

This would be a dangerous expedient for just such a case if the lower teeth did not shut outside, and thus lock the canine and lateral incisor, which are being pressed outward by the action of the rubber elastic at the same time that the central incisor and bicuspid are approaching each other. The power of the elastic to throw them out is equal to the power drawing the incisor in.

The following quotations and illustrations describe a practice followed by Professor Flagg, and published in the

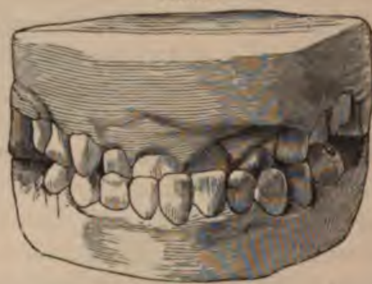
"Transactions of the Odontographic Society of Pennsylvania." Referring to cases where the superior incisors articulate within the inferior, he says:

"For the correction of this form of irregularity, the ordinary practice has long been the adaptation of a plate over the teeth of the lower jaw, upon which inclined planes were so arranged that, by occlusion with the upper teeth, these should be forced outwardly, and at the same time some backward movement of the lower teeth be effected by producing a certain amount of change in the angle of the inferior maxilla. The application of this force is dependent upon one of two causes, viz.: the persistent efforts of the patients themselves in closing the teeth upon the planes, or by means of pressure with elastic bands arranged over the head and under the chin, after the manner of the Fox bandage, for preventing luxation during extraction. By means of these appliances, the corrections of very bad cases of this irregularity are sometimes effected in astonishingly short periods of time; but, on the contrary, it is not unfrequently the case that month after month passes by without any manifestation of progress. . . . Children will so protrude the lower jaw as to bite behind incredibly long planes, and upon the least accession of tenderness they will only eat such soft food as can be manipulated with the tongue, and never touch the planes at all. . . . I think that in the correction of irregularities all apparatus should be self-acting—so constructed as to require no coöperation on the part of patients, and, moreover, so arranged as to prevent the possibility of their interference with its workings.

"In consequence of these views I have for several years abandoned entirely the use of inclined planes, and have substituted for them, in correcting cases of the kind under consideration, a combination of wire, ligatures, and gutta-percha, which arrangement I can much more clearly elucidate by means of models than by description.

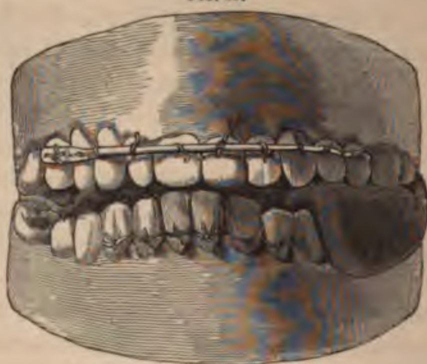
"Fig. 88.—Miss A., aged fourteen. Inclined planes had been adjusted upon the teeth of this patient, and worn for a period of one year. From want of coöperation upon the young lady's part, and from disinclination to bite upon tender teeth, no result was obtained.

Fig. 88.



"Fig. 89.—Front view, showing gold wire adjusted to upper teeth, silk ligatures thrown around lower teeth, and gutta-percha guard, to prevent occlusion, molded upon left

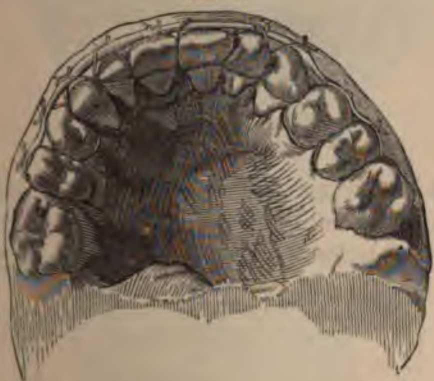
Fig. 89.



lower molars and bicuspid. The wire was secured by ligatures to the four superior bicuspids, and *one central* was gently brought forward by silk. After it touched the wire, it was firmly attached, and thus having gained strong points at either end and in the center of the wire, the remaining teeth were brought into position with much ease and rapidity.*

"Figs. 90 and 91.—Inside views of both jaws, showing attachments to wire upon upper teeth, and the apparatus which was used for *drawing the lower teeth in.* Silk ligatures were thrown around the twelfth-year molars (both sixth-year lower teeth had been extracted by the gentleman who had employed the inclined planes, with the view of insuring the correction). India-rubber rings (from tubing) were secured to these teeth, and *attached together* by a short double *silk* ligature; silk was then passed around the lower

FIG. 90.



front teeth, and the two rings stretched, as is very clearly demonstrated in Fig. 91.

"The fact of the more frequent presentation of the lower permanent teeth *posteriorly* to the deciduous is probably known to all of you, and it is my practice, both by teachings and ligatures, to prevent any attempts on the part of parents which shall result in removing or even loosening the deciduous teeth, so long as it is possible to retain them with any comfort to the patient. By this means the inward inclination

* This case does not seem to be dissimilar to the one the author treated with wedges, as described on page 127.

given to the inferior permanent centrals is so great as to frequently insure their position under the superior centrals; and, if it is indicated by the presentation of the superior centrals in the rear of the superior deciduous centrals that

FIG. 91.

this will not be accomplished, I at once remove the superior deciduous centrals and direct pressure to be made with the thumb on the palatine faces of the permanent centrals. The

FIG. 92.

position assumed by the thumb is such as will at the same time naturally press upon the labial faces of the lower teeth, and thus a good result is almost always effected.

"Fig. 92.—Miss L., aged seven. All the *superior decid-*

ous teeth inside the inferior; marked prótrusion of the lower jaw; a family peculiarity.

"Fig. 93.—The same, open. The inferior deciduous incisors were tied to the laterals to insure the presentation of the inferior permanent centrals *posterior* to the superior deciduous centrals.

"I regard the accomplishment of a natural occlusion between the centrals as more than half the battle gained, for it

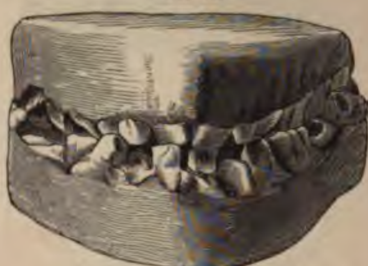
Fig. 93.

will readily be seen, by examining the dental preparations of subjects under six years of age, that the position of the forming teeth is such as will indicate their being governed, to a very great extent, both as regards eruption and location, by the proper or improper placing of the anterior teeth; for the laterals are formed *posterior* to the centrals in the inferior jaw, and *anterior* to the centrals in the superior jaw.

"Fig. 94.—The superior deciduous centrals were extracted upon the first indication of presentation from the superior permanents; the thumb used to make pressure to throw them forward; the inferior deciduous centrals have been lost naturally, and the occlusion is *almost* as would be desirable.

"Fig. 95.—The same, open; ligature securing slight rubber ring thrown around lower sixth-year molar, and attached to left central, exercising *gentle* traction. Was tied on at 8 o'clock A. M., and at 1 o'clock P. M. was removed, and the tooth secured with silk, *completely under* its permanent antagonist. When the relative development of the other two

FIG 94.



teeth will *insure retention*, the same process will be repeated with them, probably in the course of two or three weeks from this writing. By this means a serious deformity will have been corrected without annoyance either to patient or practitioner, without trouble to the latter, and without pain or much expense to the former.

"One thing is indispensable for the accomplishment of good results by this method of treating irregularities, and that is, *a knowledge of knots;* for teeth are so shaped, so rounded, and so smooth that ordinary tying will not avail much. But there are knots which meet every emergency, from the 'figure-of-8' for protruding incisors to the 'secured loop' for turning the roundest tooth. These are only to be taught by demonstration, and acquired by repeated trial and some little experience.

"Fig. 96 shows an irregularity of the teeth of both jaws in the mouth of a young lady fourteen years of age. The treatment consisted in removing all the second bicuspids, above and below, throwing India-rubber-tubing ligatures

Fig. 95.

around the six-year molar left inferior, and the left inferior first bicuspid and cuspid, drawing the two latter backward and into the arch, at the same time passing a silk ligature around the lower incisors (Fig. 97) in such a manner as to force into position an overlapping left central. In the upper jaw a plate was adapted to the palate, secured by silk liga-

Fig. 96.

tures to the first permanent molars; pins were placed in the plate in such a manner as to allow of the attachment of two

Fig. 97.

elastic bands, which were secured by silk threads to the central incisors (Fig. 98), drawing upon the mesial face; other

Fig. 98.

bands were so arranged as to draw upon each lateral angle of the centrals, passing between the centrals and laterals from their palatine faces, and running along the labial and buccal faces of the teeth unto the first molar of either side; tubing was thrown around the remaining superior bicuspid of either side and the molar, for the purpose of approximating these teeth, thus affording space for the proper placing of the irregular centrals. By this arrangement nine ligatures were exercising traction at the same time, gradually and beauti-

FIG. 99.

fully performing their work of correction. Fig. 99 shows the result."

The following case of Professor Richardson's is not very dissimilar to the preceding one:

"The nature and extent of the malplacement of the lateral incisors and cuspidati in the case under consideration are sufficiently indicated in the accompanying cut, Fig. 100. There is some lateral contraction of the arch, and a rather marked projection of the upper front teeth beyond the lower. The subject is a miss, between twelve and thirteen years of age, of somewhat delicate organization, spare habit, and of predominant nervous temperament. As there was plainly inadequate room in the arch for a corrected denture, the anterior bicuspids were extracted, a procedure which not only afforded ample room in the arch for the misplaced teeth, but made it possible to carry all of the teeth anterior to the second bicuspids backward, effecting a nearer approximation of the upper and lower incisors, and a corresponding diminution in the projection of the upper lip.

"After the extraction of the first bicuspids, a narrow

FIG. 100.

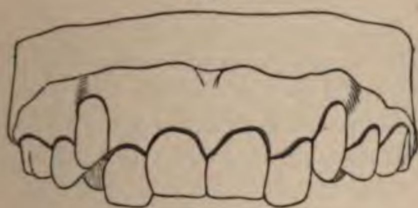
band of vulcanized rubber (Fig. 101) was constructed, embracing the six anterior teeth. Pressure was made upon the misplaced teeth by means of wooden pegs inserted in holes drilled through the band, at such points as were indicated by the direction which it was desired the teeth should take. In the present case the pegs rested against the posterior mesial angles of the lateral incisors in such a way as to force

FIG. 101.

them, when the band was applied, outward and backward, while those inserted into the opposite or labial portion of the band carried the cuspidati backward and inward. These pegs projected but slightly at first, and were lengthened from time to time, as the teeth moved, their removal and replacement being but the work of a few minutes. Before applying the band, all connecting partitions of rubber were divided, and the band cut away sufficiently at necessary points to enable the teeth to move in the desired direction. In most cases this band may be removed and replaced by the patient for the purpose of cleansing the teeth.

"The mechanical action of this simple fixture is readily apparent. The band, when applied, being forced apart by the intervention of the pegs, acts by virtue of its elasticity as a clamp or compressor, forcing the teeth in a direction opposite the insertion of the wooden pins. The band in this case was first applied on the 4th of November, 1872. On the 28th of the same month the cuspids had fallen far enough back to let the lateral incisors take their place within the circle of the centrals, as shown in Fig. 102. I

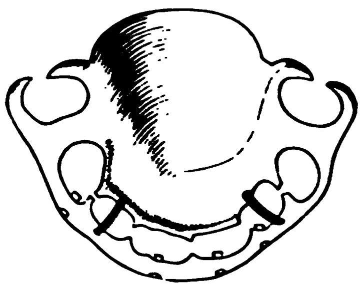
Fig. 102.



found the case now complicated with a marked elongation of the lateral incisors. This was in part *accidental*, by reason of inflammatory thickening of the investing membranes and partial luxation, induced by the forces applied to these teeth, but not wholly so, since the following fact clearly indicates that it was in part also *absolute*, namely: that, in applying force to their cutting edges in the manner hereafter described, the disparity in length between the centrals and laterals was about half-way overcome in from twenty-four to thirty-six hours, the teeth becoming at that point apparently fixed and immovable, requiring afterward the application of the same force for some twenty-four days, without intermission, to effect the same degree of shortening, indicating unmistakably the absorption of bone and deepening of the sockets.

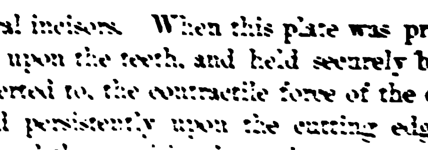
"Without any published precedent, so far as I am aware, I entered upon the novel undertaking of shortening (relatively) the elongated teeth in question, by pressure applied on a line with their long axes. To this end, a plate afford-

Fig. 103.



ing fixed points of resistance was constructed, having clasps attached and pinned to the centrals with wooden pegs resting against their anterior, and the plate against their posterior surfaces, as represented in Fig. 103. To this plate firm elastic cords were attached, stretching across the openings

Fig. 104.



for the lateral incisors. When this plate was pressed firmly to its place upon the teeth, and held securely by the means already adverted to, the contractile force of the cords, acting forcibly and persistently upon the cutting edges of these teeth, produced the requisite shortening (as seen in Fig. 104) in twenty-six days from the date of their application. During this time pressure was also being made upon the cuspids, which, in addition to forcing them farther backward and inward, assisted in fixing the plate in aid of the shortening process.

"The shortening of the laterals accomplished, the treatment was thereafter directed to the cuspids, forcing them backward and inward, until the result shown in Fig. 104 was attained. Having brought the latter within the circle of the anterior teeth, I was content to trust the matter of their ultimate elongation to the corrective forces of nature.

"Finally, a plate was made, resting accurately against the posterior faces of the central and lateral incisors, and cut away somewhat posteriorly to the cuspids, to enable the latter to drop down until they should become symmetrical in length with the adjoining teeth. The case was dismissed January 30th.

"The efficiency of the band contrivance has been amply demonstrated in my own practice in cases much more intractable than the one here related, and I confidently commend it as the most simple, practicable, and thoroughly efficient means of correcting a very large class of dental irregularities with which I am acquainted."

There are several points suggested in the treatment of this case as described by Professor Richardson, to which the reader's attention is invited.

I have seen the elongation of the laterals in a number of instances in my own practice, in cases similar to the one described, but I have never seen any evidence that there was such a deposition of bone in the alveolar socket as to make the elongation permanent. Realizing that pressure upon the side of a tooth always has a tendency to produce such a temporary thickening of the investing membrane as to lift it partly from the socket, I have watched the results of the pressure narrowly, and, as soon as any elongation showed itself, further *progress* was delayed until a comparatively healthy tone had returned. No retrogression was allowed;

the continued movement was simply arrested and the position maintained. I have never known an instance where the teeth thus temporarily lengthened did not return to their position unaided within a short time. I think it quite possible that Professor Richardson was misled, and that his effort at their reduction was unnecessary.

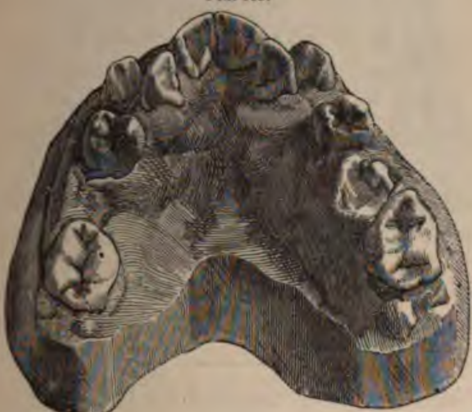
So far as the operation of shortening or driving teeth higher into their sockets was a novel operation, he had probably overlooked the report of the case now found on page 133, but which was exhibited to the New York Dental Society May 9, 1866, and a report of the same published in "The Cosmos" in September of the same year. And again, in "The Cosmos" for October of the same year, in the proceedings of the American Dental Association, there appears a statement in detail of the same case, from which I quote this passage: The teeth were carried back "and *driven up into their sockets* nearly one third of the length of their crowns."

The method adopted by Professor Richardson in the general treatment of his case was undoubtedly an effectual one, but, in the author's experience, open to the objection of requiring more attention from the operator in adjusting the pins, etc., than some other equally effective appliance.

Dr. H. Meredith White reports the following cases in "The Dental Cosmos":

"Miss M., aged fifteen years, came to the office January 2d. Fig. 105 represents the condition of the upper jaw, with the exception of the two deciduous molars, which were removed that day. It will be seen that the eye-teeth and first bicuspids are too far front, and that the incisors are behind their proper arch. It was deemed expedient to draw back the eye-teeth and first bicuspids to their places before attempting to bring forward the incisors, it being thought imprudent to encumber or distress the mouth much. A plate was accordingly made for the jaw, fitting firmly against the front teeth. In front of and attached to bands that pass around the first molar teeth were small rings, one for each band. Attached to each ring was a piece of India-rubber tubing, which was drawn forward and slipped over the bicuspid of each side. In a few days they were drawn to their proper places; then a section of tubing was tied to each ring, and then ligated to the eye-teeth, which were more difficult to move, it requiring between two and three weeks. By actual measurement in the mouth, the bicuspids were drawn back one eighth of an inch, and the eye-teeth three eighths

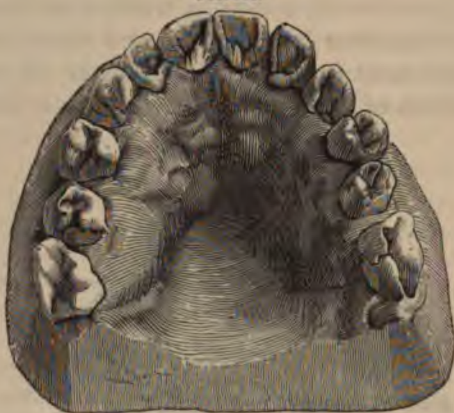
Fig. 105.



of an inch. These teeth were then held in their places by means of ligatures, it being found that there was a great tendency to recover their former positions. A bar was then added to the plate, and passed in front of the incisors, which were ligated to it; and in three weeks they were in their proper places.

"A plate with pieces for the back part of the incisors was then made, and a thin and delicate hickory bow made to extend to the second bicuspid of each side, which had now come through. To the bow all the moved teeth were tied, by means of which the teeth were settled and became firm in a regular arch. The patient continued to wear the plate to hold the teeth for some time after the completion of the case. October 10th the patient ceased wearing it. The plate was kept by the patient, who was instructed to place it in the mouth every few weeks; and, if any change

Fig. 106.



in the position of the teeth took place, to resume its use. Fig. 106 represents the case when finished."

In the following case, reported by Dr. H. M. White, the patient was in his twentieth year, and in good health:

"The right superior lateral incisor stood entirely within the arch of the lower jaw. The left superior lateral struck upon parts of the left inferior median and lateral incisors, and, by the constant friction to which it was exposed, had been so much worn on the cutting edge that the dentine could be seen between the anterior and posterior plates of the enamel: on this account it was shorter than the lateral of the right side. The arch of the upper jaw was nearly as small as that of the lower, and the spaces that the laterals should have occupied were but half sufficient for their accommodation. The position of the teeth before and after treatment will be seen by referring to Figs. 107 and 108.

"In regulating these teeth, two things were to be accomplished: 1. To enlarge the arch; 2. To place the irregular teeth in their proper places. These two steps were accomplished at the same time. As the labial surfaces of the laterals were somewhat round, resembling canine teeth, it was evident that by forcing the teeth forward they would act as wedges and widen the arch, and at the same time would gain their proper places. By the aid of inclined planes, one for each lateral, adapted to a plate fitting the under jaw, this was gained. In addition to this a plate was made for the upper jaw, having crib-bands for the first and

FIG. 107.

FIG. 108.

second bicuspids of each side, and a bar to run around in front of the upper arch, standing away from the labial surfaces of the teeth about an eighth of an inch, and soldered to the crib-bands; patent thread ligatures were secured to the necks of the laterals, and the ends drawn tightly around the bar and tied. These ligatures were renewed every three or four days so as to keep up a continual traction. The inclined planes were worn continually, thus making them powerful auxiliaries; in the mean time, by propping the teeth apart about a quarter of an inch, they allowed the laterals to slip over the lower teeth. From time to time the bar of the upper plate was lengthened by placing it over the arm of a small anvil, and striking it with a small riveting hammer. This was done to make room for the teeth as they advanced.

The central incisors were coming forward at the same time, and increasing the size of the arch.

"After pursuing this course for three months the teeth had arrived at their proper places. The inclined plane and the plate with the bar were now dispensed with; but a new plate for the upper arch was made, with pieces fitting against the back parts of the four incisors, in order to prevent retrocession or turning of the teeth. This plate was worn nearly two months, so as to give the teeth sufficient time to become firm in their sockets. The plate was then left off, there being no further use for it. The teeth were regular, and looked very well; but the shortness of the left lateral, referred to above, was objectionable. Concerning this I consulted Dr. J. D. White, who directed me to tie a string very tightly around the neck of the tooth, under the free margin of the gum, which in a few days would cause the tooth to protrude, and thus make it longer. He said that he had availed himself of this method in many cases where there was a shortness of one or two teeth, and had permanently lengthened teeth in this way, but that great care must be taken to keep the irritation within proper bounds, and that growing teeth could always be lengthened in this manner, and occasionally matured teeth also; but success in the latter was not always certain.

"I tied very tightly a patent thread ligature around the neck of the short tooth, and under the free margin of the gum. I saw the patient in three days, and observed that the tooth projected from its socket to a slight extent. The ligature was still retained, and the patient was seen again in three days. The tooth had already lengthened sufficiently; there was considerable irritation and some pain. The string was removed, and the patient directed not to use that side of the mouth for several days, and occasionally to apply a little pounded ice in a rag to the gum above the tooth, and to return in a week. The patient came as directed. All irritation had subsided, and the tooth had shortened, but not to its original state. By practicing this treatment every alternate week, so as to give the tooth time to recover each successive shock, the end was accomplished in six weeks. The tooth is as long as its fellow of the other side, and, after having its rough edges dressed off, presented a good appearance. It has now been over two years since the affair was concluded, and so far no ill effect has arisen from this novel plan of lengthening teeth, which has been very successful in the hands of him whose advice I followed.

"It may be proper to add that during the first fifteen days of regulating teeth, by means of any apparatus, there is always more to fear than during the subsequent treatment, since violent periostitis is apt to occur, and, if it does, it is more difficult to treat, and more destructive in its consequences than apparently the same amount of inflammation occurring during the treatment of a case of irregularity that has been under way for a longer time."

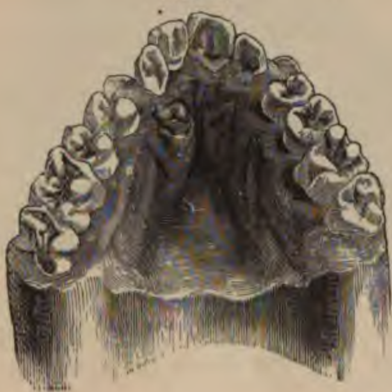
Prior to 1860 Dr. J. D. White expanded the superior dental arch by "placing a plate in the roof of the mouth as far up as it could be extended, but cut through, to make two halves, with a hinge in front, back of the incisors; this plate or plates open and shut like a hinge. These plates are fastened to the first molars or bicuspids, as the case may be, and a spiral spring is attached on either side, with the bow of the spring extending around behind the front teeth and close to them, so as to be out of the way as much as possible. It will be seen (Fig. 109) that the action of the spring is to separate these plates, which not only force the teeth out, but also cause the alveolar ridge and gum to follow and mold themselves accordingly. This is more especially necessary when the regulating of such cases is commenced before the complete growth of the roots of the teeth to be acted upon. We completed the treatment of a case about a year since, to which we think this apparatus was expressly adapted. It was the case of a child about eight years old. The superior front incisors and the first permanent molars only were erupted, and the superior arch and entire row of teeth fell inside of the lower as completely as one cup or saucer sets in another. It gave a large and swollen appearance to the lower border of the face, and a contracted appearance to the cheek-bones below the eyes. The space between the first permanent molars only admitted the point of the little finger, and the roof of the mouth was so contracted as to look more like a fissure than the roof of a mouth. As a matter of course, at this age the roots of the molars of the first set were partially absorbed, and the attempt to force them out

FIG. 109.

would be to excite undue absorption and dislodge them prematurely. Besides, if they had been thrown out, the *caps* forming in the jaw of the permanent teeth might not follow the deciduous teeth. In other words, we regarded it as necessary that the whole, jaw-teeth and all, should be moved together, to insure success. We have not been disappointed: the jaw molded beautifully, and in about a year the whole upper jaw was placed outside of the lower; and it has made such an alteration in the expression of the face that the child would not have been recognized except by those who watched the progress of the case. After the jaw was forced to the desired position, a solid plate was struck up to hold the parts in their new position until the first molars were lost and the bicuspids had grown sufficiently long to grasp each other, lower and upper, to insure the permanency of the case."

In 1859 Dr. A. Westcott undertook the correction of an irregularity which involved the expansion of the entire su-

FIG. 110.



perior dental arch. In his account of the treatment, as given in "The Dental Cosmos" of the same year, we are enter-

FIG. 111.

tained with a glowing description of the almost insurmountable obstacles he had to encounter. To make such an apparatus as he finally used with success would be quite suffi-

FIG. 112.

cient to deter the ordinary dentist from undertaking the correction of such deformities. The foregoing figures illustrate the cases: Fig. 110 shows the condition of the teeth

FIG. 113.

and jaw, and Fig. 111 the articulation or bite at the commencement. Figs. 112 and 113 show the result at the conclusion of treatment, a period of five months. The first object was to expand or spread the jaw *laterally*—the upper jaw being, at a point opposite the bicuspids, nearly half an inch too narrow to articulate properly with the corresponding teeth of the lower jaw. To accomplish this, the first fixture employed is the one seen in Fig. 114. This consists of double clasps (one for each bicuspid), both soldered to a cross-bar, bent so as nearly as possible to fit the arch of the jaw.

FIG. 114.

This was fitted in all respects as clasps are fitted to a plate, only substituting the bar (made of silver wire, No. 17) for the plate. This was made to fit snugly and firmly, and placed upon the teeth, the curved bar being straightened from time to time as the teeth moved. Finding that the fixed connection of the bar with the clasps destroyed the hold of the clasps upon the teeth, it was substituted by the one shown in Fig. 115, which was made with joints to ac-

FIG. 115.

commodate such change. With this fixture the arch was widened at the bicuspids, but then arose the doctor's most serious obstacle, viz., the enlargement of the arch anterior to the bicuspids.

His next stratagem was the fixture represented in Fig. 116. This consists, as in the former pieces, of double clasps (A A), taking the places of those on the bent bar. These clasps are connected by a straight bar, which is made nearly the whole length of tubular wire. This tube has a screw cut in its inside the whole length, and is soldered to one pair of the double clasps. The other pair of clasps are soldered to a wire which screws into this tube, the object being to lengthen or shorten the bar at will. The clasps being nearly fitted to the teeth, and the bar so adjusted as to admit of their setting easy, we have the starting-point.

To complete this fixture for the purpose of moving forward the front teeth, we next soldered a flat piece (C C) of sufficient width for hinge-joints to connect with it the tubes D D D D, which are to receive the spurs E E E E. These tubes, which have a screw cut on the inside, are attached to the flat piece on the bar, by first soldering to the end of each

FIG. 116.

an eye, F F F F, consisting of a flat round piece to receive the rivet, holding it to the main bar. Into these tubes are screwed the spurs, which are to bear and press against the teeth to be moved. These spurs are kept in place against the teeth by making a slight depression in the teeth themselves, with such a drill as is used for drilling steel or other metals.

The Doctor's advice to those engaged in the treatment of such cases contains some valuable suggestions:

"1. Never undertake to regulate teeth until the first set of teeth are shed, and the second set are in their place. I do not mean by this that we should never attempt to *prevent* irregularity by timely extraction, and perhaps by other means.

"2. When a case is presented, and the proper time has arrived for commencing operations, let the inquiries be: 'Does the patient, or the parents, or the guardians, fully appreciate the nature and importance of the operation, so much so as to place the patient *fully at your control*, and cheerfully to remunerate you for your time and skill?' If both these interrogatories are answered affirmatively, then you may safely undertake the task; but if either is even doubtful, and especially the former, you had better dismiss the case.

"3. If you decide to commence the operation, take accurate impressions of both jaws, and of the two in combination, or an articulating impression, and, before you see your patient again, or prepare any fixtures, *study them carefully and thoroughly*, and come to definite and distinct conclusions before you make the first move that is seen by the patient.

"4. Set the *price*, if you can, before you commence, and require at least one half in advance (which often secures a punctuality which nothing else will), and be sure to set it high enough (and there is little danger of your getting it too high), and then be faithful to the last degree, whether you make or lose money. *Never curtail any effort for fear your arrangement may not prove profitable.*

"5. *Consider well the constitution and the health of the patient.* If the constitution is naturally feeble, and especially if the health is bad, better by far run the risk of confirmed irregularity than undertake any operation of this kind of much magnitude."

I can not refrain from inserting a portion of the report of the treatment of a case of irregularity which was made before one of the prominent dental societies and published in "The Cosmos." It needs no comment other than that it was not intended as a travesty on mechanical surgery:

"The cast of the superior maxillary, as it originally was, presented a very contracted arch and irregular set of teeth. The object was not only to regulate these teeth, but to expand the roof of the mouth and increase the size of the arch,

the whole length of tubular wire. T…
in its inside the whole length, and …
the double clasps. The other pair …
wire which screws into this tube, th…
en or shorten the bar at will. The …
to the teeth, and the bar so adjuste…
ting easy, we have the starting-poin…

To complete this fixture for th…
ward the front teeth, we next sold…
sufficient width for hinge-joints to …
D D D D, which are to receive th…
tubes, which have a screw cut on …
the flat piece on the bar, by first so…

Fig. 114.

an eye, F F F F, consisting of a …
the rivet, holding it to the main …
screwed the spurs, which are to …
teeth to be moved. These spurs …
the teeth by making a slight de…
selves, with such a drill as is use…
metals.

The Doctor's advice to those …
such cases contains some valuabl…

"1. Never undertake to regu…
of teeth are shed, and the second …
not mean by this that we shoul…
irregularity by timely extraction, …

"2. When a case is presente…

… employed is
… The teeth
… be acted upon
… the amount of
… at one time.
… the patient is
… lower teeth, which
… expanding the arch
… As soon as one
… should be taken,
… time necessary for
… days to two weeks,
… of it. If it is but
… a few hours; but, if
… each plate may
… of time which each
… about two weeks, the
… *twenty-eight.* The case
… to complete it. When
… commenced with."
… believed to be the
… for both parties inter-
… experiment, although

… regularity which Dr. Gil-
… aphic Society of Penn-
… a young lady of four-
… essed by the members
… superior laterals stood
… by the central incisors,
… centrals as to leave
… impossible to

draw the laterals into their proper position without sacrificing the bicuspids; at the same time the central incisors raked outward, so as to make the lip unduly prominent. The lower front teeth raked inward so much that they did not approximate the superior teeth when the mouth was closed. The right upper second temporary molar was still in place, and the pulp had been removed from the first lower molar.

"Dr. McQuillen said it was difficult to form an opinion as to what plan of treatment would be the best to adopt in treating a case of irregularity of the teeth when the conclusion had to be arrived at merely from an examination of

FIG. 117.

plaster models. An inspection of the mouth and a view of the features of the patient, in person or by means of a photograph, was a necessary aid in forming a correct diagnosis. He had frequently been consulted by fellow practitioners residing at a distance, who had sent plaster models by mail, but none of them had ever thought of forwarding photographs of patients. The age of the patient, the laxity or density of the tissues, the constitutional peculiarities, were points on which one should be informed, and this could be best acquired by a personal interview. With these drawbacks, he would suggest the introduction of a piece of hickory wood between the superior laterals to act as a wedge and force them past the central incisors, and then would use the silver bar and rubber ligatures, as proposed by him in 1859, the ligatures being attached to the laterals, so as to draw them into their proper position in the arch. During all this time an inclined plane made of hard rubber and fitted to the lower teeth would materially aid in forcing the laterals into their proper position.

"Dr. Long would pursue the same treatment as that suggested by the preceding speaker. If the cuts in the bar on the side toward the cuspids were extended farther back, the ligatures would press the cuspids back at the same time the laterals were being drawn forward.

"Dr. Head: When it was necessary to use ligatures, he had found a plate, with hooks for securing the ligatures, to produce better results than when attached to a bar, which frequently gives rise to serious trouble by slipping up on the gum.

"Dr. Stellwagen: It is essential to success that the patient should be willing to undergo the suffering necessary to accomplish the object desired, namely, a regularly arranged set of teeth; and it will ever be premature if we commence before such consent has been obtained. Hence the patient should have arrived at an age capable of reasoning. A second step in this by no means inviting branch of practice is to study the patient's features, both full face and profile, noting any defects that may be apparent. Many times protracted suffering, and even serious injury, may be avoided by remembering that it is unnecessary to expand the alveolar arch simply to get the whole of the teeth in position, where it is large enough to harmonize with the face and does not impair the voice or mastication. The specialist who unnecessarily prolongs the treatment to save useless teeth at the risk of causing more serious disturbance, as dyspepsia, nervous debility, etc., is as fit a subject for ridicule as the ignorant physician who overloads the digestive organs with drugs for neuralgia caused by an exposed tooth-pulp. While it is questionable or even bad practice to preserve useless teeth, always remember that it is rare that any of the six anterior teeth can be removed without serious deformity resulting from the loss. The first or second bicuspids, from their liability to disease, their secondary importance in speech, expression, or mastication, and finally the spaces left after their extraction being so easily filled and so frequently sufficient for the purposes of the orthodontist, are all-sufficient arguments for the sacrifice of these organs in preference to others. The occlusion of the teeth, the manner in which they tend to interfere with the movement of each other, also the proposed occlusion to be gained after the treatment has been completed, should be taken into account."

The following remarks and illustrations are taken from Tomes's "System of Dental Surgery":

"Some difference of opinion exists as to the best mode of pressing the teeth outward. Recently, vulcanite plates fitted to the palate, and extended over the molar teeth, have been adopted. The vulcanite over the masticating surfaces of the molar teeth is left sufficiently thick to prevent the upper and lower front teeth from influencing each other when the mouth is closed.* The plate is fitted to the necks of the teeth to be operated upon, between which and the plate portions of dry compressed wood are placed, in cavities cut in the vulcanite for their reception. Each instanding tooth will have its corresponding cavity in the plate, the formation of which requires some little attention. The form should be similar to that of a shallow drawer, the front of which has been removed, and so proportioned as regards the upper and lower surfaces of the plate in which it is cut that the section of wood will not fall out into the mouth. The

* It will be unnecessary, except in extraordinary instances, to make the provision here proposed by Mr. Tomes. As described elsewhere, the fixtures and the disinclination to bite unduly will prevent the lower teeth from retarding the movement of the upper ones.—The Author.

wood should be fitted to the cavit
at that end which lies toward the
been adjusted to the mouth, holes
for the admission of ligatures, wh
and tied to one or other of the m
the mouth.

"In arranging the ligatures, ca
do not press upon and irritate the
bered that the gums approach nea
faces of the teeth on the lingu
Hence the holes in the plate sh
corresponding to the free edge of
rests, and continued obliquely in
the line followed by the gum
teeth. If this precaution be o
tied, will pass in a straight line
tooth to the lingual surface of
with the gums. In selecting
ligatures are to be passed, we
and the position of the teeth a
should the temporary molars
make use of them in prefer
The abrupt termination of th
larly suitable for the purpose
which they will be retained r
little consequence.

"By the foregoing means
preparatory to the introductio
cells for the reception of wh
side by the teeth to be move
by the plate. After compre
dry willow, plane, or some o
be cut off, and from these fr
will fit with moderate accur
plate and teeth, taking care
parallel with the long axe

f the upper
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gum, and the
to restore the
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change in posi-
been gained, it
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the irregu-
central teeth
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wood commences to absorb moisture it will expand, and in a direction transverse to that of its grain. In expanding, either the tooth in front of it must move outward, or the plate must be driven backward, and with it the molar teeth to which it is fitted. But, as the front teeth are capable of the least resistance, they are the first to yield, and therefore gradually advance before the expanding wood. From time to time the wedges must be renewed, each new piece being slightly larger than its predecessor; and, as the teeth move upon an axis situated near the apices of their respective roots, the receptacles become changed in form, and it will

FIG. 118.*

be necessary to modify the form of the grooves in the ivory plate. If this precaution be neglected there will be a difficulty in retaining the wood after the teeth have been moved from their original position. The receptacle will have

* "Showing vulcanite plate fitted to the upper jaw, for the purpose of forcing outward the central incisors. The vulcanite is left sufficiently thick over the masticating surface of the back teeth to prevent the lower teeth from influencing those to be operated upon. The plate is retained by ligatures passed through the vulcanite and round the temporary molars; posterior to the central incisors, the apertures of the cells for the reception of the compressed wood are shown. Below the figure, a section of the parts *in situ* is given, showing the cell in its length, with the piece of wood removed and placed underneath."

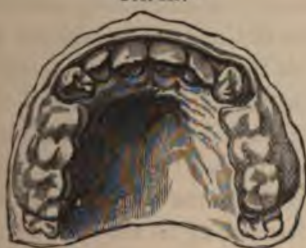
changed in form as respects the relative size of the upper and lower portions. Hence it becomes necessary to deepen that end of the groove which lies near the gum, and the excavation must be made sufficiently deep to restore the parallelism which has been lost by the outward movement of the tooth. When the required amount of change in position is considerable, and the half of this has been gained, it may be necessary to discard the original plate, and substitute a new one fitted close to the teeth operated upon, so as to admit a thinner and more manageable wedge than that which would have been required had the treatment been continued with the first made apparatus.

"It is doubtful whether, as a general rule, more than two teeth can be advantageously operated upon at the same time. If, for instance, the four incisors are involved in the irregularity, it may be desirable to push forward the central teeth first, and then move the lateral teeth, or *vice versa*. But in adopting this plan we must not neglect to take means to prevent the teeth first operated upon from retreating to their old place while the others are being forced forward. This may be accomplished by inserting into the vulcanite frame pegs of wood, the free ends of which rest upon the backs of the moved teeth. In this application of the wood the end of the grain will rest upon the tooth, and, as there is but very slight expansion lengthwise of the grain, the teeth will be simply held in position.

"When the whole of the instanding teeth have been moved outward to an extent sufficient to insure their passing in front of the lower teeth on the mouth being closed, the use of the apparatus may be discontinued. Sometimes, however, it will be found that the back teeth of the upper and lower jaws, from having been kept apart during the treatment, lose their proper antagonism. They become raised in their sockets, and prevent the front teeth from meeting each other; under these circumstances those portions of the vulcanite plate which extended over the masticating surfaces of the back teeth must be removed so as to allow the teeth to come in contact, while the plate prevents the front teeth from falling back into the former position. In a few days the proper antagonism will be restored, and the plate may be discarded.

"Instead of using vulcanite, metal may be used for the plate. The molar teeth on either side are capped with gold, the caps being made so that they fit tightly upon the teeth. From these a band of metal is extended in front of the teeth. Holes are drilled in the band opposite to the teeth, and strong silk thread is passed round the neck of each tooth and through the corresponding holes, and tied tightly on the outer surface of the band. The teeth will by degrees

FIG. 119.*



be drawn toward the band; but the process is a slow one, and requires frequent renewal of the ligatures.

"I have commonly used vulcanized caoutchouc in the place of silk; with this material the tension is more uniform, and the renewals need not be made so frequently. The fixing of the India-rubber to the band was at first a difficulty; tying was impracticable, and hooks could not well be used. I found, however, that by cutting fine slits with a hair-saw obliquely through the metal band, and then passing the two

* "Shows metal caps fitted to the molar teeth, with a band extending from them in front of the incisors. To the metal band so fixed, ligatures, after being passed round the front teeth, were attached, and drew the inverted teeth forward until they came in contact with the band."

ends of the caoutchouc in a state of tension into them, the ligatures were firmly retained. Silk ligatures require renewal every second day, but the caoutchouc will last double the time, and will produce a much more rapid effect. I have in favorable cases succeeded in bringing teeth out in the course of a fortnight, and the case has been dismissed.

"*Torsion, or twisting of the central incisors* upon their axes, is far from rare. The defect in position may be common to and equal in each tooth, or it may be greater in the one than in the other, or it may be confined to one tooth only. Either the mesial sides may be directed toward the palate, or they may be turned toward the lips, or the one tooth may be twisted in the one, and the fellow tooth in the other direction.

"In a case recently under treatment, the right incisor made its appearance at the age of thirteen, with the lingual surface parallel with the median line of the mouth. In this case the tooth is a quarter of a turn out of place; but instances are recorded in which the twisting has extended to as much as half a turn, so that the lingual surface presents to the lips. The patient was a female, aged fourteen years. The right central incisor, up to the age of thirteen, did not make its appearance, consequently the crown of the right lateral and left central teeth leaned toward each other, leaving an interval insufficient for the missing tooth to take its natural position. At thirteen, however, the tooth appeared, with its median side directed toward the lip, but it was not till a year had elapsed that the case came under treatment. The succeeding figure will show the general position of the teeth, and it may be remarked that the canines were slightly more prominent than the anterior teeth. A careful examination led to the conclusion that, supposing the laterals and the left central incisor were pressed out, so as to range evenly with the canines, sufficient space would thereby be gained to allow the twisted tooth to hold the normal position. Acting under this impression, a plate was made to fit the palate, and attached to the bicuspids by wire continued over the crowns of those teeth on either side of the mouth, and terminated by a small T-like extremity, which, by way of protecting the teeth, was covered with a thin investment of floss silk. In this manner the plate was firmly retained in its place.

"The next proceeding consisted in soldering to the back part of the plate two bands, composed of gold, rendered elastic by the addition of three grains of platinum to one pennyweight of the ordinary eighteen-carat gold. The free ends of the bands were adjusted to press outward and from

FIG. 120.*

the irregular tooth the two contiguous teeth, in the manner shown in the accompanying figure.

"In the course of nine days, sufficient effect had been produced to render it desirable that the incisor itself should

* "Shows the right central incisor twisted on its axis to the full extent of a quarter of a revolution, with the adjoining incisors in close contact with its labial and lingual surfaces. The metal plate used in the first stage of the operation is shown *in situ*, with the two elastic bands of gold soldered to the back part of the plate, and the free ends in a position for separating the right lateral and left central incisor in order to gain space for turning the displaced tooth. In the sketch below, the manner of adjusting the wire bands for the retention of the plate is shown."

be acted upon in order that the increased interval should be occupied by the tooth for which it had been obtained. A second plate was constructed. In this a bar of gold was continued in front of the teeth, and attached to the anterior T-piece on either side. Metal cells for the reception of compressed wood were then soldered to the plate and to the band. One was placed so that the wood would press upon the distal angle of the tooth, the other upon the labial surface near the median angle. The forces thus brought into play, acting in opposite directions, turned the tooth upon its axis, and were sufficient to influence the impinging lateral and central teeth, and force them out of the way of the

Fig. 121.*

slowly turning tooth. In a few days it became necessary to alter the position of the receptacles for the wood, and subsequently to move them from time to time toward the retreating angles of the tooth.

"After the second plate had been in use three weeks, the tooth had so far changed its position that the mesial side stood slightly in front of the left incisor, and the distal side

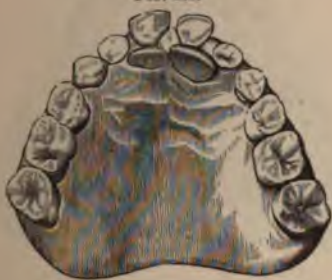
* "Shows the condition of the case illustrated in the preceding figure after the adjoining teeth have been separated by the elastic bands, and the displaced tooth turned slightly from its original position. The plate used in this, the second stage of the operation, is shown *in situ*, with the metallic boxes for the reception of the compressed wood in the positions suitable for effecting the further progress of the treatment. It will be apparent that the boxes will require a change of position when the tooth has moved away from them."

a little posterior to the lateral incisor, presenting a degree of irregularity which would attract but little notice.

"As the left incisor was still a little internal to the arch which would be described if the canines were taken as the guide for its formation, a cell was adjusted upon the plate behind that tooth, and the wood brought into operation. At the same time, the operation upon the lingual surface near the distal angle was continued, and the degree of pressure upon the labial surface was considerably reduced. In the course of a second term of three weeks, the tooth was brought into position, ranging evenly with the contiguous teeth.

"The foregoing illustration will show the principles upon which the operation was conducted, although the wood-re-

FIG. 122.



taining cells are given in one position only. It must be understood that they were moved from time to time, so as to follow up the moving tooth, and so adjusted as to bring the pressure to bear in such directions as at the time appeared to be required."

In Fig. 122, copied from Mr. Tomes, it is manifest that the first step is the removal of the deciduous centrals and them only.

If the permanent centrals have developed no more than they appear to have done in this engraving, it is quite possible to bring them forward to their true position without

14

the necessity of wearing any fixture. Working at them with the thumb by the child itself, or with a bit of stick as a kind of lever, using the lower teeth as a fulcrum, will often succeed. If an appliance is required, one of the various forms of adjusting a gold wire or band in front, to which the teeth may be attached and drawn by elastic ligatures, will be found quite effectual.

Fig. 123, another illustration from Mr. Tomes, "shows a case in which the V-shaped conformation was attended with unusual contraction in the neighborhood of the bicuspid and first permanent molar teeth. On the left side both of the

Fig. 123.

bicuspids were removed, and in the right the second bicuspid was extracted, without any advantage being gained as regards the contracted condition of the palate. The deformity is so great, and the base so contracted, that successful treatment would be attended with great difficulty."

Unless there were circumstances connected with this case which neither the drawing nor the description suggests, it is likely that it would have been found quite as amenable to treatment as the cases of a similar character, described on pages 107, 115. It is astonishing that any one could suppose that the extraction of any teeth could have any tendency to correct the deformity. Expansion of the dental arch was clearly required, and extraction of teeth could under no circumstances promote expansion.

"When the lateral teeth are situated as in Fig. 124, we need not hesitate to remove them, supposing the antagonism is normal, and a more forward position of the central teeth would leave a wide interval between the lingual surface of the upper and labial surface of the lower teeth on the mouth being closed. But if the central incisors in such a case passed behind the corresponding teeth of the lower jaw, it would then be our duty to bring them forward, and afterward force the laterals into the space which would be formed by the previous operation."

FIG. 124.

I somewhat fear that the advice given above by Mr. Tomes to remove the offending laterals is not sufficiently guarded. He says if "the antagonism is normal"; but the *antagonism* with the lower teeth may be regarded as natural, i. e., all the teeth articulating accurately with the corresponding ones, and yet both jaws be too narrow for their proper relation to the face. In many cases which have come under my observation similar to the above, the whole upper arch has been too contracted, and there was found room for the misplaced laterals as soon as the arch was expanded to its proper width. There is also another reason for caution, which is, that it is very common to find some one or more frail or decayed bicuspids or molars, and that, if any teeth are to be extracted, it is better to take the defective ones and then force the laterals into line. But the arguments for and against such practice will be found in full on pp. 45 and 51.

Dr. Angell, of San Francisco, in "The Medical Press," describes his treatment of a case of irregularity for a miss fourteen and a half years of age.

The left canine of the upper jaw was completely outside the arch, the lateral incisor and first bicuspid being close together, and the former so far inside the arch as to close within the teeth of the lower jaw, the contact of which had worn

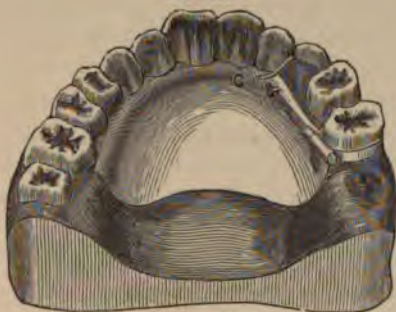
Fig. 125.

the enamel considerably from its labial surface. The exigencies of the case required that the bicuspids on the left side be moved outward and backward. The arrangement of the teeth and the adjustment of the apparatus employed are shown in Fig. 125. The six-year-old molar had been removed because of advanced decay, and the second permanent molar had not then erupted. The description of the screw here used will be found on page 73.

"This apparatus was placed in the mouth, when the shaft D was made to revolve until the fixture was made comfortably firm, when the patient was provided with the key and instructed to keep the shaft as uniformly firm as possible."

In two weeks the jaw was sufficiently widened, and the plate as seen in Fig. 126 was adjusted, the molar and bicuspid of the right side having been moved apart so as to admit a clasp fitted to the molar. A collar was extended from the plate

Fig. 126.



to the posterior proximal surface of the lateral incisor, and a nut was soldered to the plate at the point C, near which the collar was attached, through which a smaller shaft having a thread corresponding to the nut was made to revolve. To

Fig. 127.

the opposite end of this shaft was affixed the common chain-swivel, to which was soldered the original clasp affixed to the extremity of the first shaft. This apparatus was placed in the mouth, and the patient again provided with a key and instructed to apply it often enough to keep up a uniform pressure. Within a few weeks both bicuspids were carried back sufficiently.

The rotating shaft was now removed, and a spring was soldered to the plate at the point to which the nut was originally affixed, and from which it extended so as to press upon the anterior approximal surface of the first bicuspid, as seen in Fig. 127. This spring in a few days moved this tooth so as to leave sufficient space to receive the cuspidatus. The original collar adapted to the posterior approximal surface of the lateral incisor was extended and curved so as to press upon the labial surface of the cuspidatus, and within a week from this application we had the satisfaction of seeing it within the arch it was originally intended to occupy.

PART II.

PALATINE DEFECTS.

CHAPTER VIII.

CONGENITAL AND ACQUIRED LESIONS.

CLEFT palate has usually been said to arise from one of two causes, a congenital or an accidental: the congenital, as

FIG. 128.

its name implies, dating from birth, and its origin being an arrest of development; and the accidental, as its name implies, being the result of accident or disease.

Strictly speaking, *cleft* palate is almost always congenital, for the following reasons: In cases where the deformity arises from an arrest of development, there is a longitudinal fissure of the palate on the median line, never elsewhere, and always a fissure; while, in cases of injury to the palate by accident or disease, the loss of the organ is sometimes partial and sometimes entire, rarely resulting in any two cases in a loss exactly the same—frequently in a destruction of the posterior border and adjacent tissues, and in no wise

Fig. 129.

resembling a fissure. Such defects are not uniform in locality nor in extent. They consist sometimes of simple perforations, and at others involve the destruction of the velum, a considerable portion of the os palati, the vomer, turbinated bones, and maxilla, and the loss of a greater or lesser number of the teeth.

Fig. 128 represents a congenital fissure of the velum only; Fig. 129, a fissure of the soft palate, hard palate, and

Fig. 130.

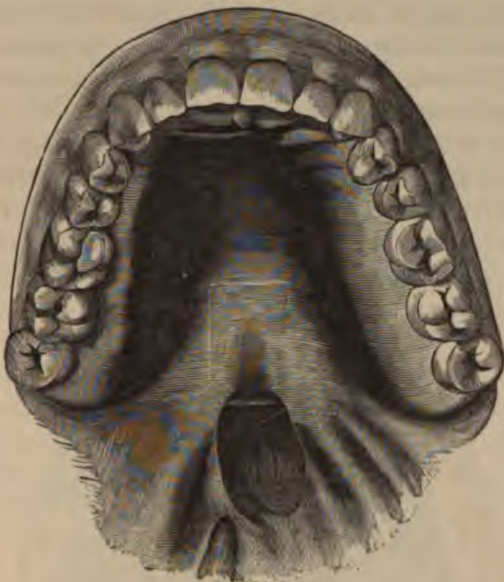
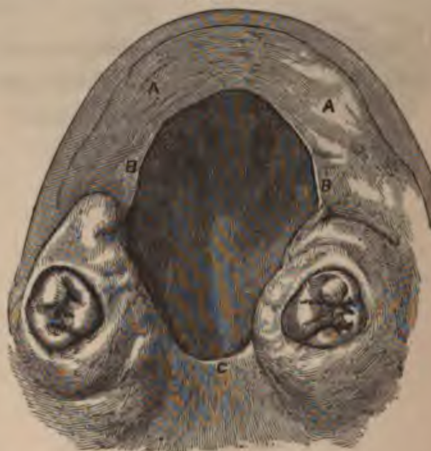


Fig. 131.

maxilla, also congenital. Letter A indicates the *vomer*, B B the *turbinated bones*, and C C the bifurcated uvula. Fig. 130 shows a partial destruction of the soft palate by disease; in this case a cicatricial union has formed between the remnant of the velum and the pharyngeal walls. Fig. 131 shows a *perforation* of the hard palate arising from the same cause, and Fig. 132 illustrates the entire destruction of the roof of the mouth in front of the soft palate, including the adjacent maxilla and the bones of the nasal cavity, also caused by disease.

Fig. 132.



It is uncommon to see the loss of a portion of the palate by accident or disease, which bears any other resemblance to a cleft palate than a want of entirety; therefore, it may be said that true cleft palate is always congenital. This defect is usually accompanied by more or less deformity of the sides of the alveolar arch and of the teeth. Sometimes the sides of the arch are forced too far apart, but it is more common to find them contracted or pinched together, the result, probably, of the pressure of the external muscles where the osseous bridge between the sides is wanting. The teeth are often irregular, because of the deformity of the maxilla upon which they are placed, and this is especially the case with the teeth in the vicinity of the fissure through the alveolar arch. If the defect follows only one of the intermaxillary sutures, the adjoining canine on one side of the fissure and the lateral and central incisor on the other side will be likely to be twisted or tipped from a normal position, and in some cases undeveloped. In cases of double fissure, where the cleft follows both intermaxillary sutures through the alveolar border, the incisor teeth which belong to the premaxillary bone are always defectively developed and abnormally placed.

The origin of cleft palate, as before stated, lies in an arrest of development, the causes of which arrest are unknown. Certain it is that the arrestation occurs at a very early period of fœtal life, probably before the end of the second month. The development of the fœtus being simultaneously from the two sides and uniting on the median line, it is found in a normal development that union has taken place by the end of the tenth week; consequently the causes which operated to induce the arrest were in action before that time. There has been some evidence that the deformity was inherited, but, even if such cases were traced back through the ancestry until we arrived at the initial, we should be equally at a loss to account for the first arrestation. On the other hand, by far the large majority of cases seem to be free from all inherited taint, and are isolated cases in the family. It does not seem to be confined to any class or condition in life, and, like other departures from a normal type, examples may occasionally be found among the most cultured and the purest blood; but the large majority of cases come from the lower walks of life—from the poorly nourished and physically depraved.

The fissure of the velum or palate varies very much in its extent in different individuals, showing that in some cases the active causes were not operating until the union at the median line was nearly complete, with sometimes so slight a fissure as a mere bifurcation of the uvula, while in others the arrest was at such an early period that it prevented a junction of any part of the two halves of the hard and soft palates, prevented a junction of the intermaxillary with the maxillary bone, and also prevented the perfect formation of the upper lip, thus presenting the deformity known as harelip. Thus we frequently see cleft palate without harelip, and sometimes, though very rarely, harelip without cleft palate. When the fissure involves the maxilla, it follows the median line from the uvula until it reaches the intermaxillary bone, when it turns aside and continues along one of the intermaxillary sutures; and, if the lip is involved, the fissure of the lip always corresponds with the termination of the defective suture. Consequently, a fissure of the lip is never on the median line, but always at one side.

In cases where the palatine fissure involves both maxillary sutures, there appears in front a compound or double fissure of the lip. In such instances, previous to a surgical operation, the upper lip appears to be entirely wanting; the intermaxillary bone is suspended from the nasal septum, and in the roof of the mouth the vomer hangs along the median line without being joined or articulated to the maxilla on either side.

Neither cleft palate nor harelip is an arrest of union merely, but an arrest of the formation of both hard and soft tissues. If there were full development of tissue and only failure of union, the evils following would be much easier remedied. This evil is not so serious with the defective lip as with the defective velum. In the former case the adjoining abundant tissue is a reserve upon which the surgeon can draw with impunity; in the latter there is a scantiness of tissue and no adequate reserve. Consequently the former cases, when in the hands of a skillful surgeon to remedy, are always a success, while in the same hands the latter are frequently failures.

A fissure of the palate would naturally be supposed to affect primarily deglutition, and the earliest efforts at a remedy were directed to this point; but a closer observation has shown that in the adult deglutition is not impaired, the regurgitation of either fluids or solids being very rare. With the infant, the position of the head in taking nourishment is favorable to deglutition, and long before it has reached maturity it learns by management to overcome the inconvenience or difficulty in swallowing. Accidental lesions, however, coming generally in adult life, produce in this respect very great inconvenience. In both cases (accidental and congenital) the faculty of distinct articulate speech is seriously impaired by defects of any extent.

The only evil arising from congenital cleft palate which demands the interference of science and art is its impairment of speech. With a loss of any portion of the palate, whether congenital or accidental, sufficient to make a permanent communication between the buccal and nasal cavities, the perfect articulation of any spoken language is impossible. In the English language, spoken with a defective palate, the sound of D approximates to the sound of N, that of B to M; K and G become impossible except under very peculiar conditions; and S, T, and Ch become difficult and sometimes impossible. Besides, the resonating tone-character of both buccal and nasal cavities becomes entirely changed by their partial or complete union, or by the change in their form and dimensions. From these various causes the speech of people so afflicted becomes altered in tone, indistinct in its enunciation, wanting in many of its sounds, difficult and sometimes impossible to understand, and altogether disagreeable. To such an extent has this cause, and this alone, operated on a sensitive mind, that it has often in the absence of relief driven the sufferer from society and made him utterly wretched. This is quite sufficient to call forth all the resources of science in seeking a remedy.

The cure for these evils must be the closing of the abnormal passage by some means which will restore to the deformed organs their functions. In perforations of the hard palate, unless of extraordinary extent, the method is very simple. In the loss of the soft palate by disease the remedy is more difficult; and in extensive congenital deformity still more complicated means must be resorted to. The treatment of these lesions has been both surgical and mechanical. The congenital defects have been treated by both surgery and mechanism, but the acquired cases have been almost always relegated to mechanism.

The surgery of congenital fissured palate is embraced within the last half century. The first effort of the kind was made by a dentist, Le Mounier, in 1764; but no importance was attached to the operation until the time of Roux, who performed it upon a young American physician in Paris, about the year 1825; and in this country about the same period the operation was successfully performed by Dr. John C. Warren, of Boston, who was at the time in ignorance of the success of his Parisian *confrère.* To these gentlemen is due the credit of the revival of staphyloraphy, and in later years to Ferguson and Pollock, of London, who contributed much by their skill to its surgical success.

Staphyloraphy (a word of Greek derivation, signifying suture of the uvula), although rapidly falling into disuse, is still maintained by some as being the only treatment which such cases should receive. It is performed by paring the edges of the cleft velum, and uniting them with sutures. Sir William Ferguson, who probably attained a larger percentage of success during his time than any other surgeon, found that success dependent upon the division of the levator and tensor palatal muscles. Without this division the strain upon the sutures was such as frequently to break up the junction and destroy the union; with the tension taken off by the division of those muscles, the percentage of union was largely increased.

The fact that such distinguished authority should adopt and continue to practice such an operation during his lifetime was quite sufficient to stimulate others to adopt it without question as to its beneficent results. But one thought in the interest of patients has seemed to govern all surgeons in this practice, which was, that a roof to the mouth of natural tissue must be better *per se* than no roof or than an artificial one; and, although the practice has been tested in a thousand cases by the most eminent surgeons of their time, it has resulted in such a uniformity of failure, considered as a beneficent operation, that it should have been utterly abandoned long ago. Certain it is that it has been performed many times when the only apparent object was to gain *éclat* by the skillful use of the knife in a difficult case before an admiring audience, and with no possible hope of even a union or a surgical success. The only cases in which surgical interference is justified are those rare ones of slight separation and with an abundance of tissue, where the division of the aforenamed muscles would not be essential to success; but, of hundreds of cases that might seek surgical aid, very few would come under this exception. The reasons for failure are based upon the anatomy and physiology of the vocal organs, and upon the mechanism of speech, for the full understanding of which the reader is referred to the chapter upon that subject, but which may be briefly stated as follows:

Articulate speech is the result of certain definite sounds, the combination of different sounds, and of interruptions to such sounds, which are by common consent associated with definite ideas, and thus express them. The voice as it issues from the larynx is modified in its tone and character by resonance in the buccal or nasal cavities separately, and in certain cases simultaneously by both. It is directed or interrupted in its passage by certain organs with which it comes in contact, and thus an almost endless variety of tones and combinations of tones is created.

One of the most important organs in this direction (interruption of voice) is the velum palati. It is essential to the perfection of human speech that the nasal passage for the outflow of sound should at certain times be completely shut off, and all the sound directed through the mouth. If in such cases there be any escape of sound behind the curtain of the palate, the purity of speech is destroyed. The soft palate, in conjunction with the muscular wall of the upper pharynx, must be under active control to produce this result. If the palate be deformed, or either it or the pharyngeal walls paralyzed or inactive, we shall find a change in the tone of the voice, and more or less indistinctness of utterance, depending upon the extent of the deformity or inactivity. The proverbial nasal twang of the "Yankee" is entirely owing to an inaction of these two organs. There is in those cases an escape of sound into the nasal cavity which is altered by the resonance of that cavity, and which should have been shut off. In passing, we may say that this is not owing in any sense to a deformity of those organs in the "Yankee," but rather to a lazy habit of speech imitated necessarily by the children whose ultimatum is to copy their elders, and thus the habit becomes confirmed as the normal condition of the speech of a whole community. But the function of the velum palati in articulate speech is not confined to the interruption of the nasal passage; in the formation of certain sounds it must be depressed and held in firm contact with the dorsum of the tongue, and the sound directed and prolonged through the nasal passages. All this involves a palatal organ of flexibility, mobility, and extent.

The reason why staphyloraphy is so generally a failure, even where it is a surgical success, is because the newly formed septum is rigid, tense, and deficient in length; in the large majority of cases it can not by any possibility be brought into firm contact with the pharyngeal wall, and imperfect speech will necessarily and always follow this defect. To the credit of surgery be it said that it has done probably all it can under the circumstances, and the only surgical hope of the future seems to lie in the direction of making the operation at a very early period of life, with the expectation that, as the organs develop in tissue, function, and activity, the defect will be overcome.

As surgery fails, mechanism comes to the rescue. Where Nature is deficient, she is supplemented by art, and an organ whose function was destroyed by accident, disease, or want of development, can have that function restored by properly adapted mechanism. The restoration of speech to a person who has once possessed that faculty and lost it through a destruction of the palate, is comparatively easy; but to confer the faculty of perfect speech with an artificial organ, upon one who has been afflicted from birth with the absence of the natural organ, and has grown to maturity without the ability of distinct utterance, is a much more difficult problem. In acquired lesions even crude appliances, made without much skill or accuracy, are often very beneficial; while in congenital cases the full resources of science and the nicest adaptations of art are needed to accomplish the desired result.

The partial destruction of any organ of speech may occur after the acquirement of speech, and nature makes an extraordinary effort to overcome the difficulty by a new use and activity of other organs which in a measure supply the deficiency. Thus, the total loss of speech would follow the destruction of the hard palate, but an instant restoration would result upon the introduction of an obturator. But in a congenital case the faculty of perfect speech must be acquired by practice even after the introduction of the most skillfully constructed and scientific appliance. In a description of the treatment of these cases the two classes and the different conditions above referred to must be kept distinctly in the reader's mind.

All apparatus adapted to the roof of the mouth, whether forward or back, to the hard palate or soft palate, may properly be designated as *artificial palates;* but as such instruments may be divided into two distinct classes, operated upon different principles, and applied in the main to entirely different cases without the possibility of interchange of principle, I therefore denominate the one an *obturator*, and the other an *artificial velum.* An obturator, according to this distinction, is a stopper, plug, or cover, hard, non-elastic, and stationary, fitted to an opening with a well-defined border or outline, and shutting off the passage. Such instruments are of nearly universal application to perforations of the hard or soft palate resulting from accident or disease, but they are rarely applicable to a congenital fissure of the velum. An artificial velum is not a stationary stopper, but an elastic, movable valve, under the control of the surrounding and adjacent muscles, closing or opening the passages at will, and is applicable especially to congenital fissures, occasionally where the soft palate has been destroyed, but never to perforations of either the hard or soft palate.

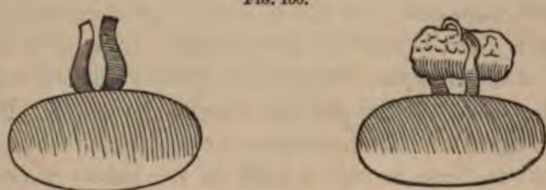
CHAPTER IX.

HISTORY OF OBTURATORS.

THE term obturator is taken from the Latin *obturare*, signifying to *stop up;* and history shows obturators to have been among the earliest applications of mechanism to the mouth. The first recorded definite suggestion of a piece of mechanism to act as a palatine obturator is that of Alexander Petronius, who preceded the celebrated Ambroise Paré by a few years. He says: "If the decayed bone of the palate falls of itself, or if we extract it, the pronunciation is altered so much so that the patient can scarcely be heard. But it is possible, in certain circumstances, to repair this loss; for example, when there is only a hole in the palate, we can stop it up with cotton, with wax, with a gold plate, or in any other way that the genius of the artist suggests, having care to give to these instruments the same concave form as the palatine vault."

The first definite description of an obturator was by Ambroise Paré, whose first work was published in 1541; and although Guillemeau, writing fifty years later, says that obturators were applied by the Greek physicians, it is quite likely it was more a matter of inference by him than an authentic record of a fact. That the principle of an obturator was known to the ancient physicians, and that such a principle would be easily and naturally conceived by a person suffering from a perforation of the palate, is more than probable; and therefore it is likely that relief was obtained by the very simple means within the reach of every one, such as a piece of sponge or wad of lint thrust into the perforation, or a piece of thin leather, or any membranous substance which could serve the purpose temporarily of a stopper or covering. But the first recorded attempts at making a permanent obturator by mechanism are those of Paré before mentioned. Paré's description is as follows: "Many times it happeneth that a portion or part of the bone of the palate being broken with the shot of a gun, or corroded by the virulency of the Lues Venerea, falls away, which makes the patients to whom this happeneth that they cannot pronounce their words distinctly, but obscurely and snuffling; therefore I have thought it a thing worthy the labour to show how it may be helped by art. It must be done by filling the cavity of the palate with a plate of silver or

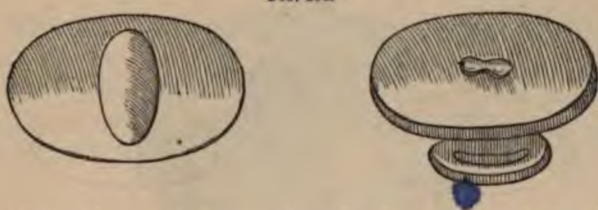
FIG. 133.



gold a little bigger than the cavity itself. But it must be as big as a French crown, and made like unto a dish in figure; and on the upper side, which shall be towards the brain, a little sponge must be fastened, which, when it is moistened with the moisture distilling from the brain, will become more swollen and puffed up, so that it will fill the concavity of the palate, that the artificial palate cannot fall down, but stand fast and firm, as if it stood of itself." (See Fig. 133.) "This is the true figure of those instruments whose certain use I have seen not by once or twice, but by manifold trials, in the battles fought beyond the Alps."

Paré gives also another form of obturator, as shown in Fig. 134, which resembles very much the cuff-button of the modern toilet. The larger button or disk being adapted to the roof of the mouth, and covering the opening, was connected by a revolving stud or screw to an oblong disk, which represented the extreme length of the perforation. The head of the stud passing through the larger disk, and being accessible to a pair of forceps, enabled the wearer to pass the instrument through the opening, when, by revolving the stud, the long diameter of the upper disk was made to bridge the short diameter of the perforation, and thus sustain the obturator. The efficiency of such obturators, if properly adjusted, would seem to leave nothing to be desired. The loss of speech would be instantly restored, and comparatively little inconvenience would be the immediate result; but time would develop the fact that any pressure by a foreign substance upon the adjacent tissues would produce

FIG. 134.



their absorption, and the continued enlargement of the fissure and the swelling of the sponge by the absorption of moisture would be eminently conducive to such a result. I have myself seen a case recently where a patient had made a wad of cotton fulfill all the offices of an obturator, and thus enlarge an opening of moderate size through the roof of the mouth, until its boundaries were the alveolar ridge and the soft palate. (See Fig. 170.) The principal objection to the stud form, Fig. 134, is that it would prevent a final closing of the aperture from natural causes, experience having shown that, in many cases where the aperture is only bridged over, healthy granulations form, and ultimately the gap is completely filled.

About fifty years subsequent to the publications of Paré appeared those of Jacques Guillemeau, but the instruments which he describes seem in no way to differ from those of his predecessor. He continues the use of the sponge, mounted in the same way, and also the stud-button.

In 1756 Laurence Heister describes an obturator, but it is the concave disk of Paré, with but a slight change in the method of attaching the sponge. These two methods appear to have been the only ones adopted during a period of nearly two hundred years.

In 1728 "Le Chirurgien Dentiste," by Pierre Fauchard, was first published. Fauchard described and illustrated

Fig. 135.

much more complicated mechanism for this purpose than anything which preceded him; nevertheless, the principle of support was much the same as that of his predecessors. He depended upon passing through the aperture and resting upon the superior surface of the surrounding border; but he can be readily pardoned such a course with such instruments as were complicated with artificial teeth in a mouth where there were no remaining natural teeth which would give support. As he seems to have been the first to construct such formidable apparatus, the ingenuity which he displayed in their contrivance entitles him to much credit. The plan which he adopted was that of a "concave-convex plate to cover the fissure; to the center of the convex surface he attached a tube, through which passed a screw, to the superior extremity of which were attached two wings; the inferior extremity terminated in the concave surface of the plate in a small head. The wings were folded together and passed through the fissure, and, when the artificial palate was in its place, the screw-head was turned, and the wings were spread across the fissure, and rested on the nasal surface of the roof of the antrum of Highmore. The wings had each a small piece of sponge attached to their under surface, which readily adapted itself to the surface on which it rested, and thus the pressure of the wings on the tender mucous membrane

FIG. 136.

FIG. 137.

could be tolerated." Various appliances of his are illustrated in Figs. 135 to 139.

No improvement was made upon Fauchard until Bourdet, who published a treatise in 1756, recognized the evils of wearing an instrument in the aperture, particularly the expanding sponge, and recommended arching over the vault of the palate by thin sheet metal, supported by attachment with silken ligatures to the teeth on either side, and thus not only prevent the enlargement of the orifice, but assist nature in the effort to reduce it.

FIG. 138.

FIG. 139.

Nothing of importance in the history of obturators appears again until the advent of M. Delabarre, who published his treatise on "Mechanical Dentistry" in 1820. He adopted the ideas of M. Bourdet, and improved the instrument by substituting metallic bands about the teeth, after the manner of the modern clasp, in place of the ligatures, for support. The ligature created an irritation of the gums which the

FIG. 140.

clasps avoided. Fig. 140 illustrates the improved obturator of Delabarre. The same author contrived another and somewhat formidable apparatus, which was an obturator and velum combined; but as the description of the instrument comes more properly under the head of artificial vela, the reader is referred to a subsequent chapter upon that subject for the details. p 260

Up to this period we are indebted entirely to the French for skill in this department, and for its record. All of the aforenamed authors were French; but since that period the art and the literature have passed entirely into the English language, with one notable exception—M. Preterre, of Paris, who has made a larger number of protheses for the buccal cavity than any or all of his predecessors.

The first English author of any importance was Mr. Snell, who published a treatise in 1828. His obturators for perforation of the hard palate were adapted in recognition of the principle of simple juxtaposition as advanced by Bourdet; and, as a proof of the correctness of the principle, he cites a case under his treatment where two apertures of considerable dimensions were covered, and ultimately contracted and closed entirely. This pathological fact being now confirmed by fifty years of experience added to Snell's, determines the true principle upon which all obturators or simple perforations should be based. In the more complicated cases of accidental lesion, requiring an obturator and velum, Mr. Snell seems to have had considerable experience, and, from his own account, very marked success. The cases which he relates in his treatise are exceedingly interesting, and show a true perception of functions to be restored, and a scientific skill in the adjustment of apparatus which would put to shame some of the vaunted superiority of the present day. His most ingenious appliances in which a velum was required were a marked improvement in simplicity over his predecessors, a detailed description of which will be found in a subsequent description of artificial vela.

In 1841 Dr. Warren Rowell, of New York, constructed an obturator which was sufficiently peculiar to entitle it to a place in history. The case was one of extensive loss of the roof of the mouth, including nearly all the teeth, the vomer, and turbinated bones. The posterior portion of the palatine aperture was formed, to a considerable extent, of a semi-cartilaginous substance, possessing sufficient elasticity to allow a larger body than the opening to be pushed up through it, and when so forced up it would be supported above the aperture by the edge returning to its original position. This, he hoped, would support a light plate, if the obturator could be so shaped as to rest upon the cartilaginous ledge after it

Fig. 141.

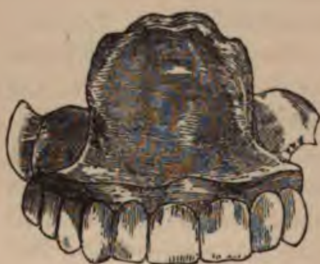


Fig. 142.

was introduced. Without quoting the description which is given of his method of procedure, it will be sufficient to state that the obturator which he constructed consisted of a plate larger than the opening in the palate, and covering the anterior part of the alveolar ridge, to which artificial teeth were attached, and an irregularly shaped drum or air-chamber, larger above than below, where it was connected with the palate plate. "The neck of this bulb or drum is of the exact size of the opening in the palate, and the upper part or summit has several depressions, which correspond with the irregular surfaces of the remaining nasal bones. The anterior part of the palate plate, to which the teeth are attached, as may be seen in Fig. 141, is composed of two plates, to compensate by its thickness for the deficiency of the alveolar ridge. The drum is seen rising from the palate plate, to which it is soldered. In Fig. 142 is represented a lateral view of the piece. The palate plate and drum are composed of fine gold, and made very light."

Of this obturator it is stated that it was worn for several years with entire satisfaction, and restored the functions of mastication, deglutition, and speech. Nevertheless, the weight of the piece must have been such, together with the strain upon the orifice in its constant removal, that it could not have been permanently supported by resting upon the superior border of the aperture. It is quite likely that its permanent usefulness arose from the nicety of its adaptation, and from the skill acquired by the patient in its management. We see this last principle illustrated often in cases of badly-fitting dentures on the upper jaw, that will not keep their position for a moment except by the constant activity of the adjacent muscles, and yet the wearers will retain them in position during the most lengthy and trying ordeals. Dr. Rowell's obturator was probably so well adapted to such a case, that there could be no improvement upon it in form, and it could be bettered only by a change of material for something of less specific gravity.

Dr. S. P. Hullihen describes in the "American Journal of Dental Science" an obturator which he constructed for a case where the velum was lost by disease. He says:

"An artificial palate made upon this plan will be composed of four parts: 1, a valve, made from gold plate, as thin as it can well be worked; 2, a spiral spring about an inch long, and of the size usually made for whole sets of teeth; 3, a slide, one inch and a half in length, and of the width and thickness of a common watch-spring; 4, a plate, larger or smaller, as the case may require, struck up in the usual way, to fit the roof of the mouth. The size and form of the valve are obtained by taking an impression of the posterior opening of the nares. The plate composing it should be struck up in two parts, front and back, which, when soldered together, makes a hollow body (*a*), as shown in Fig. 143. At the upper end of the valve a small pin is soldered,

Fig. 143.

the point of which looks downward, and of sufficient thickness to fit very tightly in one end of the spiral spring. The spiral spring must be made of such a length as will permit the valve to rest slightly upon the upper surface of the remnants of the lost velum. The slide has a pin in the posterior end, looking upward to receive the other end of the spiral spring before described. The anterior end of the slide has a small button looking downward. The slide is attached to the plate by two small clasps (*b b*), as represented in Fig. 144.

Fig. 144.

The plate may be made to cover the entire roof of the mouth, when necessary; or it may be made only sufficiently large to permit the mounting of the slide. These different plates, when put together, particularly if the plate is to cover the whole roof of the mouth, make a plate of the form represented by Fig. 143. Fig. 144 shows the attachment of the spiral spring to the valve and slide (*c c*). The staples (*b b*) confine the slide to the plate, and there is a button (*d*) on the end of the slide, by which the valve may be set back or forward, as desired by the patient, without removing the plate from the mouth.

"The plate should be made to fit the several parts for which it is intended with great exactness. The plate must fit the roof of the mouth, and the teeth to which it may be secured, in a faultless manner. The slide must be arranged so as to permit the valve to be drawn so closely against the posterior opening of the nares as to close them, or to be pushed back, so as to leave them entirely unobstructed. The spiral spring, as I have before remarked, must be made of such a length as will allow the valve to rest slightly upon the upper surface of the remnants of the lost velum. The valve should be sufficiently wide at its base to overlap the remnants of the velum so far as the parts on each side will permit without producing irritation. No other part of the valve than the base should be allowed to touch, unless when brought forward against the nares. Unless all the parts are so arranged, the palate will not be properly constructed, and will not, of course, answer the desired end.

"Thus it will be perceived that the peculiarities of this plate are: 1, a valve to fit the posterior opening of the nares; 2, the attachment of this valve to a slide, by which the patient is enabled to adjust the valve while in the mouth in such a way as to admit through the nares just the quantity of air desired; 3, the mounting of the valve on a spiral spring, which will permit it to vibrate backward and forward as the breath is inhaled or exhaled, and also to be moved by any muscular action that may remain in the remnants of the lost velum, thereby answering, to a great extent, the purposes of a velum."

It is hardly conceivable that such an instrument, bearing in no sense a resemblance to the lost organs, could possibly restore to any degree the lost functions. That it might have been of some benefit in a single case is possible; but as a principle for general application it is defective, and, in view of modern improvements, the experiment is not likely to be repeated.

In 1858 Professor Buckingham, of Philadelphia, made an obturator for "a gentleman who on a previous occasion had

FIG. 145.

a tumor removed, which covered a portion of the posterior surface of the hard and the anterior surface of the soft palate. The surgeon, on its removal, had divided the velum and uvula, so that the case resembled a congenital deformity. The attempt had been made twice to bring the soft parts together again by a surgical operation, which had failed. Fig. 145 shows the appearance of the parts very clearly—the letters A and B showing the thickened muscles as they hung down on the side of the pharynx. He made for this case an obturator (Fig. 146), the plate of which covered the whole of the roof of the mouth, with a bulb attached to extend up into the posterior nares, and well back toward the antero-posterior walls of the pharynx, leaving but a small space between them. This obturator enabled the pa-

FIG. 146.

tient to eat and drink without annoyance; without it food would pass into the nares and occasion much inconvenience. It also greatly assisted his voice, as many of his words could not be understood when it was not worn, but he could articulate them with great distinctness when it was in place."

FIG. 147.

In January, 1858, Dr. J. D. White published in the "Dental News Letter" a description of an obturator combined with nearly an entire set of artificial teeth, in a case of traumatic lesion of the palate. The lost substance is sufficiently represented in Fig. 147 to be understood. The principal interest in this obturator lies in the materials used. A silver plate was approximately fitted to a cast made in the usual way from an impression of the parts, and a rim of silver was raised around the alveolar border to which the teeth were soldered. But over the whole of this silver plate, upon both sides, was covered gutta-percha. The silver plate was small enough to be completely imbedded in the gutta percha, and knobs of the same material were formed to plug the openings into the nasal cavity and into the antrum. The completed instrument is shown in Fig. 148. The appliance was made before vulcanite came into general use; otherwise it would probably have been preferred, as being much more

FIG. 148.

durable. Gutta-percha, however, answers an excellent temporary purpose where immediate use is required.

In the "Dental Cosmos" for 1860 is described an obturator made by Dr. McGrath to supply the loss of the soft palate as shown in Fig. 149, the result of syphilis: "The fissure extended from the posterior opening of the nares through the velum to the palate bones, and was nearly an inch in breadth. The uvula was entirely gone, as well as the lateral half arches, and along with them the palato-pharyngei and constrictores isthmi faucium muscles. In this case deglutition was impaired to a great extent: the food would pass into the nares, and the fluids would also pass into the nasal cavity and out through their anterior openings. The disease had not confined itself to the palate, but, extending to the nasal organs, had completely destroyed their internal structure as well as a portion of the nasal bone, to such an extent as to materially change the external shape of that organ.

"The obturator constructed for this case was of one piece, and made to cover the hard palate completely, extending from the central incisors to the posterior wall of the pharynx,

FIG. 149.

ynx, and passing a short distance beyond the edges of the opening on each side. (See Fig. 150.) The plate was made to press firmly against that portion of the soft palate which remained, yet not so firmly as to be the cause of irritation, the edges of the plate being slightly bent downward for the same reason; the object being to prevent the possibility of the soft parts being drawn above the palate, which would afford a communication with the nares. The posterior edge of the obturator was bent downward at a right angle with the body of the palate, and curved so as to form with the posterior wall of the pharynx an oval opening sufficiently large to permit the patient to breathe freely through the nostrils. In the act of deglutition the muscles would contract and press against this portion of the plate, thereby cutting off the communication with the nares. To this plate were attached three artificial teeth, two lateral incisors and one molar, the whole being retained in position by means of clasps around the teeth."

FIG. 150.

We come now to the consideration of the most scientific obturator which has ever been applied to natural deformities.* In all the cases described in the foregoing pages, the instruments were constructed for, and applicable to, accidental lesions only. Whenever a case of congenital fissure presented itself, and any really scientific effort was made to supply the functions of the undeveloped organs, it was by an

* The author is not prepared to admit that this obturator is the most scientific *instrument* for congenital fissure; but, keeping up the distinction between obturators and vela, it is the most perfect *obturator*.

attempt at an artificial velum—Snell and Stearn both claiming complete success in such cases, not by an obturator, but by a flexible elastic velum. According to the theory followed by them of expecting articulate speech to result only from the same muscular activity as with perfectly developed organs, it would be impossible for the same kind of utterance to follow from a totally different kind of an organ. Hence, the natural velum being of a very elastic character and an important organ of speech, it was not deemed possible for the function of speech, destroyed by its absence, to be restored by any appliance that did not resemble the natural organ in the important characteristics of elasticity and flexibility. The idea was lost sight of that speech is not a natural function, like digestion or respiration, but a function acquired by the education of certain muscles, which are trained to produce such effects; and consequently, if the power of certain muscles were destroyed, it might be possible to train other muscles to new uses and produce similar results. It could only be in accordance with this last suggestion that an *obturator* could be of benefit to articulation in a congenital fissure of the palate.

In 1867 Dr. Wilhelm Suersen described before the Central Association of German Dentists, at Hamburg, his method of constructing obturators, in which he announced a principle in the mechanism of speech with an artificial organ which had never before been advanced. From a report of his lecture in the "American Journal of Dental Science," for December, 1867, I make the following extract:

"In order to be able to pronounce all letters distinctly, it is accordingly necessary (besides other conditions, which are far away from our present subject) to separate the cavity of the mouth from the cavity of the nose by means of muscular motion. That separation is, under normal conditions, effected, on the one hand, by the velum palati, which strains itself (consequently by the levator and tensor palati); but on the other hand, also, by a muscle which, to my knowledge, has, in connection with these operations, not yet received a sufficient amount of attention—I mean the *constrictor pharyngeus superior*. This muscle contracts itself during the utterance of every letter pronounced without a nasal sound, just as the levator palati does. The constrictor muscle contracts the cavum pharyngo-palatinum, the pharynx wall bulging out; and it is chiefly on the action of this muscle that I base the system of my artificial palates.

"These palates, which in all their parts are made of hard caoutchouc, consist of a teeth-plate suitably attached to existing teeth, and which, at the same time, covers the fissure in the hard palate (if such a fissure exists). Where the fissure commences in the velum, that plate terminates in an apophysis broad enough for filling up the defect. This apophysis is at the same time of such thickness as to keep up a contact between the high edges forming the sides of the apophysis and the two halves of the velum, even when the levator palati is in activity. To bring about this contact the more surely, the high edges forming the sides do not rise straight, but obliquely, toward the outside. The lower surface of the apophysis, turned toward the mouth, lies on about an equal level with the velum, *if the latter is raised by the levator palati*. But, when the velum hangs loosely downward, the back part of the artificial palate is lying over it. This back part, accordingly, fills up the cavum pharyngo-palatinum, and in such a manner as not to impede the entrance of the air into the cavity of the nose when the constrictor pharyngeus superior is inactive. Thus the patient can without any impediment breathe through the nose. But, as soon as the constrictor contracts the cavum pharyngo-palati (this happens, as I will repeat for the sake of clearness, in the utterance of every letter with the exception of *m* and *n*), the muscle already named reclines against the vertical back surfaces of the obturator. By this operation the air-current is prevented from entering the cavity of the nose and compelled to take its way through the mouth, and thus the utterance loses its nasal sound. To the existence of those vertical surfaces, and consequently to the thickness of that part of my palates which fills up the fissure in the soft palate and the cavum pharyngo-palatinum, I must attach special importance. But for that thickness, the levator palati, when it rises upward, would not remain in contact with the side-edges of the obturator, nor would the constrictor pharyngeus be able to effect a sufficient termination if the portion of the obturator nearest to it consisted only of a thin plate."

The following engravings illustrate the instruments described above:

Fig. 151.

Illustration I.—Case of an acquired defect of the soft palate.

Fig. 151.—Representation of the mouth without the apparatus.

Fig. 152.—The apparatus *in situ.*

Fig. 153.—Side view of the apparatus.

Fig. 154.—The apparatus seen from the back.

Fig. 155.—The apparatus seen in front.

Fig. 156.—The apparatus seen from below.

Fig. 157.—The apparatus seen from above.

The plate *a* and its narrow and thin apophysis *i*, which extends from the boundary *b* of the hard palate to the commencement of the defect *c*, serve only as supporters to the real thick obturator *d*. The latter lies in the pharyngo-pala-

Fig. 152.

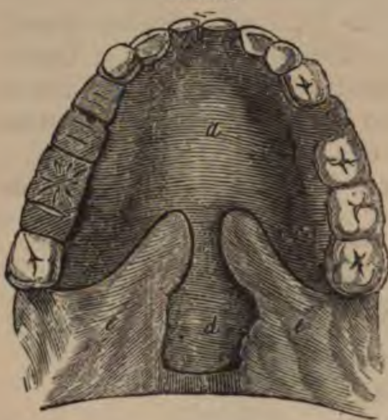


Fig. 153.

tine hollow, so that the lower surface of the obturator turned toward the mouth is about on the same level as the rest of

Fig. 154.

the velum palati, *e*. Against the vertical side *f* and back-edges *g* of the obturator, the walls of the pharynx lean, if

Fig. 155.

the latter is contracted by a contraction of the superior constrictor of the pharynx. But, if the muscle just mentioned in activity, the obturator does not touch the pharynx The contraction of the constrictor superior, therefore, the valve formed, with the help of the obturator, be-

Fig. 156.

the cavity of the mouth and that of the nasal bone, any relaxation of the above-mentioned muscle immedi-eopens that valve.

Fig. 157.

.ustration II.—Case of a constitutional fissure of the nd soft palate.

Fig. 158.—Representation of the mouth without the apparatus.

FIG. 158.

Fig. 159.—The apparatus *in situ.*
Fig. 160.—Side view of the apparatus.

FIG. 159.

FIG. 160.

Fig. 161.—The apparatus seen from the back.
Fig. 162.—The apparatus seen in front.
Fig. 163.—The apparatus seen from below.
Fig. 164.—The apparatus seen from above.

The designation of the letters is the same as in Illustration I. The thickness of the obturator begins where the fissure in the soft palate commences. With the high side-edges

FIG. 161.

h of the fore part of the thick obturator (which edges ascend, not straight, but obliquely, toward the outside) the side-halves

FIG. 162.

of the fissured velum palati *e* are in constant contact; even when the latter are raised by the action of the muscular

FIG. 163.

levator palati. The proportions of the back part, which, in the same manner as in the case of an acquired defect, fill up the cavum pharyngo-palati, are as in Illustration I. *K k* are the two halves of the fissured uvula. (See Figs. 158 and 159.)

This form of an obturator in case of *acquired palatine defects* does not possess any superiority over any other method of construction which should make it remarkable. It has already been shown that a variety of forms may be adopted which will improve articulation, if the one characteristic be maintained, viz., that when in use the adjacent muscles are able to meet it and shut off the nasal escape of sound. *It is only when applied to congenital fissure with success that it rises into a meritorious position.*

FIG. 164.

Many years have now passed, in which the principle has been put to a number of tests, and some judgment may be formed upon it; and there is proof quite sufficient to sustain the position that the constrictor muscles of the pharynx may be educated to the performance of functions which they would never be required to exercise in conjunction with perfectly developed adjacent organs. To their increased activity and extra developed power is undoubtedly due the readiness with which patients acquire articulation in cases where the velum has been totally destroyed by accident or disease, and its place supplied by a very crude substitute.

My own experience leads me to the conclusions:

1. That in most cases of *congenital defects* the patient will acquire correct articulation more easily and more certainly with an elastic velum scientifically adjusted than with any other form of apparatus.

2. That, in a majority of cases of the like defect, a patient will never acquire distinct articulation with an obturator.

3. That, where a patient afflicted with a congenital absence of the palate has overcome the difficulty by wearing an artificial *velum* until clear and distinct articulation has been acquired, he may exchange the velum for an obturator, and continue to articulate properly.

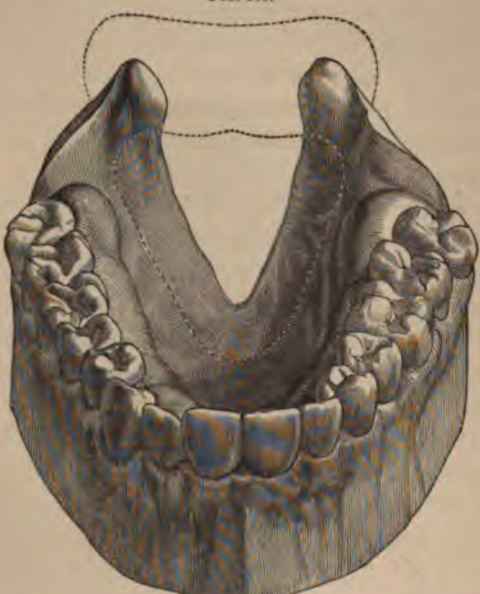
4. That of all *obturators* to supply deficiencies of the soft palate and induce correct articulation, the one introduced by Suersen contains the truest principle, and is best adapted to the purpose.

Acting on these convictions, I have in late years treated fissured palates upon these principles, viz.: A patient of intelligence is supplied with an artificial velum, after a plan to be indicated in another chapter. As this form is a very near approach to the absent organ in form and characteristics, it is expected that, with proper application, improvement in articulation will immediately follow, and that the improvement will continue until perfection is attained. When this period is reached, which may be in a few months or in a few years, the elastic and more perishable velum may be exchanged for a permanent obturator, so adjusted that the partial education of the pharyngeal muscles, as organs of speech, may be completed.

This treatment has been carried out in a number of instances with my most promising patients, and with gratifying success. The following case from practice is an example:

An Obturator substituted for an Artificial Velum.—There came to me in 1865 a young man seventeen years of age, with congenital fissure of the palate, which was confined almost entirely to the soft tissues, the apex of the fissure being in the border of the palate-bone. There was no harelip and no external deformity to indicate a defective organ within. His speech had all the characteristics accompanying the average case of fissured velum, being so defective that it was with difficulty he was understood by strangers. He belonged to a family of excellent social standing, had the advantage of a good education, and was fitted by

FIG. 165.



training to take part in a business in which his father was largely interested. But his inarticulate speech was an obstinate bar to his advancement. The model of the fissure is shown in Fig. 165.

I made for him an artificial velum of soft vulcanized rubber, which is shown in Fig. 166, letter A, and was attached to a gold plate marked B, which was sustained in its position by being clasped to the first permanent molar on each side of the mouth. This artificial palate when worn bridged from side to side, and covered all the fissure from the apex down to the junction of the bifurcated uvula with the soft palate. The position is shown by the dotted line in Fig. 165. That portion in Fig. 166 marked C reached across the pharynx in a somewhat horizontal position, and came nearly in contact with the constrictor muscles of the pharynx. Articulation was therefore made possible with this instrument, because the action of the levator muscles was such that the artificial velum could be lifted until it touched the

FIG. 166.

posterior wall of the pharynx, and thus shut off the nasal passages at will.

Immediately on the introduction of this instrument the patient put himself under the vocal training of a professor of elocution. His improvement in articulation was rapid, and he was enabled very shortly to consummate his desires by taking part publicly in business. His mastery of articulation was so satisfactory to his friends and himself that he became one of the most grateful persons for whom I ever rendered a service. Such an expression as this came to me after a time: "I had the strongest desire as a boy to become a teacher in a Sunday-school when I came to be old enough, and it was a most painful thought that I should always be debarred that satisfaction by my defective speech. Now I am superintendent of a flourishing mission-school, and I am constantly called upon to use my voice in that capacity, and in others, sometimes for an hour, before a mixed audience, and I am told no one would suspect that I ever had a defect of speech."

I found in process of time that this patient, by his experience and more than ordinary intelligence, was a valuable aid to me in studying the mechanism of speech with an artificial organ; and, after a ten years' experience with an artificial velum, I proposed to him to make a change for an obturator. I had reflected much on the principle advanced by Suersen in 1867, of educating the constrictor muscles of the pharynx to become organs of speech, and I had applied this principle in some cases with more or less success; but I desired to put the principle to a more scientific test than I had yet had an opportunity to do. The case of my patient before described would give me every facility by an intelligent coöperation.

My model of the fissure was obtained, which of course was the same as shown in Fig. 165. Upon this I formed a mass of softened gutta-percha, filling up all the roof of the cast to a level of the teeth, and projecting into and through the fissure. Its direction followed the incline of the sides of the gap to about midway its length, when it was continued horizontally backward, and terminated in a lump or bulb about the size and shape of an ordinary Spanish chestnut. This mass when cold was introduced into the fissure, and after some slight changes of form the bulb was softened in hot water and again introduced. The patient was directed to swallow immediately and as frequently as possible.

These experiments of softening and exposing to the pressure of the constrictor muscles in swallowing were continued until there was no perceptible reduction in size or material change in the form of the bulb. This muscular activity had driven a portion of the mass upward and another portion downward, clearly and distinctly marking the boundary of the superior constrictor. Such portions of the bulb as had been squeezed beyond what was needed to shape the obturator were trimmed away, and the whole more symmetrically formed previous to making a duplicate in vulcanite.

A final test of the utmost possibilities of contraction of the pharyngeal muscles was made after all the reduction in size had been obtained from the yielding of the mass. Any substance of sufficient stability to retain its position would resist somewhat the power of muscular contraction; therefore, after the mass was carved into shape, it was gradually reduced in size where the muscles came in contact with it, until they would barely touch it in the process of deglutition. As this could not be determined by the eye, the test was made by painting the pharynx with a little paste of chalk and water, contact of which with the wax or gutta-percha surface would show very distinctly.

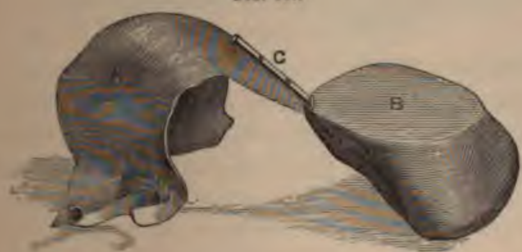
Having determined with the utmost nicety the ultimate form of the obturator, it was duplicated in substantially the same way as is usual in making artificial dentures on a vulcanite base, except in one particular. Being desirous of making the whole instrument of as little weight as possible, I made the bulb hollow in the following manner: After the gutta-percha form was removed from the flask and the mold was ready for packing with rubber, I made a paper pattern in sections of the hollow chamber in the flask which represented the bulb. By cutting out the sheet rubber to the shape of these patterns and joining them together at their edges, the bulb was approximately formed, care being taken to have it small enough to drop readily into the chamber where it was to be vulcanized. Previous to closing this unvulcanized bag a few drops of water were introduced, and the bag hermetically sealed, the edges being moistened with a little chloroform to insure their adhesion. The remainder of the space in the flask was packed in the usual manner, and the whole vulcanized with no other than the ordinary care. The result was that the steam formed within the bag expanded it without bursting, and drove it into all the inequalities of the chamber, and thus produced an obturator so light that it would float in water. This was finished up and given to the patient to experiment with.

Figs. 168 and 169 represent substantially the form of this vulcanite obturator. The broad surface of the rear of the bulb is essential to the complete closure of the posterior nares, as are also the high sides which come in contact with the levatores palati. I have recently seen an instrument which pretended to carry out the Suersen principle, but it was a simple flat tongue in the fissure, without sides or rear surface, and the result was a complete failure. It was only an aggravation without benefit.

In a few days he returned with much to say in its favor, but also relating that it was impossible to produce certain sounds which he had learned to do with ease with his former apparatus. The gutturals were especially defective, showing that either the pharynx did not meet the obturator, or that the dorsum of the tongue failed to make close contact with it, or possibly both. I came to the conclusion, however, that, as the artificial velum followed down the line of the fissure to a much lower point than the obturator did, the tongue had been accustomed to being elevated to only such a point where it expected to meet with sufficient resistance to retain the sound until ready for the explosion. If, now, as in case of the obturator, this base of resistance were removed farther from the tongue, the sound would naturally be defective in proportion to the distance.

This led me to an experiment to test the best point at which an obturator should stop to be met by the tongue for articulation. I cut the bulb from the apparatus, leaving it simply as a plate across the roof of the mouth, with a thin, tongue-like extension continuing down in and along the line of the fissure shown in Fig. 167, letter A. Upon the posterior surface of this tongue was riveted a bar of gold about one tenth of an inch in width by half that in thickness, and five eighths of an inch long, beveled inwardly toward the plate and running lengthwise (letter C). The bulb, letter B, was then fitted to the bar with a dovetailed groove, which would permit it to slide up and down the bar for a distance of half an inch, thus permitting a very extended range of movement by drawing it higher up into the posterior nares or dropping it down into the pharynx. The bar fitted the groove so tight that it would keep any position in which it was placed. Equipped thus with a machine that he could alter

Fig. 167.



at discretion, my patient began again his experiments, and in the course of a fortnight returned to me with the discovery of the exact point at which the bulb must be set to give him the greatest benefit. This point was at a much lower level than the instrument had originally provided, being nearly as low as the uvula, and where I would have supposed before that it was impossible to tolerate so large an unyielding mass during deglutition, but I found that he had worn it during meals without discomfort. His voice and enunciation were so much benefited that I was encouraged to take the next step and reproduce the instrument in gold.

The roof of the mouth being very high in the center, the cast was filled up at that point so as to bring the golden roof at a lower level and make the dome more symmetrical and better formed for enunciation. Subsequently this space above the gold plate was filled with vulcanite. Twenty-carat gold was used in both plate and bulb, that which formed

FIG. 168.

the bulb being rolled down as thin as it was possible to work it, and the whole being a very accurate duplicate in form of the perfected instrument in vulcanite. Figs. 168 and 169 show two views of this instrument—a side view and a rear view.

FIG. 169.

I was not surprised to find my patient return to me in a few days with gratitude and praise unbounded. I had before made obturators of gold, and upon the same principle, and had always observed the marked improvement in voice that a metallic sounding-board gave over one of either hard or soft rubber. In the present instance the gentleman, after wearing it a day or two until feeling quite familiar with it, called to his aid a professor of elocution and went into a large public hall, and for an hour subjected himself to criticism in reading, in singing, and in declamation. The professor pronounced his effort as absolutely without fault, and the clearness, distinctness, and resonance of his voice remarkable.

The sum of my experience with obturators is this:

1. That of all obturators this is the best form for a congenital fissure; but, while the wearer is enabled to articulate perfectly with such an instrument, it is only *after* he has learned articulation with another apparatus.

2. That a soft, elastic artificial velum is much better adapted to the acquirement of articulation than an unyielding, non-elastic substance; but when acquired an obturator may be substituted.

3. That in very rare cases articulation may be acquired with an obturator only; but it is the result of the extra activity of the pharyngeal muscles, while with the elastic velum the levators of the palate contribute largely.

CHAPTER X.

TREATMENT OF ACQUIRED LESIONS OF THE PALATE.

ANY unnatural opening from the oral to the nasal cavity which will permit the free passage of the breath will impair articulation. Any appliance which will close such passage, and can be worn without inconvenience, will restore articulation.*

Obturators were formerly made of metallic plate, gold or silver being most commonly employed, and many ingenious pieces of mechanism were the result of such efforts; but latterly vulcanized rubber and celluloid have almost entirely superseded the use of metals. These substances have been found preferable to metals, being much lighter and more easily formed and adapted, particularly when of peculiar shape.

From the preceding history of obturators we see that the makers have in most instances sustained the apparatus by passing into or through the opening, and by pressure upon the surrounding tissues. As early as 1756 Bourdet recognized the impropriety of such a procedure, for he says: "Before considering the cicatrized perforations of the palate as being of a nature incapable of diminishing in diameter, practitioners should satisfy themselves thoroughly and beyond a doubt that such is the case. We do not think that this con-

* The student will bear in mind that no cognizance is here taken of openings similar to those described in cases of congenital fissure, where the surgeon has united the soft palate, and left an opening through the hard palate to be covered by an obturator.

dition of permanency can exist, for positive facts attest the contrary; and as holes made in the cranium with the trepan close almost entirely, in like manner those of the palate constantly diminish."

Numerous examples might be adduced to prove the impropriety of sustaining an obturator by any fixtures which act upon the lateral parts, as they necessarily tend to increase the dimensions of the opening in the palate. In a case re-

FIG. 170.

cently in the author's practice, the patient closed a small perforation of the hard palate with a wad of cotton, the swelling of which tended to enlarge the opening and necessitated a still larger plug, until the entire roof of the mouth and teeth were carried away, leaving but a narrow rim along the alveolar border. Such a case is shown in Fig. 170. Cases have also occurred in the author's practice where palatine openings, resulting from disease, have been carefully bridged over with a plate without entering the perforation or cavity; healthy granulations were stimulated, and the opening eventually closed, thus doing away with the necessity of an obturator.

It is of the greatest importance that all such instruments should be executed in the most perfect manner, and made to fit accurately all the parts with which they are to be in contact, so that they may not produce the slightest irritation or exert undue pressure upon any of the surrounding parts. This is even more essential than in fitting an artificial denture in a healthy mouth, as in the latter case the tissues recover their tone often in spite of the irritation of a badly fitting denture; but, in palatal lesions resulting from disease,

FIG. 171.

FIG. 172.

the system is generally in such condition that a slight irritation may be followed by alarming inflammatory symptoms.

In simple perforations of the palate, a plain plate of vulcanite, celluloid, or metal, covering the gap and fitting close to the adjacent palatal surface, without any attempt to enter the opening, and sustained by the natural teeth, is all that is required. Fig. 171 represents such an obturator, sustained in its place by impinging upon the natural teeth with which it came in contact. Accuracy of adaptation and delicacy of form are all that are essential in such cases, and restoration of the speech will immediately follow.

Fig. 172 represents a more complicated obturator, adapted to an opening in the soft palate. The necessity for a variation in the plan will be found in the constant muscular action of the soft palate, which would not permit without irritation the presence of an immovable fixture. This is contrived, therefore, with a joint, which will permit the part attached to the teeth to remain stationary, while the obturator proper is carried up or down as moved by the muscles. The joint, A, should occupy the position of the junction of the hard and soft palates. The joint and principal part of the appliance is made of gold, the obturator of vulcanite. The projection B lies like a flange upon the superior surface of the natural palate and sustains it; otherwise the mobility of the joint would allow it to drop out of the opening. This flange is better seen in the side-view marked C. It is readily placed in position by entering the obturator first, and carrying the clasps to the teeth subsequently.

Figs. 171 and 172 will illustrate the essential principles involved in all simple obturators. The ingenuity of the dentist will often be taxed in their application, as the cases requiring such appliances all vary in form and magnitude.

The steps to be taken in the formation of an obturator are not unlike those used in making a base for artificial teeth. It is essential that an accurate model be obtained of the opening, the adjacent palatal surface, and the teeth, if any remain in the jaw. For this purpose, an impression taken in plaster is the only kind to be relied upon. Care must be used that a surplus of plaster is not forced through the opening, thus preventing the withdrawal of the impression by an accumulated and hardened mass, larger than the opening through which it passed. To avoid this, beginners or timid operators had better take an impression in the usual manner with wax. If this is forced through, it can be easily removed without injury to the patient. From this wax impression make a plaster model, and upon this plaster model form an impression-cup of sheet gutta-percha, using a stick, piece of wire, strip of metal, or any other convenient thing for a handle. This extemporized impression-cup must not impinge upon the borders of the opening, neither should it enter to any extent. With a uniform film of soft plaster, of from one sixteenth to one eighth of an inch in thickness, laid over this cup, a correct impression can be taken without any surplus to give anxiety. If the desired obturator is to be only a cover of the opening, the impression can be readily taken in plaster by placing a small bit of damp paper over the opening, which will adapt itself to the border of the cavity and prevent the plaster from entering it.

Upon a correct plaster model, taken from such an impression, the obturator should be molded out of gutta-percha or other plastic substance; the subsequent steps being in principle the same as making any other piece of vulcanite. If it is desirable that it should enter the perforation to restore the lost portion of the palate, it must not protrude into or in any way obstruct the nasal passage. *The entire freedom of the nasal passage is essential to the purity of articulation.* That portion of the obturator which occupies the oral cavity should be made as delicate as possible, consistent with its strength and durability.

There are many cases of accidental lesions of the palate, generally the result of syphilis, where the loss is confined entirely to the posterior part of the soft palate, and where an obturator would be inadmissible, or at least objectionable. In such a case an unyielding appliance is undesirable; the constant activity of the surrounding parts might not tolerate it without discomfort. The material used for a substitute should be soft, flexible, and elastic; and elastic rubber is admirably adapted to the purpose.

Fig. 173 represents a defective palate belonging to this class, the uvula and a portion of the contiguous soft palate being destroyed by disease. It will be seen that a portion of the soft palate along the median line remains, and consequently there will be considerable muscular movement, which must be provided for, and which may be taken advantage of. It is desirable to make this movement available in using an artificial palate, as thereby more delicate sounds are produced than otherwise. This case presented some extraordinary difficulties in the fact that all the teeth of the upper jaw had been extracted; and it was necessary therefore to adapt a plate which should not only sustain the teeth for mastication, but bear the additional responsibility of supporting the artificial palate.

In the choice of material best adapted as a base for the teeth in such instances, it is preferable to choose that which will prove the most durable. There are too many interests

FIG. 173.

involved to risk the adoption of anything but the best. In the case under description the patient desired duplicates, and two sets of teeth were made, one on gold and the other on platina, with continuous gums. The plates were made like other sets of teeth, with the exception of a groove located on the median line at the posterior edge, to receive the attachment for the palate marked C, in Fig. 174, which shows the set of teeth with palate attached. The wings, marked A and B, are made of soft rubber; they should be made about one line in thickness in the central parts, tapering off and thinning out to attenuated edges wherever the edge comes in contact with soft tissues. But, in an emergency, pieces of the proper shape might be cut from sheet rubber. The objection to the latter plan is, that the edges are not so delicate nor so comfortable as when the flaps are especially made. The frame to support them is made of gold, with a joint to provide for the perpendicular motion of the natural palate. When the artificial palate is in use, the joint and frame immediately contiguous lie close to the roof of the mouth; the rubber wing A bridges across the opening on the inferior surface or side next the tongue. The wing B bridges across the opening on the superior or nasal surface, and is also prolonged backward until it nearly touches the muscles of the

FIG. 174.

pharynx when in repose. Both these wings reach beyond the boundary of the opening, and rest on the surface of the soft palate for a distance of from one eighth to one fourth of an inch, thus embracing the entire free edge of the soft palate. This last provision enables the natural palate to carry the artificial palate up or down, as articulation may require.

When the organs of speech are in repose, there is an opening behind the palate sufficient for respiration through the nares. When these organs are in action, a slight elevation of the palate or a contraction of the pharynx will entirely close the nasal passage and direct all the voice through the mouth. The palate thus becomes a valve to open or close the nares, and will be more useful when made with thin, delicate edges, which will yield upon pressure. An instrument thus made will restore, as far as possible by mechanism, the function of the natural organ. No attempt need be made to restore the form of the uvula; nothing would be gained by such an effort, as its function in articulation is doubtful.

Fig. 175 represents the artificial palate separated into its constituent parts. The frame is bent at the joint in the engraving to show a stop marked D, which prevents the appliance from dropping out of position. C shows a tongue

FIG. 175.

which enters the groove in the plate of teeth and connects them. The rubber flaps are secured to the frame by the stud and hooks seen in the engraving. The process for making the rubber wings will be found described on page 302.

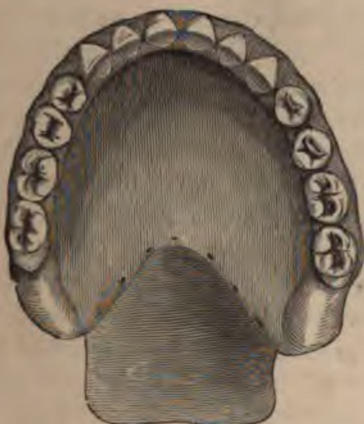
Fig. 176 shows a more extensive palatine defect of the same class. In this case the entire soft palate is gone, together with a small portion of the hard palate at the median line. Although this defect is greater in extent, the means for its remedy are more simple. The muscles of the palate are entirely gone, and consequently no perpendicular movement need be provided for. The appliance in this case will resemble an elastic obturator more than the valve-like palate of the preceding one. The principle here adopted is substantially that recommended by Mr. Snell fifty years ago, and subsequently used by Mr. Sercombe, and consists of a plate with a set of teeth in the usual form, and attached to its posterior edge an apron of soft rubber, which will bridge the opening on its inferior surface extending nearly to the pharynx. Fig. 177 represents the set of teeth with the palate attached. In Mr. Sercombe's appliance, described on page 268, this apron was made of the common sheet rubber

FIG. 176.

in the market, prepared for other uses, and is objectionable for two reasons: 1. A want of purity in the materials of which it is compounded, in many instances substances being used in its manufacture which would prove deleterious to the health of the patient; and, 2. Its uniformity of thickness. It is preferable, therefore, to make a mold in which to form a palate of pure and harmless material—one which shall be of sufficient thickness in the central part and at its anterior edge to give it stability, and yet shall have a thin and delicate boundary wherever it comes in contact with movable tissue.

Such a palate may be made in a mold by substantially the same process as hereafter described. (See page 301.) It may be secured to the plate by a variety of simple means. One which will give as little trouble to the patient as any other is to make a series of small holes along the edge of the plate, and stitch it on with silk, or fine platina, gold or silver wire may be used. It is desirable in such a case to have

FIG. 177.



the plate and palate present a uniform surface on the lingual side. In fitting the plate, therefore, it may be raised along the posterior edge from the sixteenth to the tenth of an inch, according to the thickness of the palate desired. The rubber will thus be placed on the palatine surface of the plate, and present uniformity on the lingual surface.

A little thought will show that in this case the patient must educate the *muscles of the pharynx alone* to do the work of shutting off the nares, which in the former case was performed by them in conjunction with the muscles of the palate. Perfect articulation will depend upon the success of the patient in this new use of these muscles. In cases of acquired lesions of the palate, such as are under consideration, this education of the muscles to a new work will not be difficult. The patient at some former time has had the power of distinct articulation; his ear has recognized in his own voice the contrast between his present and his former condition; the ear will therefore direct and criticise the practice until the result is attained. It is astonishing to what an extent muscles may be trained in this way to the successful performance of an unnatural function. In the case illustrated by Figs. 176 and 177 the defect had existed for twenty-eight years, the patient at the time of the introduction of the artificial palate being nearly fifty years of age. The effect upon the speech was instantaneous. Articulation was immediately almost as distinct as in youth; and this remarkable distinctness can only be accounted for upon the assumption that the pharyngeal muscles had undergone a thorough training in the vain effort to articulate without a palate.*

These two cases, chosen to illustrate the application of artificial palates in accidental lesions, required, as will have been perceived, entire upper sets of artificial teeth in connection with the palates. This selection was purposely made because the difficulties to be overcome are much greater. In cases where there are natural teeth remaining in the upper jaw, the palate and its connection with the plate would be substantially the same, and the plate could easily be secured to the teeth by clasps in the same manner as a partial denture.

* An account of this case appeared in the "Argus," of Bainbridge, Georgia, August 1, 1868, written by the patient himself, who was the editor of that paper.

CHAPTER XI.

HISTORY OF ARTIFICIAL VELA.

The history of artificial vela begins with M. Delabarre. In the last chapter a distinction was made between obturators and artificial vela, which must be kept in mind. The definite history of obturators goes back more than three hundred years, and that of artificial vela scarcely more than fifty; due, possibly, to the fact that there was no suitable material known, prior to the discovery of caoutchouc, of which a substitute for the natural palate could be made.

M. Delabarre was, in all probability, the first one who conceived and put into practical use a soft, flexible, elastic valve, which would fulfill to any degree the functions of a natural velum. The case was one of syphilitic origin of extensive character. The entire roof of the mouth and soft palate had been carried away, together with nearly all the teeth, necessitating a formidable apparatus, which was a combination of denture, obturator, and velum. The denture was made of mineral teeth mounted on a platinum base, and sustained *in situ* by a spring connecting with a skeleton frame resting upon the lower teeth; restoring, to a certain degree, the form of the lost structures, and not unlike, in its general contour, to the full upper denture of the present day. To the posterior edge of this denture he attached a velum and uvula of "gomme élastique" (India-rubber).

In reading M. Delabarre's account of this apparatus, he seems to have been more anxious to conserve deglutition than to restore the articulation of the voice. To this end he devised a valve in the anterior part of his denture, which, by a system of compound levers, was connected on the superior surface with the velum and uvula, and operated by pressure of the forward part of the tongue. Fig. 178, copied from Delabarre's treatise, illustrates the instrument. A shows the valve in the roof, which rose up on pressure from below and was returned by a light spring. B B indicate two levers hung in the middle upon axes; the anterior end of the first

Fig. 178.

attached to the valve, and the posterior end of the second attached to the velum and uvula, so arranged that the motion of lifting the valve would be communicated to the velum and elevate that also. This "machine," as Delabarre calls it (the term being singularly appropriate when transferred to English), could only be operated by the tongue in a certain position, and therefore the machinery could not have been of any advantage in articulation, although Delabarre claims that the whole apparatus was of great benefit to the patient in mastication, in deglutition, and "for the articulation of words." In the light of modern science we can not regard the *machinery* as of any advantage; the velum would, in all probability, have contributed an equal benefit without it. Such a complicated apparatus would be likely to become easily disarranged, and not of a very permanent character; therefore it is not surprising that we find no record of any attempt to make an application of it to other cases.

The object of this detailed description is chiefly to give a clear understanding of the first attempt to make an artificial velum. Granting that this experiment of Delabarre's was a complete success, its importance must not be overrated. The case was one of accidental lesion; and later experience has shown that a very simple and often a very crude appliance will restore articulation to one who formerly possessed that function. Nevertheless, to him must be accorded the credit of the first conception and practical application of the only material which could be adapted to a velum; and, although the caoutchouc of that day was a very perishable material, compared with the same substance as improved by vulcanization, his experiment laid the foundation of successful artificial vela, and, in all probability, encouraged Mr. Snell, of London, in his experiments made shortly after, and for which he claims complete success.

Mr. Snell makes the date of his construction of an artificial velum about 1823, and this is the first record I have been able to find of any effort to remedy the evils of *congenital fissure* of the palate by mechanism. All appliances made prior to that time were for accidental lesions, and congenital cases were considered as hopeless except by surgery, and even at that date the era of staphyloraphy was just dawning.

His first case was that of a young lady with fissure of both hard and soft palate along the median line, which does not appear in the record to have been complicated with harelip. He "obtained a correct model of the defective parts, from which a gold plate was formed to fit the roof of the mouth, reaching as far back as could be worn by the patient, to the posterior part of which two pieces or flaps of India-rubber were attached, thus filling up the deficiency of the soft palate. A small movable piece of the same material was also attached, by means of a gold hinge, to the center of the lower piece, to imitate as near as possible the natural uvula. A piece of ivory was next fitted to the upper or back part of the gold plate, and carried upward until it came in contact with the remaining part of the septum narium; this was, of course, firmly attached. The whole was held in its situation by means of two gold springs soldered to the plate, which were fixed round one of the molars on each side." Mr. Snell shows, in his treatise, that the principal object which he desired to attain was an improved articulation of the voice, and for the above instrument he claims most satisfactory results.

In an improved appliance which he made subsequently, "the piece of prepared elastic gum is attached to the posterior part of the plate, where the natural soft palate commences, extending downward on each side as low as the remaining part of the uvula, and grooved at its lateral edges to receive the fissured portions of the velum. A movable velum is placed in the posterior center of the elastic gum. That these may partake of the natural movements of the parts during deglutition, a spring is affixed behind them, one end of which is fastened to the posterior and anterior surfaces of the principal plate, and the other end rests gently against the posterior face of the India-rubber; this keeps it always in close apposition with the edges of the fissure during deglutition." It is much to be regretted that there is no engraving of this instrument; but, from a careful reading of this last quotation, I am inclined to the opinion that it describes a velum of triple form, which was not unlike in principle the one introduced by Dr. Stearn, in America, twenty years later. (See Fig. 179.)

Dr. Stearn's experiments mark a distinct epoch in the history of artificial vela—not so much from a better understanding of the requirements in such cases, nor from a superiority of skill in the adaptation of an apparatus, as from the accidental good fortune of having brought to his notice the best substance which has yet been discovered for this purpose. It was in 1841 or 1842 that Dr. Stearn, a young graduate in medicine, and a native of Springfield, Massachusetts, where he was then residing, became acquainted with Mr. Goodyear, who was then conducting his experiments in combining sulphur with rubber to improve it. Dr. Stearn was afflicted with a congenital cleft palate, the fissure being confined almost exclusively to the soft palate. He had been twice or thrice operated upon surgically, but in each instance staphyloraphy proved a failure, and his only hope of benefit lay in mechanism. Being naturally of an ingenious mind, and acquainted with the improvements in rubber, he gave his attention to the construction of an artificial velum for himself. When it is considered that he was without any practical knowledge of mechanical dentistry, and did not, and could not, make such a model of the parts as is now considered essential, and that all his efforts were tentative upon himself, the results were marvelous. He then demonstrated that a very formidable apparatus could be introduced within the pharynx, and worn with comfort, and with it articulate speech could be perfectly acquired. More than fifteen years after this I came to know Dr. Stearn, and his voice, articulation, and enunciation were so clear and distinct that but few would have suspected the deformity without an anatomical examination.

Like most other pioneers in great inventions, Dr. Stearn arrived at the result by the most complicated means. His instrument was a marvel of ingenuity, and the process by which it was made, in the light of modern simplicity, was an undertaking of some magnitude. Instead of the more scientific plan, as now used, of obtaining an accurate cast of all the parts involved, and to such a cast adapting an instrument, and afterward making a metallic mold in which to produce the rubber duplicates, he began his work by *carving* a mold out of wood, in which to vulcanize the velum. To obtain some idea of the form to be given to the mold so that the resultant casting should fit the fissure, he took small impressions of various parts with soft wax attached to the end of a bent stick, and copied the forms thus ascertained in his wooden mold. Encouraged by the approval of distinguished

FIG. 179.

surgeons in this country, he visited London and Paris in 1845, and contributed a valuable article upon the subject to the London "Lancet." His instrument and his ingenuity were much admired, but it is evident that its complexity carried the idea pretty generally that it was not of universal application, as we find that the little interest it awakened soon died out, any efforts made by dentists to adopt it were abandoned, and in a few years it was unknown to the mass of the profession, and only remembered as a brilliant exceptional effort.

Figs. 179 and 180 are representations of the two sides of the Stearn instrument, the former showing the oral side, and the latter the nasal or pharyngeal surface of the same instrument. In Fig. 179, *m m* show a portion of gold plate, which continued on the side of the ragged edge until it was clasped to teeth on each side of the mouth. The remnant of the natural palate filled the groove marked *g g*. The broad lower edge, as seen in the engraving, hung in the pharynx, and provision was made for the approximation of the

FIG. 180.

sides of the fissure and for other contractile muscular action by slitting the body of the instrument up the middle, and, to prevent sound escaping through the slit, the valve or flap marked *v l v* covered it. The action of the artificial velum, when subject to muscular movement, would be, that the sides marked *g g* would lap over and slide upon each other in the act of deglutition so easily and readily as not to irritate the surrounding structures. Owing to the instability of the rubber, and particularly after it had been worn a short time, it became necessary to give extra support to the valve, so that it should be retained firmly against the body of the instrument; and a gold spring was arranged, as shown upon the other side of the appliance in Fig. 180 at the letter *f*. The curved bands, marked *f f f* and *s s*, were of rubber homogeneous with the piece, and introduced to give stability and fill out the velum when contractile muscular power was relaxed. The aforementioned valve was not intended in any sense to represent the uvula, which its appearance and locality may suggest, but was a necessary result of the division of the instrument along the center.

It was with much satisfaction that Dr. Stearn viewed this trifold character of his instrument, regarding this method of providing for the contraction of the surrounding muscles as a triumph of skill. To quote his own language in 1860: "I wish to be understood as saying, in exact terms, that I consider the slit and opening through the center, and its closure by a sort of valve on the anterior surface, as an essential feature of all artificial vela; and also that I do not acknowledge the remotest obligation to any other person for this one idea, which did not present itself to my mind until I had occupied myself with my first case (in 1841 and 1842) for more than a year. . . . Eighteen years have since elapsed, and I have not yet conceived any other possible way of constructing an instrument at once simple, delicate, and durable, but in this *triple* form; and, though I trust and believe that others will hereafter improve upon my methods, I am confident that this one feature will be preserved in all successful 'obturators.'"

An important principle, enunciated by Dr. Stearn as essential to the success of all artificial vela for congenital cleft, was, that the instrument filling the fissure in the natural palate must be of the nature of a valve, under the control of the muscles surrounding it, and so arranged that it could be elevated by them, and thus the nasal passage shut off, as is absolutely essential in the production of certain sounds belonging to articulate language. This principle was carried out by him, first, in the character of the material chosen, being of a yielding, elastic nature; and, second, in the form, being made to embrace the levator muscles and subject to their control.

It is remarkable what little effect was produced upon either the surgical or mechanical treatment of cleft palate by Dr. Stearn's invention, or by his contribution to the literature

FIG. 181.

in the London "Lancet." In such notice of his invention as was given him in the earlier editions of Harris's "Dental Surgery," he was called "Mr. Stearn, a surgeon of London"; and the student looked in vain for such a description of the apparatus as would enable him to construct one. So entirely was he lost sight of, that in May, 1857, we find Mr. Edwin Sercombe, in a paper read before the Odontological Society of Great Britain, saying: "I knew nothing at the time, nor indeed until I commenced writing this paper, of Mr. Stearn's invention. . . . The principle laid down by Mr. Stearn as necessary for the construction of a useful velum, I recognized and acted upon, without, as I have already said, knowing of the existence of his paper; had I known of it, it is more than likely that I should have contented myself with endeavoring to imitate his very ingenious contrivance, but, ignorant of his plan, I was free to work out my own design. My velum is made of two pieces of vulcanized India-rubber, the larger piece extremely thin, the smaller much thicker. The shape of both is represented in Figs. 181 and 182. The dotted line on both shows where they are attached by sewing to the posterior margin of the gold plate, which has a single line of

FIG. 182.

holes punched in it for this purpose. The exact size of the larger piece will vary in each case, for it is necessary that its free convex margin should not touch the back of the pharynx when the sides of the fissure approximate in the act of deglutition, as, however soft the material of which it is formed may be, a raw and painful spot will quickly be the result; but at the same time it must be close to the back of the pharynx, or otherwise the articulation will be more or less indistinct, as the sound will not be retained in the cavity of the mouth long enough to undergo the coining-like process of articulation, but will escape into the cavity of the nose, and produce more or less of the characteristic nasal sound of this lesion. This piece should also be extremely thin, as it is absolutely necessary that it should adapt itself with great readiness and completeness to the ever-varying sides of the fissure; but a piece of such tenuity as is necessary to secure this vital point, weighted with mucus, would quickly droop, but for the support which is given to it by the smaller and stouter piece which lies immediately underneath it. These two pieces of sheet rubber sewed to the posterior margin of the gold plate—the thinner to its upper surface, and the thicker to its lower—have been found in more than one instance to restore to the person using them a distinct articulation."

An examination of these illustrations shows that even Mr. Sercombe failed to comprehend the principles enunciated by Mr. Stearn as essential to success. Two principles were vital to Dr. Stearn's instrument, viz.: first, *that the artificial velum should embrace the levator muscles of the palate so that it could be lifted by them;* and, second, *that it should bridge the upper pharynx behind the uvula and cut off nasal communication at will.* Neither of these qualifications is seen in Mr. Sercombe's velum, and it is quite safe to say, as the results of later experience, that *perfect* articulation with such an appliance as shown in Fig. 182 for a congenital fissure of the palate would be impossible.

Ten years after that, viz., in 1867, Mr. George Parkinson, of London, described his method of making artificial vela (or rather they might be called movable obturators), which seem to have been an improvement upon Mr. Sercombe's, but in no sense an effort to produce anything like the Stearn apparatus:

"In a case of congenital fissure of the palate extending through the hard tissues and alveolar ridge, after having taken a correct model of the parts in wax or plaster of Paris, I commence by fitting a thin plate of gold over the vault of the palate, as far back as the posterior margin of the palate-bone would have extended had the bony arch been perfect. To the posterior margin of this plate, by means of a hinge, is attached a velum, constructed of hard, well-polished, vulcanized India-rubber, formed in such a manner as to fit the palatine surface of the remnants of the soft palate and allow them to glide over it in the act of deglutition. To keep the velum in its place, one end of a delicate gold spiral spring is made fast to it, the other end being fixed on the nasal surface of the gold plate representing the hard palate. This spring must be so adjusted as just to keep the India-rubber velum in contact with the soft parts, and allow the portions of uvula

FIG. 183.

Palatine surface.

FIG. 184.

Nasal surface.

on either side to approximate in the act of deglutition. Each particular case may require some slight modification, but all that I have treated on this principle have been, I think, highly satisfactory. The voice is not always immediately improved, as education of the tongue is necessary in all congenital cases. The patients for whom I have constructed these palates have, without any exception, expressed great comfort from their use, the only inconvenience ever complained of being a slight nausea on the instrument being first introduced, which generally passes off after a few minutes. The materials used are perfectly durable. The only part that could possibly get out of order is the spring; but this would only be the result of careless manipulation out of the mouth, and could easily be repaired at a trifling cost."

History of the Author's Appliances.—In February, 1860, a young lady about twenty years of age, from Virginia, was recommended to me by the late Mr. Asahel Jones, of the then firm of Jones & White, of world-wide reputation

Fig. 185.

among dentists. She was born with double fissure of the lip and extensive fissure of both hard and soft palate. The lip had been operated upon and the gap successfully closed. The intermaxillary bone had been partially removed, carrying away all the incisor teeth, and leaving a broad gap between the canines. Fig. 185 is a very accurate representation of the fissure. In it are seen the disarticulated vomer, marked A; the turbinated bones, B B; and divided uvula, C C.

In my desire to benefit her, I re-read all the literature I could find upon the subject, with but little satisfaction, and ended in making a plate of vulcanite, of which Fig. 186 is an illustration. This obturator is exactly like such as are made even to the present date, and the claim frequently put forward that they are an improvement upon anything heretofore used. It was worn for a few days with entire comfort, when my patient informed me that she had accidentally heard that there was a gentleman in the city engaged in manufacturing pursuits, who had made a palate for himself which was a great success. I obtained from her his address and hunted him up, and the reader may judge of my aston-

FIG. 186.

ishment when I found that he was the veritable "Mr. Stearn, surgeon, of London," the description of whose apparatus in Harris I had vainly tried to comprehend.

I recommended the father of my patient to employ him, and he somewhat hesitatingly consented to make for her an artificial velum if I would construct the prothesis for the hard palate. The work was carried on in my office and laboratory, and I early saw that the method of producing the velum was not as likely to insure mechanical accuracy as a plan which would naturally be followed by a dentist; and this stimulated me to endeavor to produce the same result by my own plan. In due time Dr. Stearn completed his velum, which, with the hard-rubber obturator and teeth of my make, is shown in Fig. 187, drawn from that identical instrument.

My plan began by obtaining a plaster impression of all the fissure and all the adjacent surfaces, resulting in the model shown in Fig. 185. I believe this to have been the

FIG. 187.

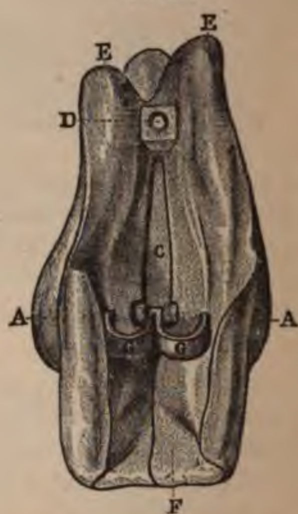
first successful attempt ever made to use plaster of Paris for so extensive an impression. Upon the model I formed a pattern of gutta-percha, and copied it in hard rubber or vulcanite. This vulcanite model or pattern of an artificial velum was carefully finished, and steps were taken to make a mold

FIG. 188.

in which to vulcanize duplicates of soft or elastic rubber. Instead of the wooden mold of Dr. Stearn, I used type-metal, because of the ease with which it could be cast and the accuracy with which the parts could be fitted; and this I believe to be the first use of type-metal for this purpose. The result was an artificial velum of much nicer finish than could be obtained from wood, but naturally bearing the characteristics of the Stearn instrument. Mine is shown in Fig. 188. It possessed some variations which were of advantage, but they were of minor importance. The patient alternated in wearing the two, and finally gave the choice to mine; but candor compels me to say that its only advantage lay in the nicer adaptation, which was entirely due to the method of procedure. The patient was subsequently seen by a number of

Fig. 189.

Fig. 190.



distinguished surgeons, and the improvement in her speech pronounced remarkable; but there remained many imperfect sounds which practice alone could overcome.

Subsequent experience with other cases showed me that the form then used, complicated with delicate gold springs, was objectionable; and my first effort at improvement was to do away with the gold spring, which kept the central flap from drooping, and sustain the flap by connections or springs of the same material. Such a change is shown in Figs. 189 and 190, which are drawings from an artificial velum made in 1863. Fig. 189 represents the oral surface, and Fig. 190 the superior or nasal surface. A A A represents the groove which corresponded to the border of the fissure. E E shows processes which lapped on to the floor of the nares and assisted in its support. C is the central flap, same as used in the Stearn palate, and G G are the two bows or springs of rubber which sustained it. In swallowing, the sides B B approached each other, sliding under the flap C. This instrument was made of soft rubber in a type-metal mold, the mold itself being an intricate affair; but the instrument was simple in its application, and was of as much benefit in articulation as anything which has been produced since.

At the meeting of the American Dental Convention, held that year at Saratoga, a gold medal was awarded me for my success and improvements in such appliances; and subsequently the Odontographic Society of Pennsylvania awarded me another gold medal for the same reason.

In the autumn of 1864 I visited London, and by invitation read a paper on the subject before the Odontological Society, December 4th. The criticisms upon the complexity of my instrument, showing that its production was above the reach of the ordinary dentist, and the necessary cost of it precluding its adoption by persons of small means, led me to serious thought with a view of simplifying it; and, on December 11, 1864, I conceived and made a model in paper of the first purely original instrument that I had thus far produced. This was at once unique and entirely different from anything which had been produced by any one before. The change consisted chiefly in abandoning the "triple form" of Stearn, doing away with the central slit, the flap, and all gold and other springs. These arrangements in the former appliances, it will be remembered, were to provide for the movements of the divided uvula and adjacent remnant of palate. In deglutition, the sides of the fissure are seen to approach each other, and in many cases come quite in contact. With all the former instruments the different parts lapped and slid on and over each other in deglu-

FIG. 191.

tition; but in the new one, Figs. 191 and 192, it will be se that the halves of the uvula approach each other betwe laminæ of the artificial velum.

For fifteen years I have used this form, and applied it i

FIG. 192.

hundreds of cases of congenital fissure, and have made no improvement beyond simplifying the method of production. I know of no other form, or attempt at making an elastic ial velum, which fulfills the functions that this one nor do I believe it possible to make a flexible, yielding ment, which shall be of so universal application, in any form or by any other method.

CHAPTER XII.

TREATMENT OF CONGENITAL FISSURE OF THE PALATE.

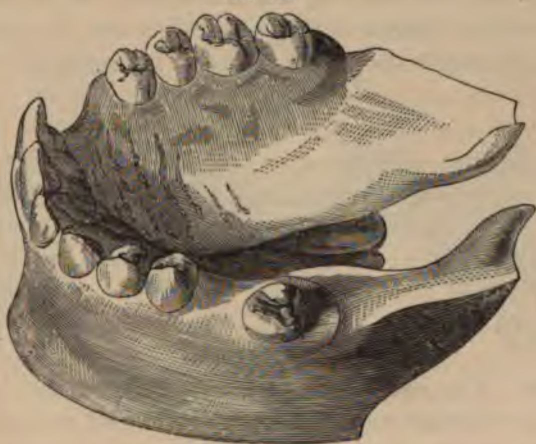
CONGENITAL fissure of the palate presents far greater difficulties to be overcome than cases of accidental lesion. The opening is commonly more extensive, the appliance more complicated, and the result more problematical. Nevertheless, appliances have been made in a large number of cases which have enabled the wearers to articulate with entire distinctness, so much so as not in the least to betray the defect. Most of the earlier efforts in this direction were merely obturators—plugs to close the posterior nares; and the results were far from satisfactory.

A reference to the history of obturators and of artificial vela will show the ingenuity of some of these contrivances. It was not until it was recognized that the two classes of cases, accidental and congenital, were entirely distinct that much progress was made. Nearly every case of acquired lesion can be treated by an obturator with success; but rarely will an obturator be of benefit in a congenital fissure, even if the congenital and accidental lesion present substantially the same form of opening. The character of the different classes has been constantly confounded in the discussions upon the subject, and an instrument admirably adapted to one class has had claimed for it an equal application to the other class.

It should be understood, therefore, as a rule to which there will be few exceptions, that *congenital fissure of the soft palate requires for its successful remedy a soft, elastic* *and movable appliance;* and that, with the most skillfully made instrument, *vocal articulation must be learned* like any other accomplishment.

The various inventions for this purpose are described under the "History of Artificial Vela." The Stearn instrument, with all its complexity, embodied the true principle, viz., *the rendering available the muscles of the natural palate to control the movements of the artificial palate.* To Snell is possibly due the credit of having first recognized

FIG. 198.



this principle, but his description is so defective as to leave the matter in doubt.

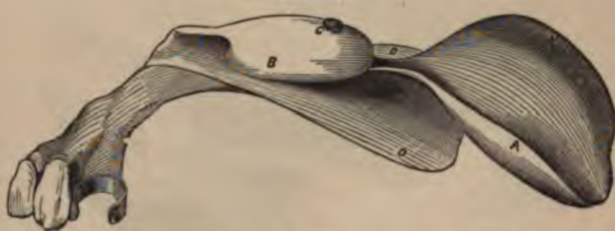
The essential requisite of an artificial velum is to replace, as far as possible, the natural form of the defective organs with such material as shall restore their functions. Muscular power certainly can not be given to a piece of mechanism, but the material and form may be such that it will yield to, and be under the control of, the muscles surrounding it, and thus measurably bestow upon it the function of the organ which it represents.

In the discussion of the failure of staphyloraphy on page

211, and in the chapter on "Mechanism of Speech," the necessity for the separation of the buccal and nasal cavities in perfect articulate speech is clearly set forth. Therefore, every artificial palate—whether elastic or non-elastic, of the character of a velum or an obturator—must be so arranged that the pharynx can be at times completely closed.

Fig. 193 represents a model of a fissured palate, complicated with hare-lip on the left of the median line. There is also a division of the maxillæ and the alveolar process; the sides, being covered with mucous membrane, lie in contact with each other, but they are not united. If desirable for any reason, a simple surgical operation can be performed, which will unite both hard and soft tissues at this point of

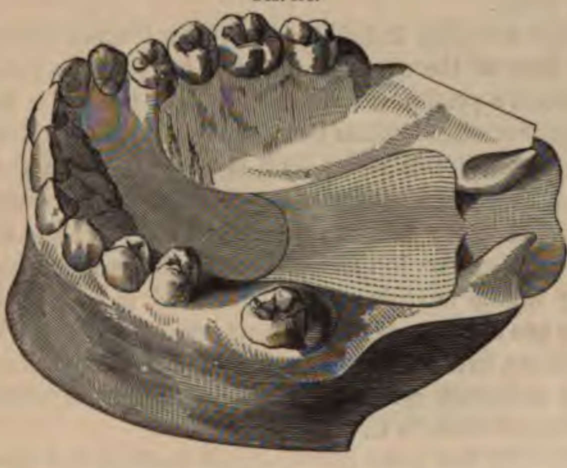
FIG. 194.



division. The left lateral incisor and left canine tooth are missing—whether extracted or undeveloped was unknown. Fig. 194 represents the artificial velum, as viewed upon its superior surface, together with the attachment of a plate containing a clasp and two artificial teeth to fill the vacancy. The lettered portion of this appliance is made of elastic vulcanized rubber, to which the velum is connected by a stout gold pin, firmly imbedded at one end in the hard-rubber plate. The other end has a head marked C, which being considerably larger than the pin and than the corresponding hole in the velum, it is forced through—the elasticity of the velum permitting—and the two are securely connected. The process B laps over the superior surface of the maxilla (the floor of the nares), and effectually prevents all inclination to droop. The wings A A reach across the pharynx, behind the remnant of the natural velum and bifurcated uvula. The wings D D rest upon the opposite or anterior surface of the soft palate.

Fig. 195 represents a model, the same as Fig. 193, with the appliance shown in Fig. 194 *in situ;* the wing D D, in Fig. 194, and the posterior end of the artificial velum A, alone being visible in this figure. The reader will bear in mind that the essential characteristics of this appliance are a

Fig. 195.



soft, elastic substance filling the gap in the soft palate, with a flap behind as well as before, which enables it to follow all movements of the muscles with which it comes in contact, and thus perform to a very considerable degree the function of the fully developed natural organ.

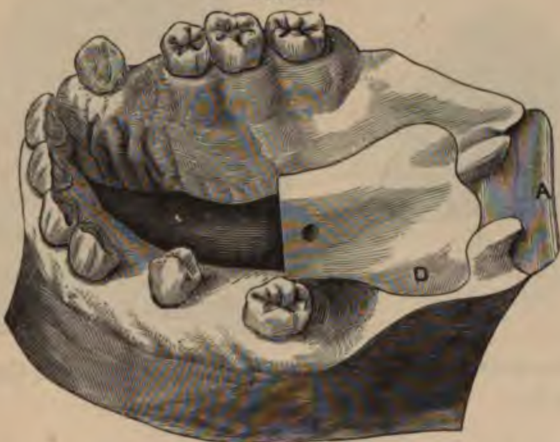
Figs. 191 and 193 represent two cases of remarkably general likeness, although they differ twenty years in age and more than five years in the period of time at which they were treated. The palate placed *in situ* in Fig. 191 shows an instrument which, with variations in size, is of almost universal application. It is nearly identical with the palate shown in Fig. 194, were that one cut across the middle. Like the other, it is made of soft rubber, and, moreover, it will need an additional fixture to fill the gap in the hard palate, and also to keep the artificial velum from being swallowed. In Fig. 194 there is a projection marked B, which is made of soft rubber, and is intended to assist in supporting the velum in position. This is not always necessary or desirable; there are cases where the velum is quite as well sustained without this projection, and where, if it were applied, it would injure the tone of the voice by clogging the nasal passage.

In the case Fig. 191, if support were desired by lapping on the floor of the nares, toward the apex of the fissure, it would form a portion of the hard palate or obturator, instead of being part of the velum or soft palate, as in the other. It was to produce this effect by a simple appliance that the writer labored unremittingly for more than ten years; the appliance of to-day being no modification in any sense of that of any other author, but an individual and separate invention, entirely unlike anything which preceded it, and so simple that we can conceive of no different way by which perfection of result can be so nearly attained. Hundreds of instruments of like character, now being successfully worn, attest the writer's confidence in it.

Simplicity has gone but one step further, and that has been to leave off entirely the posterior flap marked A A in Fig. 194. This has been done in England, France, and Germany, and occasionally in this country, and a parade made of the fact, as an improvement on the invention of the writer; but the experience of the past shows that in all these cases the makers have failed to comprehend the requirements of the case, and have, in attempting to improve the instrument, dispensed with one of its essential characteristics.

The latest invention, and one which the author believes to be of almost universal application, is represented in Fig. 196. To appreciate the importance of this invention, it must be borne in mind that heretofore an instrument peculiar in form has been required for every separate case. Each appliance, being made in a mold of special adaptation, has therefore entailed upon the operator a large amount of labor. With this later invention, it is believed that with a series of molds, producing a limited variety of palates adapted to the leading features in such cases, nearly every case of congenital cleft can be provided for, upon the same principle as other forms of surgical appliances made for general use.

FIG. 196.



It was only after years of experience, and the observation of many cases, that the characteristics which were common to all could be determined. Those common features are as follows: *a.* The fissure through the soft palate is always in the median line. *b.* The variations, if any, from the median line, are anterior to the soft palate in the palatine and maxillary bones. *c.* Thickness of the border of the fissure in the remnant of the soft palate is generally uniform. *d.* The sides correspond very nearly with each other in length, breadth, thickness, and contour. *e.* The chief variation in nearly all clefts of the soft palate is in their size or breadth, and this is true without any reference as to whether the fissure extends forward into the hard palate or not.

In the author's practice a series of a hundred molds, representing as many variations in size, provides for nearly every emergency; Figs. 197 and 198 illustrate the extremes. Fig.

FIG. 197.

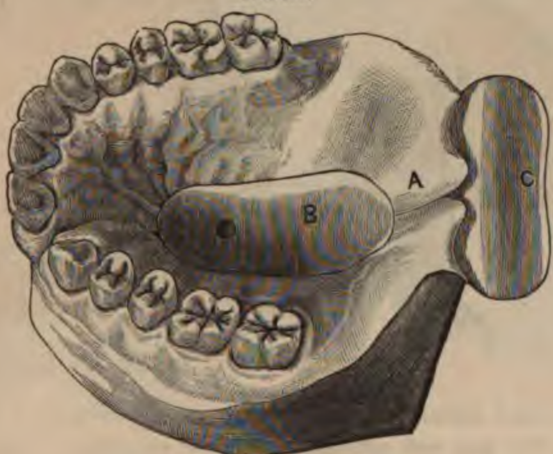
FIG. 198.

197 is the smallest size and Fig. 198 the largest size thus far ever used.

OBTURATORS AND PALATES COMBINED.—There is another class of cases, the proper treatment of which has been followed by most encouraging results. For fifty years the operation of staphyloraphy was a favorite one with surgeons, but the cases in which there was only a partial union were largely in the majority. In many instances all that had been accomplished was simply tying together a small portion of the soft palate across the back part of the fissure, leaving an opening, of greater or less size, through the hard palate, anterior to the newly formed septum. This opening has generally been plugged with an obturator, but vocal articulation has been little if at all improved.

To meet this emergency, a new form of artificial velum was invented. Fig. 199 will illustrate such a case, with the obturator and artificial palate *in situ*. The patient was a man fifty years of age. The operation of staphyloraphy had been performed twenty years previously, and an obturator of silver, and afterward one of vulcanite, had been worn constantly. Nevertheless, the articulation was not benefited, the reason being the same as in every other case of staphyloric operation; the new fleshy palate, marked A, not being long

FIG. 199.

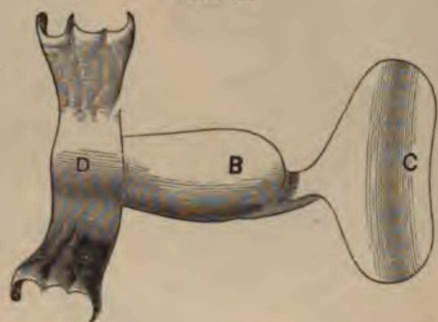


enough to close by any muscular effort the passage to the nares. There was, however, some remaining muscular action, to utilize which power was the desired object to be attained. Letter B shows the obturator, and letter C the velum. In this instance the obturator is made of soft rubber, the same as the velum, and when in use the velum is but an extension of the natural palate, as seen in Fig. 199, letter A. Fig. 200 shows the appliance when not in use. The plate D secures the obturator to the teeth, as in other cases of artificial palates. In order to introduce the piece, the broad flap

C should be first passed through the opening in the roof, and pushed back, when the whole fixture will readily fall into correct position. In the case of this patient, the improvement in vocal articulation was immediate and very decided.

Fig. 201 illustrates another case of a similar character, but with incidental circumstances much more interesting. The patient was a lady sixty-two years of age, for whom staphyloraphy was performed in 1845, and the result was a remarkable success, so far as the union of the parts was concerned. The union was perfect throughout the entire length of the fissure, including the uvula; but, although the patient

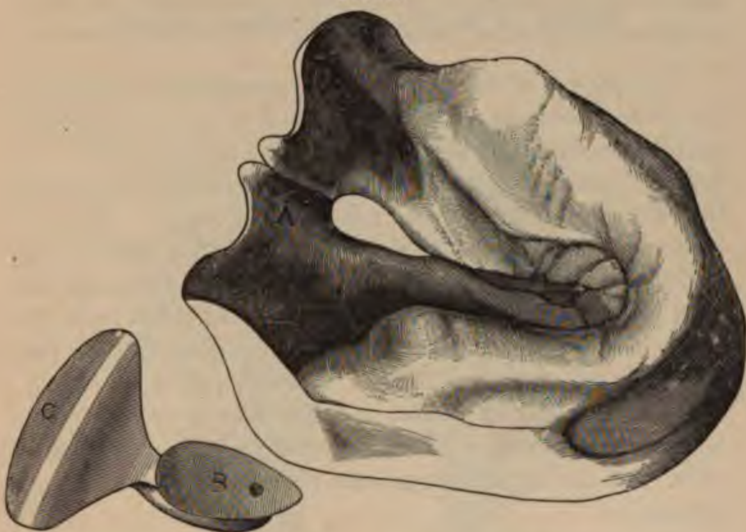
FIG. 200.



had applied herself diligently to the improvement of her speech, she was not satisfied with her progress. The fault being too short a palate, the same as in other cases, the remedy must be the same. But here arose another difficulty. There was no opening through the roof of the mouth, as in case of Fig. 199, and there was no method of securing the desired palate extension to the inferior surface of the natural palate. To convey to the artificial velum the action of the *levatores palati* was essential to success.

After consultation with a skillful and distinguished surgeon of this city (Dr. George A. Peters, New York), it was decided to undo in a measure the operation of twenty-five years before; and an opening was made through the soft palate on the median line, immediately behind the hard palate, as shown in Fig. 201. The opening was a single straight incision, which was subsequently enlarged by wearing a tent for a short time. There was no pain, and but little bleeding; and in a few days it was entirely healed. What complicated the case still further was the loss of all the teeth in the upper

Fig. 201.



jaw, an entire upper denture having been worn for years. The artificial palate was attached to such a denture, and instead of proving detrimental to the denture, it was an advantage, serving when in place to keep the back edge of the plate from the possibility of dropping. The marked improvement in articulation and the gratification of the patient were a sufficient justification for the partial undoing of such an admirable surgical operation.

CHAPTER XIII.

METHOD OF MAKING AN ARTIFICIAL PALATE.

The success of these appliances depends very much upon the perfect accuracy of the model, as it is upon this that the parts are molded. It is essential that the entire border of the fissure, from the apex to the uvula, be perfectly represented in the model, as these parts are when in repose. It is also necessary that the model show definitely the form of the cavity above and on either side of the opening through the hard palate, since that part of the cavity is hidden from the eye. It is desirable, although it is not essential, that the posterior surface of the remnant of the soft palate be shown; but it is especially important that the anterior or under surface be represented *with relaxed muscles* and *in perfect repose.* All the author's experience makes this more and more imperative.

From an extended intercourse and correspondence with dentists, I am satisfied that the "taking of an impression of a cleft palate" is regarded as the most difficult step in the whole procedure of making artificial palates. While there is no more important step, there is no necessity for regarding it as of doubtful accomplishment. It need not be made a more formidable operation than most of the impressions for either full or partial sets of teeth; and in many instances I have found greater difficulty in obtaining a good impression of the lower jaw where there were straggling teeth than I have had in ordinary cases of fissured palate.

In cleft-palate cases it is not so much the skill required in introducing the impression material, as the knowledge of a correct impression when obtained. It is a common circumstance with the inexperienced to obtain an impression of all the parts in all their intricate detail, and which to their unpracticed eye is a model of perfection, but which is nevertheless useless. The only impression of a cleft palate which is serviceable in making such an artificial palate as will be of benefit to the patient, is one which represents perfectly the remnant of the velum in *its relaxed or hanging position.*

FIG. 202.

If the velum and uvula are pushed back by contact with the impression-cup, or with too stiff plaster or other unyielding material, an unpracticed eye may not be able to detect it either in the impression or in the resultant model; and an artificial velum adapted to such a model will fail to confer the benefit it otherwise should.

There is a common mistake made in accepting an impression which shows the sides of the fissure distorted by being drawn up by the levator muscles, and unless such error is detected it will surely lead to failure. If the operator is well acquainted with the anatomy of the parts and the attachment and action of the levator muscles, there should be no hesitation in detecting the fault as soon as the impression is removed. If the operator is at all in doubt, let him study the parts closely before any effort is made to introduce material for the impression. Let him observe accurately the uniform line of the anterior surface of the velum, all the way from the junction with the hard palate to the divided uvula when the parts are in repose, and then become equally familiar with the change of form when they are in action.

Fig. 202 shows a fissured palate with the muscles relaxed and all the parts in repose. In many cases the first view obtained of the fissure will show the sides distorted, and it may be some minutes before they sink into repose; but more commonly they will appear in repose, and by touching but slightly with an instrument the action of the *levatores* will be seen catching the edges of the fissure a little more than half way up to the hard palate, and drawing them aside and upward like elbows akimbo. It is the skill used in not crowding back the soft parts when the material is introduced, and the ability to detect any adverse action of the levator muscles, that makes the getting of a correct impression of all congenital clefts as simple a matter as any important operation about the mouth.

How to obtain an Impression of a Cleft Palate.—With the requisite anatomical and physiological knowledge above indicated, the best method of procedure is as follows:

No special impression-cups are needed. The common britannia tray, of the uniform pattern for a full upper jaw, is the best thing I have yet used; and this is after repeated trials and experiments of every conceivable variety, with forms and cups made especially for the purpose and from a variety of materials. As the majority of cases will be where there are natural teeth in the jaw, the description of the process will recognize their presence.

Select from the various sizes of trays the one best adapted in size and form to cover all the teeth. Avoid its being unnecessarily large; to simply cover the teeth and rest steadily against them, without rocking, and with the handle in the center of the mouth, is sufficient. Place the tray in position against the teeth, and observe the fissured palate and uvula hanging beyond and below the posterior border of the cup. Add now an apron or extension to the back edge of the cup, made of sheet gutta-percha, wax, or any other convenient material, warming the edge of the cup and sticking it on. Let this apron come down just to the lower ends of the uvula, but on no account touch any of the soft tissues. Before any attempt is made to introduce the plaster, let the operator be sure that he has seen the tray in the position in which it will be when the impression is taken, and that the velum in its relaxed condition does not rest upon nor touch the apron of the tray. This will measurably guarantee success.

Secondly, let the *morale* of the performance, as described on page —, be borne in mind. On no account is the patient to imbibe the idea that the operation is attended with any difficulty, or that any particular importance is or need be attached to the present manipulations. Should the patient become inquisitive or nervously apprehensive, divert his mind, as no magnified idea on his part of the importance of the procedure, nor any interested coöperation, is likely to be other than detrimental. With plaster of Paris prepared as described on page —, place on the tray a sufficient quantity to fill the roof of the mouth between the teeth, and extending down in a thin film, say a sixteenth to an eighth of an inch in thickness, over the apron. Make no calculation for an amount coming around outside the teeth, as that provided for the inner parts will generally be found quite sufficient to ooze out and cover the teeth. Neither need there be any provision made, where the fissure extends very far forward, for carrying plaster away up and getting an impression of the nares, vomer, and turbinated bones. Neither is it necessary to attempt to get an impression of the chamber of the pharynx or the posterior side of the velum or uvula. Impressions of that character result in beautiful anatomical models, but when carried to an excessive extent are of no other practical value; and the attempt to get them often endangers or prevents more important matters. Bear in mind that, in the present condition of artificial vela, all that is required of an impression is to show the entire border of the fissure from base to apex, distinctly defined and in its relaxed condition, and that in a majority of instances all representations of details beyond the round border or edge are unnecessary. With this description adhered to, we have the process reduced to one of great simplicity, all superfluous appliances discarded—a common britannia cup, with a gutta-percha extension and some plaster of Paris, being all the requisites for this first and most important step.

The introduction of the plaster and its removal being already described on page —, it is unnecessary to repeat. After removal, the critical eye of the operator will detect if there are any variations from the desired shape. Sometimes the bulbs of the uvula will show themselves flattened in the impression, as they are often so delicate as to be disturbed in shape by the softest plaster; but this change is not of much consequence, as they are of little value in any association with the artificial velum. If, however, the operator observes this in the impression, and it is the only variation, and if for any reason their rotundity is desired, it can be very readily remedied in the impression by carving out the places with a round-pointed graver or spoon-shaped scraper. Those made by Mr. S. S. White, copied from the author's make, are especially adapted to this purpose.

Descriptions are given to the profession from time to time of methods for obtaining difficult impressions in cases similar to those under consideration, where wax or other plastic material is used for a preliminary impression, to be changed in form and supplemented by plaster; or again where cotton is used to support or sustain the plaster; or sticks or props of various kinds are employed. All these, in the experience of the author, are useless; they are but the leading-strings of infants. With the direct and simple means above described, experience has shown that a correct impression can be obtained in nearly all cases at the first sitting and on the first introduction.

If the first attempt ends in failure, a failure will be more likely to follow a repetition at that sitting than if the proceeding is postponed. After the first effort the muscles frequently become irritable and quiver, and draw away on the slightest touch, so that delay until recuperation comes is desirable. It has been recommended by some that a preliminary treatment be given which should accustom the parts to being handled. Such a course might be beneficial, but is not of sufficient importance to delay for any length of time the treatment of the case to accomplish that object alone. That they can be made almost insensible to manipulation by treatment and handling is shown in all cases where patients have worn artificial vela for any length of time and a new impression is taken; the muscles will then be found so stupidly quiet as to suggest that they have lost their vitality.

After the impression is taken with all the skill possible, it is essential that the resultant cast should be submitted to tests which shall prove its accuracy or its defects. So far as the artificial palate is concerned, it is essential that the plaster cast of the cleft shall indicate the precise form of the fissure *from the apex to the termination of the uvula;* the surrounding parts being in their relaxed or hanging condition, without being drawn into angles or wrinkled by the action of the levatores. The best test is to adapt a trial-piece made of sheet gutta-percha to the plaster cast, which will cover the roof of the mouth precisely as would a plate for artificial teeth. Let this trial-plate be prolonged at the posterior edge in the form of a tongue, exactly filling the fissure from side to side, bent to the same curve, and extending to the ter-

20

mination of the uvula. Being thus adapted to the plaster cast and then inserted in the mouth, the discrepancies will readily appear, and the probability is that such a test will always reveal some variations. The plaster cast must then be made to conform to the shape of the fissure by additions, removals, or alterations of incorrect portions. Additions of plaster can be most easily made with a small camel's-hair pencil, using the plaster as a thin paint. For this purpose the most convenient plan is to put a little water in a saucer, and drop a thimbleful of plaster in the water at one side; use it with the brush, without stirring or mixing. In this way skilled fingers may build up very considerable alterations in form, and the gutta-percha test will show their correctness.

It is not essential to one of experience that the pharynx behind the uvula should be taken in the impression. When the model is obtained from the impression, a representation of the pharynx can be made, with sufficient accuracy for practical purposes, by carving. It is only when the floor of the nares is used for the support of the palate that it becomes necessary to obtain a more complicated impression—one which will represent not only a portion of the buccal cavity, but all the superjacent nasal cavity. When this is required, the operation may be divided by first taking such an impression of the roof of the mouth and fissure as has been described, which we may call the palatal impression, and subsequently introducing the same impression again to get a further impression of the upper or nasal surface of the hard palate. This can be done by filling the cavity above the roof of the mouth with soft plaster down to the border of the fissure, and, while yet very soft, immediately carrying the palatal impression already taken against it, and retaining it in that position until the plaster is hard, which can be easily ascertained by the remains in the vessel from which it was taken. Taking the precaution to paint the surface of the palatal impression with a solution of soap, to prevent the two masses from adhering when brought in contact, there will be no difficulty in removing it from the mouth, leaving the mass which forms the nasal portion *in situ.* With a suitable pair of tweezers this mass is easily carried backward and withdrawn from the mouth, the irregular surface of contact indicating its relation to its fellows when brought together.

Fig. 203 shows such an impression. The portion marked A B C will be recognized as that which entered the nasal cavity. The line of separation from the palatal impression is indicated in the engraving. The groove marked D shows the impression made by the delicate uvula in the soft plaster.

FIG. 203.

The nasal portion is relatively large, showing an unusually large nasal cavity. The vomer lies between the projections marked A A, these projections entering the nasal passages. The surfaces marked B B came in contact with the middle turbinated bones; the surface marked C in contact with the inferior turbinated bones. In many instances these turbinated bones are so large as to nearly fill the nasal passages.

After the model has been tested and corrected as before described, the gutta-percha trial-piece may be put to still further use by extending until it nearly or quite touches the posterior wall of the pharynx. This test is to determine the length at which the palate can be borne, and therefore the departure from the line of the fissure across the pharynx must be at the same point, on the same line, and at the same angle that the artificial palate is to be worn. When the nasal portion of the impression does not indicate the superior posterior surface of the soft palate, the part may be represented in the model by carving.

It is not essential to the success of the artificial palate that the posterior surface of the soft palate should be represented with the same accuracy that is required on the inferior surface or on both surfaces of the hard palate. By the aid of a small mirror and a blunt probe, the thickness of the velum and the depth behind the fissure can be ascertained. Approximate accuracy is sufficient, since the portion of the artificial palate coming in contact with it is so elastic that it easily adapts itself to a slight inequality, rendering absolute accuracy less important.

The next step will be the formation of a model or pattern of the palate. Sheet gutta-percha is preferable for this purpose, although wax or some other plastic substance might answer. The form which should be given is better indicated by the drawing, Figs. 191 and 192, than it could be by written descriptions.

The Stearn instrument was made to embrace the edges of the fissure, and was slit up through the middle, so that when the sides of the fissure approached each other, as they always do in swallowing, the two halves of the instrument would slide by each other; a third flap or tongue was made, and supported by a gold spring, to cover and keep closed this central slit. (See Figs. 179 and 180.) This complicated provision for the contraction of the fissure is entirely superseded in Figs. 191 and 192, by making the instrument somewhat in the form of two leaves, one to lie on the inferior and the other on the superior surface of the palate, and joined together along the median line. When the fissure contracts, the halves of the divided uvula slide toward each other between these two leaves.

The posterior portion, marked A in Fig. 191, is made very thin and delicate on all its edges, as it occupies the chamber of the pharynx, and is subject to constant muscular movement. The sides are rolled slightly upward, while the posterior end is curved downward. The inferior portion, marked D D, should reach only to the base of the uvula, and bridge directly across the chasm at that point; and no effort to imitate the uvula should be made. The extreme posterior end should not reach the posterior wall of the pharynx by a quarter of an inch when all the muscles are relaxed (although subsequent use must determine whether to increase or diminish this space), thus leaving abundant room for respiration and for the passage of nasal sounds.

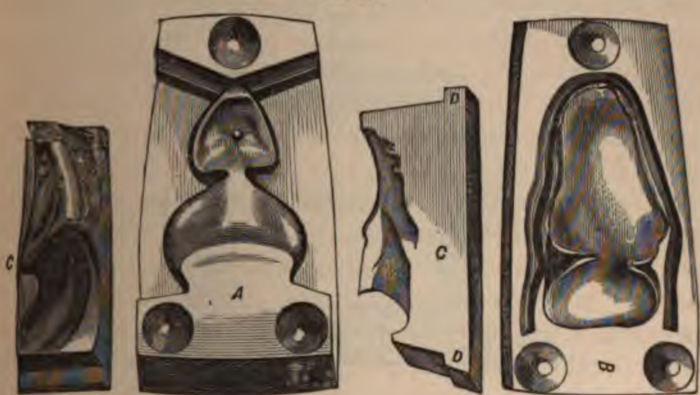
In cases where it is desirable to make the instrument as far as possible independent of the teeth for its support, the anterior part which occupies the apex of the fissure in the hard palate may lap over upon the floor of one or both nares. Such a projection is seen in Fig. 194, marked B, and like processes are seen in Figs. 189 and 190, marked E E. Were it not for this process in the first case, the palate would drop from the fissure into the mouth, the single clasp at the extreme anterior edge not being sufficient to keep the whole appliance in place throughout its entire length. Caution must be exercised that this projection entering the nares be not too large, or it will obstruct the passage, and give a disagreeable nasal tone to the voice.

The end of the artificial palate should not come against the pharynx at a right angle, but rather obliquely. Consequently, if the palate is placed at a higher level, a shorter instrument will reach across; while, if it be placed at a lower level, a much longer instrument will be required. Both extremes are objectionable. The longer palate is liable to interfere with deglutition and to split and misdirect the column of sound in its outward passage, while the shorter one will affect the quality of the voice as well as make articulation more difficult. The best form is that which follows the border of the fissure from its apex down to the junction of the uvula, with the palate, and then diverges across the pharyngeal passage, as seen in Figs. 191 and 195. There is no difficulty in discovering the line of departure from the fissure; the uvula, which is bifurcated or rather appears double, one on each side, is always strongly pronounced in its bulbous form, and its junction with the palate is always distinctly marked.

When the fissure is filled or bridged across down to this point, the instrument here forms the superior boundary of the fauces, which theretofore was without boundary because of the fissure. Theoretically it would seem that the artificial palate should stop at this point, and not continue at a different angle across the pharynx; but experience has shown the necessity for elongating it. The reason for this elongation is, that distinct articulation of the voice at times requires the passage of sound to be entirely cut off from the nasal cavity, while at other times the sound must escape in that direction. This cutting off of the nasal passage for sound is accomplished by the simultaneous action of two sets of muscles: 1. The levator muscles lift and in a sense carry back the artificial palate. 2. The constrictors of the pharynx bring forward or contract the pharyngeal wall. This is the physiological action of the palatal and pharyngeal muscles in the articulation of the voice. With an artificial palate filling a congenital cleft and terminating at the uvula, it will be found that when it is raised to the utmost power of the levatores, and the pharynx is contracted or brought forward to its utmost, there is still a gap behind the instrument for the escape of sound, and for this reason the extension must be made. As an approximate guide for this length it may be stated that if the artificial palate is of the form described and placed in its best position, the palatal and pharyngeal muscles being all relaxed, there should be a space of about a quarter of an inch between its posterior edge and the wall of the pharynx. But the final test of this must be when the completed palate is introduced.

All the peculiarities described must be provided for in the gutta-percha model, which, after having been carefully formed upon the cast, may be tried in the mouth to ascertain its length or necessary variations. When its ultimate form has been determined, provision must be made to duplicate it in soft rubber. A familiar illustration of the process here to be adopted is found in the parallel process employed when a set of teeth is made on a vulcanite base. A model form is made of wax or gutta-percha, bearing the teeth, and in all its prominent characteristics has the shape desired in the com-

FIG. 204.



pleted denture, the rubber duplicate being vulcanized in a plaster mold. In like manner the rubber duplicate of the palate, as before described, may be made in a plaster mold.

If plaster is used for the molds, it must be worked so that the surface shall be free from air-bubbles, or the rubber palate will be covered with excrescences that can not readily be removed. But ordinarily plaster molds will be found too troublesome for general use. They may be put to most excellent use, however, by using one to make a duplicate of the gutta-percha in hard rubber. This is not necessary with those who have had much experience, but with beginners it will be difficult to work up the gutta-percha as nicely as may be desired. A duplicate in vulcanite will enable the operator to make a more artistic model of the palate, and one which can be handled with greater freedom.

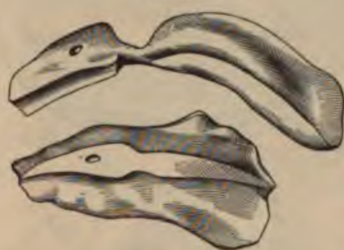
As in the course of a lifetime a considerable number of elastic vela will be required, the mold which produces them should be made of some durable material. The type-metal of commerce is admirably adapted to this use. A very complete mold is one made of four parts, such as illustrated by Fig. 204, which will produce a palate in one continuous piece.

FIG. 205.

The blocks C C are accurately adapted to the body of the mold marked A, and are prevented from coming into inaccurate contact with each other by the flanges D D, which overlap and rest upon the sides of the main piece. B shows the top of the mold, and the groove E provides for the surplus rubber in packing. Such a mold makes as perfect an appliance as can be produced. The palate is one homogeneous and inseparable piece. The cut sufficiently indicates the form of the several parts. Each of these pieces is first made in plaster, having exactly the form desired in the type-metal. They are then molded in sand, and the type-metal cast, as in making an ordinary die for swaging. When in use a clamp similar to Fig. 205 is placed around the mold to keep the several parts firm in their position.

Such a mold requires nice mechanical skill in fitting all the parts accurately, and, unless the operator has had experience in such a direction, it is better to simplify the matter. By making the palate in two pieces, to be joined after vulcanizing, as shown in Fig. 206, the mold may be made in two pieces and with much less trouble. Fig. 207 shows such a mold, made also of type-metal, but inclosed in a flask for greater convenience. The flasks are made of brass expressly for this purpose; but they are not so unlike the flasks in common use in dentists' laboratories that the latter will not

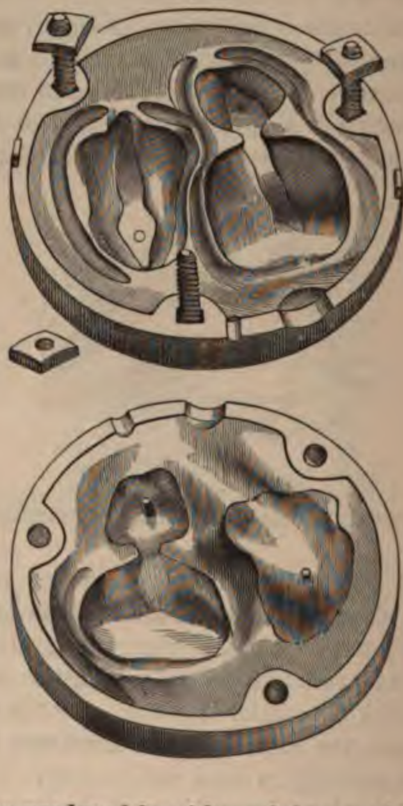
FIG. 206.



answer. The common flask is simply unnecessarily thick or deep.

This mold is produced in the following manner: The palate pattern or model having been made in hard vulcanite and separated into two parts, as seen in Fig. 206, the pieces are placed side by side in a bed of soft plaster in one half of the flask. When the plaster is set, remove the patterns and trim and varnish the surface. This form may be copied in type-metal by molding in sand and casting. To make the sand-mold, take a ring of sheet-iron of the same diameter as the flask and three or four inches high; slip it over the flask and pack full of sand. Separate them, remove the plaster from the flask, return the empty flask to the sand-mold, and fill with melted metal through a hole made in the side or bottom of the flask, the side being preferable. This half of the metal mold should be finished all it may need, when the other may be made by placing the palate patterns on the metal mold, filling the other half of the flask, and carrying out substantially the preceding steps.

FIG. 207.



The palate produced by either of these molds is shown in Fig. 208. In connection with it is also shown the plate with clasps which secure it in position by attachment to contiguous teeth. The connection with the plate is by a pin of gold passing through a hole of the same size in the palate, the head on the pin being larger than the hole through which it is forced. The two pieces of palate made in mold Fig. 207 accomplish the same result when in use, as they are held together at the forward part by the pin and head, and a few stitches of silk secure them at the posterior part.

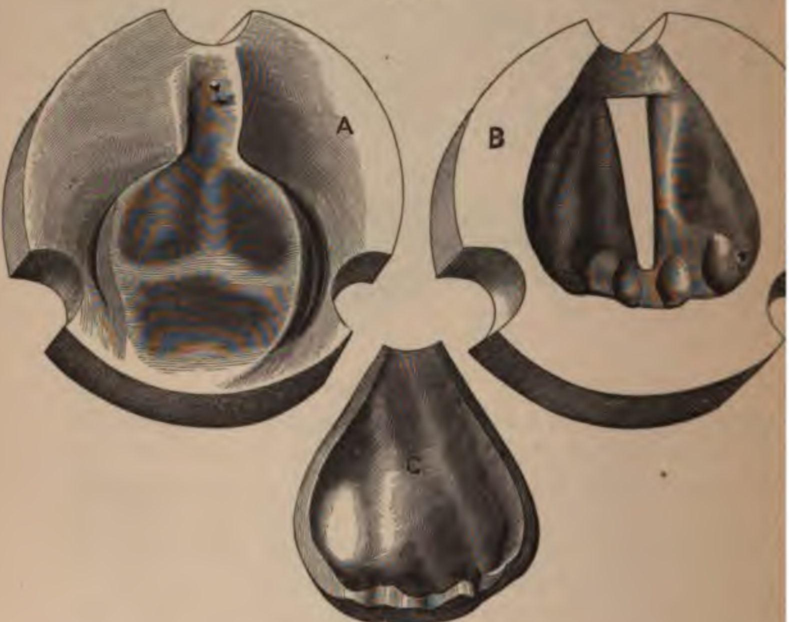
Another plan for a mold, and the one which the author has adopted for his large series of molds, is made in three pieces of metal, as shown in Fig. 209. It is the most simple and at the same time the most complete of any mold yet invented. It is inclosed in a flask like Fig. 207, but with the improvement that the resultant palate is complete in one piece, the same as that produced by the more complicated mold, Fig. 204. A represents the base of the mold

FIG. 208.

made in one half of the flask; B, the section which occupies the other half of the flask, and is placed on top of A in the same relation they hold in the cut, i. e., the under side of the section marked B fits to the surface marked A, and between these is the space for a portion of the palate. B, which we may call the middle section, represents one half of the palate on one of its sides, and the other half on the other side, the connection between the two divisions of the palate being through the opening in the center. The third section of the mold, C, turns over and fits on top of the middle section, and when inclosed in the flask makes the mold complete. When the flask is opened after the rubber is vulcanized, the palate will remain with the middle section, and can be removed by pulling the smaller part through the central opening.

The process of making a palate in any of these molds is by packing with rubber in substantially the same manner as when hard rubber is used for a dental base, with which process it is assumed the reader is familiar. By painting the surface of the mold with a thick solution of soap, or, better still, rubbing the mold over with hard soap previous to packing, the palate will be more easily removed after vulcanizing.

FIG. 209.



The rubber used for this purpose must be a more elastic compound than that used for a dental base-plate. Partially vulcanized hard rubber, which is sometimes used, is very objectionable. Not being completely cured by the vulcanizing process, it soon deteriorates in the mouth, becomes disintegrated, and all the objectionable ingredients of its composition made apparent. The compound used for elastic fabrics of commerce will answer if made of selected materials, but for this purpose it ought to be especially prepared. The permanent value of an artificial velum is much enhanced by using only material made with reference to such use. Such a composition requires not only great care in the purity of its ingredients, but the proportions and the method of working the mixture will affect materially for better or worse the articles made from it. Some rubber compounds possess a durability greatly in excess of others, and consequent increased benefit to a patient wearing such an instrument. To obtain the best results, the rubber should be vulcanized for six hours between 230° and 260° of heat, beginning at 230° and increasing 5° per hour until the end.

CHAPTER XIV.

INTRODUCTION AND USE OF ARTIFICIAL VELA.

PRESUMING that hereafter many dentists will prefer to adopt one of the forms of palates already made rather than go to the trouble, with little or no experience in that direction, of making molds and producing them, the following directions for their successful application will be found valuable:

After the plaster cast of the fissure and adjacent parts has been made and proved as before described, select from the various forms and sizes of artificial palates one best adapted to the plaster model. It is not necessary that it should come to the apex of the fissure if the apex be within the hard palate; neither is it absolutely essential that it should reach completely to the apex if the fissure comes no farther forward than the posterior margin of the hard palate. But, if the fissure is short and does not come up to the palatine bone, it is better that the artificial palate fill the fissure to the apex. At all events, it must be broad enough to cover all of the remnant of the soft palate on each side of the fissure and anterior to the uvula. Place the palate in position on the plaster model, and proceed to make a temporary plate or attachment for the purpose of trying the palate in the mouth. A very easy method is to insert in the hole in the palate a bit of common iron wire of suitable size to fit into it, with the end on the oral side bent toward the front teeth. Pour a little plaster over the gum, as represented in the model, about this wire, and reaching back to where it is inserted in the palate. When this is sufficiently hardened it can be removed, and will prove a convenient way of trying the palate in the mouth and proving its position previous to a more permanent and less alterable attachment. It may sometimes be found that, with all the care and skill used to prove the plaster model correct, when the artificial palate is tried in, some variation of its position or hanging may be desirable. If on trial the only change desired be the pitch —either to raise or depress it at its posterior end—this can be readily done by bending the pin as it appears out of the plaster. But if it requires to be drawn farther forward or carried farther back, it will be more satisfactory to reset it on the plaster model and make a new plaster trial-piece as before. This latter process, which may be termed *hanging the palate*, is of equal importance to any antecedent step, as it is quite possible to have an instrument made with the utmost nicety of workmanship, and yet so unskillfully applied as to be of little or no service to the patient.

The final security of the palate must be of course by some connection with the teeth, or, in the absence of natural teeth, with some plate bearing artificial teeth. An excellent way of arriving at this result after the hanging of the palate is determined is as follows: Instead of the pin of common wire which has been used with the plaster trial-piece, make one of gold wire of the same size, with a head upon it such as seen in Fig. 194. Put the gold pin through the palate with the head on the nasal or upper side, and bend the pin at nearly a right angle where it comes out of the palate on the oral side, pointing it as before toward the front teeth. Proceed as before with the plaster trial-piece, and when satisfactory pull the palate off the pin, replace the plaster trial-piece in the mouth, and take an impression in plaster of it and all the parts desired outside of it. When this impression is removed, the gold pin will be found standing out of it in the exact position in which it is desired to hang the palate. Make a cast into this impression, and the result will be that the pin is transferred to a model which represents in plaster the face or oral side of the artificial palate and all the adjacent gum and teeth. From such a cast as this there will be no difficulty, to the ordinary master of the details of the laboratory, in making the attachment. Such a plan as here described will be found more especially applicable to a vulcanite or celluloid base. If these materials are used, the steps are quite simple. The cast represents the whole surface with which the plate is to come in contact, with the pin in position and bent so as to become anchored in the plate. If the precaution has been taken to *flatten* the gold wire at the end, it will make the anchorage more secure. Upon this cast and over this wire the form of the attachment or plate will be worked up as is usual in making a plate for artificial teeth, and the subsequent steps will also be similar.

Experience has shown that in a considerable number of cases the pharynx will not at first tolerate so large an appliance without irritation as it will subsequently, or so large as will best secure the desired results. Consequently, it is better to introduce an instrument with a smaller pharyngeal portion. This posterior or pharyngeal part of the instrument can be reduced in size by cutting it down with a pair of scissors; but this leaves the edges thick and more or less irregular and ragged, and such a course is therefore objectionable. It will be borne in mind that the pharynx is made up of muscular tissue covered with a delicate membrane, which becomes excited to action upon contact with foreign substances, and the first effort will naturally be one of contraction, as in the process of swallowing. These spasmodic movements in some are slight and of temporary duration, while in others the vain effort to swallow the offending mass becomes uncomfortable. If now the pharyngeal portion of the artificial palate be reduced in size by cutting, the thick and harsh edges may cause irritation. It is better, therefore, to make the instrument for the first introduction with the pharyngeal part reduced in size as it comes from the mold, thus having the thin and delicate edges which are so desirable for comfort; and equally so in the selection of a palate already made: the choice of the first is better to be one which fills the fissure fully as it is desired, but one with a smaller pharyngeal extension than will be ultimately required. With an instrument of suitable materials and properly adjusted, it will be but a few days before it is worn with ease, and in a very little time its removal will be a positive discomfort.

The final length of the posterior extremity will depend much upon the activity of the muscles of the pharynx. There is a great difference in the power or control of the pharyngeal muscles, as shown by different individuals. In some the action of the constrictors is very great, while in others there is, even in deglutition, apparently but little movement. Upon the introduction of the completed palate the action of all the muscles concerned can be observed, and thus the length at which the palate shall be finally left can be determined.

In a case where the pharyngeal muscles are in a very passive state, some calculation can be made upon a cultivated activity in the future, for upon their action and control will depend, in a large measure, the improvement in speech. The Suersen obturator depends entirely upon this pharyngeal action for its success, but it is only in exceptional cases that they can be educated to the duty otherwise required of both them and the palatal muscles. It will generally be found that, as the patient makes progress in the articulation of the voice, a shorter artificial palate can be worn, and one which comes nearer to the length of what the natural palate would have been if not deformed.

The durability of an artificial velum depends much upon the cleanliness and care of the wearer. In some mouths the fluids act upon the soft, elastic rubber, and it becomes deteriorated much sooner than in others. In some instances patients have worn one for several years, while others will use one up in a few months. Dispensing with it during sleep and thorough cleansing frequently with hot water do very much to prolong its usefulness; and this necessity for cleansing should be impressed upon the patient's mind.

The age at which it is best to introduce an instrument of this kind becomes a question of importance, and at as early an age as the patient would take an interest in developing its benefit would undoubtedly be preferable. The improper position in which some of the organs of speech are placed, in the efforts of the patient to articulate distinctly, becomes so habitual as to be almost impossible to overcome, and consequently the earlier the age at which it is attempted, before these habits become firmly fixed, the better. The earliest age at which the author has introduced an artificial palate was six years, but the results were not so encouraging as to justify a repetition of the experiment at that age. The temporary nature of the teeth, to which attachment must be made, together with the lack of interest in the expected benefit, are sufficient to overbalance any advantage that might be gained in the prevention of bad habits of speech. In most instances it is not desirable that efforts of this kind should be undertaken before about the period of the eruption of the second permanent molars. The maxillæ at that time have attained nearly or quite their full size, and are not likely thereafter to change so much as to require a different form or size of appliance.

There is no limit to the advance of age at which an artificial palate may be introduced. The desire of the patient, after a recognition of the probable difficulties to be overcome, would be the principal governing motive. In one instance in the author's practice marked benefit was derived from its use within a few weeks after its introduction for a lady over sixty years of age; but it is not advisable to encourage patients of that advanced age with the hope of very much improvement of speech.

The benefit to be derived from the use of an artificial palate depends upon the intellectual status, the application, and the perseverance of the patient. The responsibility of the result rests solely with the patient after an appliance best adapted for the purpose has been introduced. Results can not be guaranteed. All that can be said is, that appliances can be made which can be worn with freedom from discomfort, and that a large number of persons have made such use of them as to completely hide in their speech any evidence of the deformity. The improvement is sometimes rapid and remarkable, in other cases slow and tedious, showing in the latter a want of application—an insensibility to the defect and a dullness of capacity. The result must be accomplished by the same character of application and training as would be given by an adult to the mastery of a foreign language or of a musical instrument.

One of the best methods of practice with an artificial palate is the effort to acquire with it the use of a foreign language. The mind becomes thus diverted from the habit into which it has fallen, and it is sometimes easier to learn to speak a foreign language well than to break up the habit of speaking one's vernacular badly. There are certain habits which cleft-palate people involuntarily acquire, which are no detriment to them in learning to speak French. Such persons are always endeavoring in their speech to compensate for the escape of their voice through the nares by a contraction of the nostrils. The *compressor nasi* comes to be with them an organ of speech. The resonance thus given by the nasal cavity destroys the perfection of their English, because the nasalization of every sound of the English language save three affects its purity (see chapter on "Mechanism of Speech"); but, with the French, nasalized sounds form an important part of the language. It is for this reason that M. Preterre, of Paris, has met with so much success with French patients by the use of an appliance with which it would be impossible for them to acquire English perfectly. Experience shows that it is far easier to acquire a foreign language in youth than in maturer years, and for that reason it is better that all cleft-palate cases come under treatment at the earliest age admissible. With an instrument scientifically adapted to the peculiarities of each case, and a training by some one who understands the mechanism of speech, there is no reason why every youthful person with such a defect may not overcome it entirely within a few months.

CHAPTER XV.

BUCCAL AND NASAL PROTHESES.

Under the above head will be described certain appliances for the replacement of lost portions of the buccal or nasal structures. All artificial teeth might with propriety be included under the general term of "buccal protheses"; but, as their application and uses are so well known, the illustrations which follow will not embrace the ordinary restoration of dental organs and their associated alveolar processes. The necessity for such apparatus arises from the accidents and diseases to which the buccal and nasal organs are subject, and consequently nearly every prosthetic effort must be in a measure an original and unique one.

In all apparatus designed for internal use in either buccal or nasal cavities, there will be but little difficulty in finding materials which are applicable to the purpose; any of the substances used as a base for artificial teeth are suitable, and the choice will depend upon the peculiarities of the case and the judgment of the operator. The difficulties will lie in the construction, for which there can be given no definite instruction other than a perusal of the following described cases.

The attempt at the replacement of a nose may be regarded as exceptional, for the reason that it is so conspicuous an organ that the appearance is of more consequence than the utility. There is no organ of the entire economy the loss of which creates such a hideous deformity as the nose, nor is the successful prosthetic restoration of any organ so difficult. Artificial teeth, eyes, legs, hands, arms, etc., are all made so skillfully as to escape detection, but artificial noses never. The best of them, however artistic or appropriate in form, are but a poor imitation of the adjacent living tissue.

At the present time there is no permanently durable substance known which has the color and translucency of flesh; and furthermore, the frequent changes in the complexion from variations of temperature, excitement, climatic exposure, etc., make the contrast of an artificial nose all the more evident. Various devices have been resorted to in the effort to overcome these objections.

In many respects wax, properly colored, forms the best imitation of flesh, but its objections are manifest, although it is sometimes used by those who are willing to put up with the trouble of constant renewals.

Celluloid has the requisite translucency, and possesses an advantage over wax in being firmer and more durable, but it is open to the objection that it is very difficult to perfectly match with it the adjacent complexion, and furthermore, in the author's experience, the substance changes in appearance under prolonged exposure to the weather; this can be partly overcome, however, by touching up the surface with suitably colored chalk crayons, whereby a very good effect may be produced.

The least satisfaction has followed the use of vulcanite, and painting the surface in imitation of the flesh. This I have done, and, although the nose was colored by an accomplished portrait-painter, there was no *life* in the organ, and the result was an æsthetic failure.

I think the most satisfactory thing of the kind I ever did was made of "rose pearl," a substance similar to celluloid, but much more difficult to work and not now easily obtained. This case is described on page 341.

There is no more appropriate place than this to describe an experiment with

AN ARTIFICIAL EAR.

I was applied to by a young man who had no external ear on the left side of his head, save a little rudimentary portion of the lobe. It was a congenital defect, and the absence was so conspicuous as to make him very anxious for an artificial one. I did not encourage the experiment, but yielded to his urgency.

A cast was taken of that side of the head, and upon it I modeled out of wax an ear to match in size and shape his natural one. This wax model was copied in celluloid. The artificial ear was secured at its lower end by a bit of gold wire passing down through the rudimentary lobe, and upon the upper and concealed surface were two spring-clasps, such as wig-makers use, by which it was caught to the hair. I succeeded in getting an excellent imitation of the opposite ear both in color and form, so that, when in position and the hair thrown carelessly about it, the falsity of the ear was unobservable. The change, however, which afterward took place in the color of the celluloid, together with the instability of the attachment, would hardly justify a repetition of the experiment.

Prosthetic Treatment of a case of Hereditary Syphilis.—In 1872 a miss fourteen years of age was brought to me by her mother, who said that the child had been for two or three years under treatment for a catarrhal difficulty, and that she had lost nearly all her upper teeth. There was no remarkable change in the expression or appearance of the face, other than that associated with the loss of the upper teeth. The upper lip was a little sunken, but no other feature seemed to be changed. An examination of the oral cavity showed three teeth only remaining in the upper jaw, viz., the first and second molars of the right side, and the second molar of the left side, while all the roof of the mouth, between and anterior to these teeth, was gone. The situation at that time is well illustrated in Fig. 210. A A represents the inner or oral surface of the lip as it was pulled out and forward in taking an impression. The semicircle B B marks the dividing line between the oral and nasal cavities. This semicircular rim was soft, flexible, and elastic, devoid of bone or cartilage in any part except at its junction with the alveolar process which surrounded the roots of the remaining teeth. The soft palate, marked C, had not lost its integrity; the uvula and the superior pharynx were also undisturbed.

FIG. 210.

Neither were the bones of the nasal cavity destroyed. D D represents the vomer and turbinated bones, covered with thickened and puffy tissue, completely filling the nasal cavity, and hanging quite level with the original roof of the mouth, as indicated by the anterior edge of the soft palate C and the rim B B.

So completely did these enlargements fill the cavity, and shut off escape by the nostrils, that the voice was not interfered with in distinctness of enunciation more than commonly arises from a cold in the head. Not being altogether pleased with the general appearance of the tissues, I consulted with her physician, one of the most distinguished in America, who was confident that the disease was entirely eradicated; that there was no doubt of its nature and hereditary character, and furthermore that "it was not likely that the mother was aware of either its true nature or its origin, as he had never conversed with her on the subject."

I made an upper set of teeth for the patient, using

FIG. 211.

vulcanite as a base, and making it as light as possible. There was nothing peculiar in this proceeding, from taking an impression, and going on in the usual way for making a set of teeth in ordinary cases. They were supported by clasping around the molars, and lay in close contact to the tissues filling the nasal cavity. The only gain to the patient was in the restoration of expression to the upper lip, and a little improved masticatory power. The articulation of the voice remained the same.

I saw no more of my patient for two years, when the mother again brought her, desiring, as she said, that I should "put a little prop on the teeth, to go into her daughter's nose and keep it up." The two years which had intervened had made sad havoc with her features. The bridge of the nose was sunken, and the end had flattened and receded until it was nearly on a line with the chin and forehead. This retrocession of the base of the nose had carried back the upper part of the lip, drawing it in and over the artificial teeth and plate, so as to produce a most unfortunate expression. With the teeth out of the mouth, the deformity of external features was even worse, and is most accurately shown in Fig. 211. There being no support for the lip, it fell back in a straight line from one corner of the mouth across to the other.

An examination of the oral cavity showed how continuous and destructive had been the disease. Another tooth had fallen out, and the process had wasted away. The vomer and turbinated bones were entirely gone. The soft palate was apparently undisturbed, nor was there any marked change in the buccal cavity proper; but above the opening through the roof there was an immense cavern, much larger than the opening, in every direction. This condition is as well represented in Fig. 212 as is possible by wood engraving, but it gives no conception of the height of this cavity, nor of its breadth in any direction. The former soft and flexible condition of the rim, marked B B, had now changed to a cartilage, firm to the touch, and unyielding as a cable, and the remaining teeth were loose in their sockets, but the tissues looked as if the disease had spent its force. The voice, too, had undergone its changes. From the clearing out of the nasal cavity had come an improvement in tone, when the artificial teeth were in place; but when they were out of the mouth, the voice blowing through the great cavity and the nostrils rendered speech almost impossible.

Prosthetic treatment now required mainly a restoration of the external features, and the most serious difficulty to overcome was the aforementioned contracted band of cartilage. Any appliance which did not force out and sustain in an advanced position the upper part of the lip, and the base of the nose, would be a failure; and the only safe way, considering the liability to excite destructive inflammation, was to compel the cartilage to relax under gentle but constant and aggressive pressure. Pressure upon one part involved a base to antagonize against, which would bear *without yielding*, and *without danger*, an equal amount of pressure. As there were no solid opposing tissues to abut against, the

FIG. 212.

problem became a very difficult one, and was only solved by the determination to spread the appliance over just as large a surface as possible, fit it accurately to every inequality, and thus, while the pressure in front was concentrated upon the median line, it would be antagonized by distribution over a very large surface.

A second serious difficulty to overcome was the conception of an appliance which could pass the comparatively small opening in the roof of the mouth, and then by inherent power expand, enter the cavity of the nasal cartilage, and constantly press forward and upward. Measured from front to rear, the nasal cavity which must be operated upon by the instrument was nearly twice as long as the entrance to it.

Fig. 213 shows the completed instrument. It was a very thin shell of black vulcanite. The appearance from below is that of an ordinary set of teeth. It was intended to restore the normal contour to the roof of the mouth, pass around the molar teeth, as seen in Fig. 213, cross over, and lap sufficiently on to the soft palate to shut the opening. The letter C shows the upper surface of the apron which lies on the

FIG. 213.

anterior edge of the soft palate. B B shows the groove formed for the reception of the rim of cartilage marked with the same letters in Fig. 212. The instrument reaches up to the top of the nasal cavity, but is open front and rear for respiration, which passes unobstructed through the nose, through the shell, and behind the soft palate, without entrance to or from the mouth.

The processes E E pass into the nose and support the sunken portions. It must be observed that in the position in which the instrument is here shown it could by no possibility pass the opening, as the anterior border of the opening is represented by a line running from B to B. The nasal elevator must therefore be so arranged as to fall back of the line B B to be introduced, and then must expand into its position. This was accomplished by attaching the elevator to the denture by a joint, as seen in the engraving, and also by extending an arm of the elevator within the shell, and terminating it with a hook. As the imagination must be drawn upon, the dotted line in the engraving shows the form of that part concealed from view. The means by which I should keep up a constant pressure, which should both relax the cartilage rim and restore the nose, and without too complex mechanism, was another serious problem until I caught a small ring of rubber tubing over the hook within the shell, and drew it back to the edge of the shell, and there caught it over a spur of vulcanite made to receive it. This invisible rubber strap is also indicated by a dotted line. The nasal elevator, as shown in the engraving, must be forced back until it falls completely within the shell, before the instrument can be carried to its place. The patient managed this without any difficulty, by putting the thumb in the roof of the denture, and holding the elevator back out of the way with the forefinger, and, when carried up, the processes E E readily found their places.

The result, after a year's trial, is shown in Fig. 214. There was naturally no immediate change. There was very little irritation from the beginning, and no destructive inflammation. The bearings E E caused a little soreness, and they were wound with lint and covered with simple cerate. The lower process now comes to the very tip of the nose between the nostrils, and can be seen or touched in either nostril, but this part, being made pink in color, is not noticeable to the ordinary observer. It is with no little satisfaction that I have viewed the action of the elastic rubber as the power to elevate the nose—a power so completely under the control of the patient, regulated at will, increased or diminished, involving little care and no expense, that it leaves nothing to be desired.

The steps by which this nasal shell and denture were produced were not remarkable, save in two particulars: First, to obtain an accurate impression in all its details of so large a nasal cavity, and remove it through so contracted an opening, is out of ordinary experience. The method pursued in getting the impression was not unlike the course a mason would follow in plastering a room. The surface of the nasal cavity was covered with a thin film of plaster laid on with a camel's-hair pencil and other delicate instruments,

FIG. 214.

until a sufficient thickness was obtained to give it stability, when it was cracked by a light blow from a mallet and a small chisel, and the pieces were removed separately through the opening in the roof of the mouth. Second, the shell and denture were completed in wax and gutta-percha, as thin and delicate as finally required, before it was placed in the flask, and necessarily a core of plaster filled all the interior, which was readily removed after vulcanization.

FACIAL DEFORMITY AND TREATMENT.—In March, 1867, there came to me a gentleman about thirty years of age, with a deformity of the right side of the face, involving a depression of the right superior maxilla and atrophy of the superincumbent tissues. This deformity did not involve the malar bone nor the inferior maxilla, and was confined to the right side of the face; consequently the want of symmetry between the two sides of the face was quite marked. The depression of the maxilla was not the result of an accident,

FIG. 215.

but was developmental and possibly congenital. That the external deformity was not wholly due to the condition of atrophy was proved on taking a cast of the mouth, when the want of symmetry in the two sides was clearly shown. My attention was more particularly directed to this depression of the bone, because the patient himself claimed that the deformity had been caused by the extraction of the first molar tooth a few years before; but that this was an error was conclusively shown by the remaining teeth being in good condition, with but slight absorption of the alveolar process where the tooth had been extracted, and by the general sinking as above stated. Fig. 215 shows the external appearance, the left side of the face being fair in outline and of moderate plumpness.

The patient's desire was a restoration of contour by prosthetic treatment; and the accomplishment of this involved the conception of an appliance, and a mode of procedure very different from the insertion of an ordinary plumper adjusted to artificial teeth, and made to take the place of wasted

FIG. 216.

alveolar processes. It required the displacement of the muscles nearly up to the orbit of the eye, and the forming of a cavity in the soft tissues into which the appliance could be introduced. This was done by making gradual encroachments upon those tissues during a period of several weeks, until the desired result was obtained. The restoration was due partly to the displacement, as stated, and partly to the forcing upward of the tissue, thus thickening the cheek and adding to its fullness.

The prothesis is shown in Fig. 216. It consisted of a gold plate three eighths of an inch wide, attached to molar teeth on the left side of the mouth, reaching directly across the palatine arch and passing through the space formed by the extraction of the molar; its continuation from this point was formed of vulcanite, the body of which occupied the canine fossa, extended back to the tuberosity of the jaw, and reached upward to the malar bone. At its anterior part a projection ran up to probably within a sixteenth of an inch of the infra-orbital foramen, and from the inferior surface a wing de-

Fig. 217.

scended as low as would be permitted on the closure of the lower jaw.

Fig. 217 shows the external effect after restoration. This result was produced, as stated before, not by a single effort, but by the introduction of the gold plate upon which was built up the plumper of gutta-percha, adding to its fullness from time to time with gutta-percha or wax, as it could be borne. While the gutta-percha was in a semi-plastic state, the jaws were exercised so that the form would be somewhat accommodated to the action of the muscles. In this manner, such shape as was required for restoration of contour, and which could be tolerated, was determined upon, and then the instrument was duplicated in vulcanite.

This was worn with entire ease and comfort for two years and a half, and required only very slight alterations, save in one particular. From the great size of the body of the plumper (its horizontal diameter being three quarters of an inch), it was desirable to save weight as much as possible, and it was made open between the wing and the part lying next the gum. The result was a most disagreeable tone to the voice—a hollow, cavernous sound, as of the voice lost in the space created by holding off the cheek from contact with the gums. The remedy followed immediately on filling up this space.

At the end of two years and a half the instrument was broken by accident; and, on duplicating it, some improvements were attempted, which consisted mainly in using soft rubber for the upper process and for the lower wing. Experience proved that these were valuable improvements; for in the first instrument the rigidity of form, due to the unyielding vulcanite, would sometimes produce a rigidity of the muscles, noticeable particularly when there was much action, as in laughter. By the substitution of elastic rubber for these portions, that disagreeable effect was remedied. The soft rubber was not attached directly to the gold plate, but the body of the plumper was made of hard vulcanite, as in the first instrument, and the elastic compound attached to that.

The noticeable features of this case are:

1. The atrophied condition was confined entirely to one side of the face.

2. That muscular tissue can be displaced to a very considerable extent without impairing its freedom of action.

3. That the cheek can not be lifted out so as to leave a

space between it and the gum without changing the tone of the voice and incidentally articulation.

LIFTING A SUNKEN NOSE.—In 1868 I was applied to by a young woman, a widow in moderate circumstances, whose portrait is here shown, Fig. 218. She stated that her nose, which was originally of fair proportions, had sunk within a recent period, and was naturally a source of much mortifica-

FIG. 218.

tion to her. She had been told by some friends that they knew of like cases, in which the nose had been lifted up and a silver bridge or support inserted. With this idea, she had applied to an eminent professor of surgery for relief, and was by him referred to me. The object of this reference was, that, if I would undertake to make and adapt the artificial bridge, the surgeon would insert it. As the responsibility for the future well-being of the patient would be very limited in the part which I was called upon to perform, I made no objection.

My first step was a cast of the face as shown in Fig. 218. From this plaster cast I cut off the nose, and dissected away at the sides at the base of the nose until I came down to an imaginary bone. The supposed contour of bone I arrived at approximately by a study of the living face—feeling the superincumbent tissues—and also by comparison with a skull. A bridge was then modeled into such form as the case seemed to require, making due allowance for the nasal tissue which it was to cover. This model was made permanent in black vulcanite and highly polished. Vulcanite was chosen because it would permit of softer, smoother edges than metal, and would be much lighter; and black vulcanite because it was believed to be harmless. This bridge is shown in Fig.

FIG. 219.

219. The base, marked A A A, was spread out and flattened like a flange, and adapted to the supposed bone. B represents the support for the middle of the nose. This bridge being in readiness, the surgical operation proceeded as follows:

Two incisions were made from the mouth through the upper lip, one into each nostril. An incision was also made from each nostril, along, beneath, and behind each wing of the nose, and along up the base of the nose, three fourths the distance to the eye. Such incisions are indicated in Fig. 218 by a dotted line. The object of the incision through the upper lip was to lengthen the columna of the nose, and thus give the nose more prominence. When this dissection was completed, the nose was turned up over the forehead, and the vulcanite bridge applied. The adaptation seemed to be approximately accurate; the bone was still covered with considerable soft tissue, and I could not observe that any change in conformation was required. Being left in position, the nose was turned down over it and the sutures inserted. A portion of the extra length of the nasal columna was needed, and the remainder cut off; the upper lip was drawn together, and the operation completed. The nose began immediately to puff up, and before we had retired from the scene it resembled a small-sized potato more than anything else in nature. However, the patient was in good condition, and in a very few weeks the lip was so sound that the scar, which was exactly in the middle, was hardly noticeable. The lip had lost the rigidity resultant upon the narrowing, and seemed as mobile as ever. The scars at the sides of the nose were scarcely observable. Nevertheless, the nose retained its potato-like form.

The retention of the bridge was without discomfort, except as a prolonged soreness was observed at the upper end. This soreness increased until it became evident that the bridge was shifting its position and twisting around; i. e., the apex of the bridge was swinging over to the right side of the nose, and likely to crop out. No external pressure to restore it seemed to have any effect, and another surgical operation was determined upon to anticipate the appearance of the bridge of its own volition. It was then determined that another bridge should be made with legs to steady it—that is, processes which should pass each side the vomer, and enter the nasal canals.

This bridge was also made of vulcanite, and on a supposititious model. It is shown in Fig. 220, and includes the dotted line. The second surgical operation consisted in separating the nose from the upper lip by an horizontal incision, and continuing up the sides on much the former line.

While this was going on, I had some gutta-percha softened in hot water, and immediately on the nose being turned up, and the old bridge taken out, I took an impression of the surface, and of the nasal passages, to the depth of more than half an inch. I made a plaster cast of these parts, with all the rapidity that I could manipulate plaster, accelerated by the aid of salt, and with equal rapidity of movement the new bridge was softened by warming over an alcohol blaze, and adapted to the plaster cast; the processes marked C C, Fig. 220, entered the nasal passages, and were quite accurately adapted. All this did not take five minutes, and probably the surgical operation was not delayed more than two or three minutes. The latter was completed in the usual manner.

The healing of the wounds went on rapidly; but the presence of the bridge was uncomfortable, and within a few

FIG. 220.

weeks it became evident that the new bridge, even with its legs, would not remain stationary. It was getting decidedly crosswise. A third operation was determined upon, and also a third bridge. It was hoped that with an accurate model of the parts, as they revealed themselves at the last exposure, a new bridge could be made so closely fitted that it would be an improvement upon the others; and also, as the nose seemed to need support only in the middle, it was deemed best to reduce it in size. Therefore, the third bridge was made like Fig. 220, exclusive of the dotted line. The nose was again cut off and turned up, and the second bridge removed. Then came a consultation of surgeons, and a decision that, inasmuch as the nose had now been lifted out for a considerable time, and some soft tissue had accumulated underneath, it would be unwise to insert another bridge; and consequently the nose was replaced, minus a bridge.

The rest of the tale is soon told. The external wounds were healed in a short time; the nose began to sink to even less than its former position, the nasal passages contracted, and in a little time were completely closed, and respiration, except through the mouth, was absolutely impossible. And the last state of this patient was worse than the first.

ARTIFICIAL JAW AND OBTURATOR. (*Gunshot Wound.*)—A Scotch gentleman, under thirty years of age, while on a gunning expedition in the Southern States, met with a serious wound of the face from the accidental discharge of his gun. Carrying the gun at his side in the woods, the trigger was undoubtedly caught by a twig, and the explosion which followed carried the contents, which consisted of shot, through the right side of the face. The charge first struck the anterior part of the chin near the symphysis, carrying away a V-shaped section of the lower jaw and alveolar process with several teeth. The further course was to the right of the nose, past the outer corner of the eye, and passing off on the temporal surface of the frontal bone. In its track it tore away entirely the right superior maxilla, all the incisor teeth, the vomer, palatine and malar bones, together with portions of the temporal, ethmoid, lachrymal, and turbinated bones. A reference to Fig. 221 will show the general character of the destruction of the soft tissues, including the right eye.

The patient was of sound constitution and otherwise in good health, and was sufficiently recovered to come North within a few weeks after the accident, when he presented himself to me for treatment. I found the wound healed. Considerable tissue had formed and filled up the vacancy made by the absence of the malar bone. The remaining portions of the inferior maxilla had approximated and united, and in doing so had destroyed the articulation with the upper teeth on the left side, and also with the upper jaw at the joint, thus throwing the chin nearly an inch to the right, and out of line. The hard palate being entirely gone, and no lips to close the oral opening, articulate speech was impossible; communication could only be made by him in writing. The patient was sustained solely with fluid nourishment.

The first step was to restore the normal articulation of the lower jaw. I recommended the patient to place himself under the surgical care of the late Professor Krackowizer,

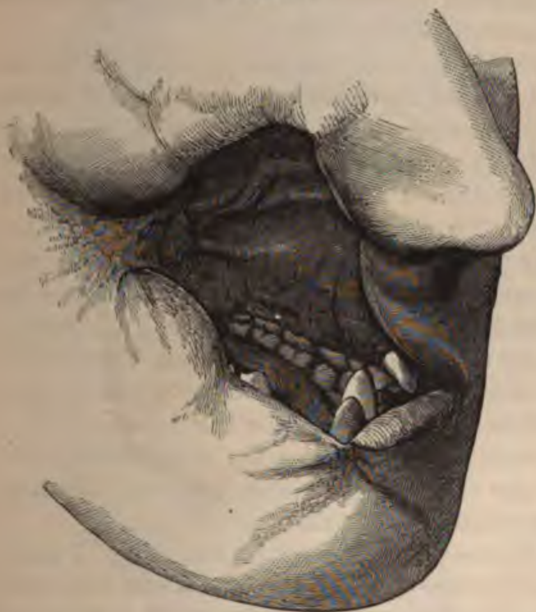
FIG. 221.

whose skill in plastic surgery was unexcelled. I made a splint to keep the lower jaw in its proper position when replaced, and together Professor Krackowizer and myself broke up the false union and carried the fragments into place, where they were retained by the splint without bandaging or other apparatus. This restored also the chin to its proper relation with the other features.

In the mean time Professor Krackowizer determined upon a series of operations for closing the opening in the cheek; the first of which was to attempt to form a lower eyelid.

The details of the surgical steps are not important to our present purpose. The operation for the renewal of an eyelid was a success, the flap being obtained by an incision along the dotted line in Fig. 221, marked A, and bringing the end marked 1 up to the side of the nose at 1, and making the attachment. It healed readily, the union was good, and in a few days a very respectable lower eyelid was the result. It

FIG. 222.



was at this stage that I made the model from which the drawing shown in Fig. 222 was taken. In this plaster cast we have a perfect representation of the buccal and nasal cavities in all their intricacies, including lower jaw, tongue, fauces, soft palate, turbinated bones, and nasal passages to the nostrils. The impression was made entirely of plaster, and taken in sections as follows:

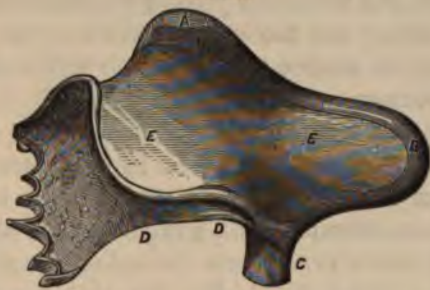
Plaster was first carried into all the intricacies of the nasal passages, thus making a roof to the mouth of plaster, the patient meanwhile breathing below the palate and through the mouth. When this was set it was removed, and the portions which followed the recesses were broken off the impression (to be subsequently restored), and the impression replaced. The removal of these portions permitted the patient to breathe above the palate and through the nose. Plaster was then applied to all the remaining portions of the buccal cavity and the external adjacent parts, and resulted in a model as shown in Fig. 222.

The next operation for the patient's benefit was a mechanical one of no ordinary difficulty. An observation of Fig. 222, together with a little reflection, will show that it was desirable to form a new roof to the mouth, a new jaw on the right side, and a new cheek-bone, if possible, to restore contour to the cheek. Such an apparatus must necessarily be bulky and more or less weighty, and, worse than all, there was no solid tissue for support. I conceived the idea, however, that if I could bridge over the roof of the mouth with something that would abut firmly against and on top of the jaw on the left side, and extend my appliance upward and outward into the locality of the missing cheek-bone, the flap which must ultimately close the cheek would come *outside and under* this artificial cheek-bone, and thus support my whole appliance on that side.

My first experiment was with vulcanite. I made a somewhat artistic model, which included a new floor to the nares, a new roof to the mouth, new jaw, teeth in front and on the right side, and a malar process. This model was then duplicated in vulcanite, and, as the bulk was great, it was made a mere shell in form, many parts being not thicker than a thin cardboard. As it was impossible to make a complete shell of one piece of vulcanite, the upper part was left open, and, after the vulcanite was finished within and without, the top was closed with a piece of aluminum plate struck into shape, accurately fitted, and cemented into its place. This instrument in a modified form is shown in Figs. 223 and 224.

The aluminum plate is represented in Fig. 223, and marked E E. A represents the portion fitting under the

Fig. 223.



inner corner of the eye; B, the malar process; D D, the edge which laps on to the soft palate. The weight of the whole when complete was very trifling. I have said that the engravings represent that instrument in a modified form. The modification consisted in the reduction of the malar

Fig. 224.

process marked B, which in the first instrument was much larger.

In the preparation of this appliance I had cut away in my plaster model of the cavity a portion which represented the soft tissue in the malar locality, a part of my plan being to make an incision in the natural soft tissues within the cavity for the reception of my malar process, and thus lift the tissues out to the desired contour. When my instrument was ready for adjustment, Professor Krackowizer made the proposed incision and the appliance was introduced. The adaptation was excellent, and the malar process was fulfilling our expectations in lifting out the cheek. With a patch over the cheek-opening to confine the sound, the patient immediately articulated distinctly.

In a few days I made a careful examination of the case, and the piece did not seem to be in such accurate contact with the firm and healthy jaw of the left side as it had appeared to be on introduction. Furthermore, I observed that my artificial malar process was immediately under the scar shown by the dotted line in Fig. 221, and also plainly seen in Fig. 222. In another few days the discrepancy of adaptation had increased, and the tissue over the malar process was becoming transparent. Within two weeks from its deep-seated introduction (there being nearly three quarters of an inch in thickness of tissue over it) this malar process was on the outside of the cheek, and everything healed and as solid as before. The explanation is, that there was nothing but cicatricial tissue over it in the start, which gave way as soon as there was any pressure on it, and the appliance traveled through it without hindrance. Nevertheless, it was not without good results. The first effect was to lift out the external contour, and new tissue formed and filled up the cavity behind the appliance as fast as it moved, so that in the end there was much more fullness than there was before the experiment was made. The instrument was then modified in shape to meet the emergency, and worn to develop any further peculiarities.

After a limited trial of wearing it with much satisfaction, I set about duplicating it in another material. As the final surgical operation would close the cavity so that the appliance could not be removed, and therefore it must remain there during life, I was not willing to subject the patient to the uncertainties of vulcanite, besides a little prejudice I had against it on the score of cleanliness and healthfulness. Freedom from weight being a great desideratum, I decided on aluminum. I shall not enter into a description of the annoying experience in my effort to conquer that material, and in the end it conquered me. I spent weeks in experimenting. I sought out everybody I knew who had had any experience with the hateful stuff. There was no difficulty in getting the sections of my shell in exactly the form I desired, and in joining them to each other; but to solder them and make a shell which would be air-tight, even leaving one last hole for vent, I found impossible, and at last I gave up in despair and abandoned the material.

There was but one recourse, and that was gold. I used twenty-carat gold, rolled down just as thin as I could work it, and succeeded in making a beautiful shell of very little weight. To this were attached the few teeth that are represented in Fig. 224. These were sufficient for appearance, and it was not desirable to provide any for masticating purposes on that side of the mouth, as masticating would create a motion which might be prejudicial to the stability of the appliance. The gold was substantially a duplicate of the first apparatus, as shown in Figs. 223 and 224. The projection marked C came down to meet a molar tooth on the lower jaw, and was made tubular and left open while working the gold. In this way there was no difficulty in making the shell otherwise air-tight. Unless there is an opening of this character, it is difficult to make a perfectly air-tight shell by soldering. I tested the shell by putting a piece of rubber tubing on this leg, and immersing the whole in water; blowing in the shell would reveal the slightest leakage by a little air-bubble on the surface. Ultimately this last opening was closed without heat.

My appliance being perfected and introduced, Professor Krackowizer continued his surgical operations. Immediately on the introduction of the instrument, the Professor performed an operation which shut it in completely. An incision was made across the upper lip, parallel with and about half an inch from its border, and the whole length of the mouth. This strip, which was free at the end on the right side, was stretched, and attached to the cheek on the right, thus making a new oral opening. At the same time other incisions were made in the vicinity of the angle of the jaw, and the cheek worked up until it was brought into contact with the opposite side of the cavity at the base of the nose. The cavity was then completely closed. Most of this operation did well. The lip and mouth were a complete success. Some parts above gave way, requiring two or three minor operations, which were much delayed by the unstable character of the tissue, resulting from so many operations. The notched appearance in the lower lip was also subjected to an operation, with much benefit to appearance.

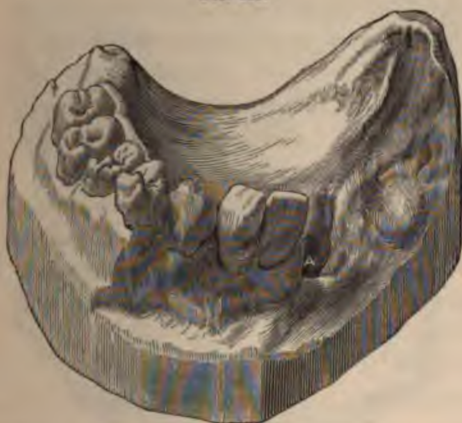
Immediately on his recovery, after the introduction of the gold apparatus, the patient told me that he masticated and enjoyed his food as well as he ever did, and there was certainly not a trace of defect in his articulate speech.

Restoration of Jaw after Gunshot Wound.—Dr. J. A. Woodward, of Philadelphia, described in "The Dental Cosmos" for December, 1865, an ingenious prothesis made for a wounded soldier:

"The following case was constructed for a young gentleman who received a severe gunshot wound during one of the battles in Virginia. Fig. 225 represents the condition of the upper jaw. The alveolar and palatine processes are entirely removed on the right side. The left central, lateral, and cuspidatus, with the process and maxillary bone immediately beneath, being broken away from the main part of the bone, fell inside the lower teeth three eighths of an inch, and were allowed to become fixed in that position.

An opening, A, extends from the mouth to the nose. The molars only retain the original articulation, the bicuspids having been drawn by the contraction of the parts inside the outer cusps of the inferior bicuspids. The right cheek, deprived of its support, falls in considerably, and requires some force to press it to its proper position. An impression-cup was made to suit the case, with which a sufficiently accurate impression in white wax was obtained. The gold plate was continued back to the last molar and over and in front of the remaining three front teeth. On the right side

FIG. 225.



it encroached upon the muscles of the cheek; consequently the cast was built up here, that the edge might be raised and well rounded. As the opening A is still contracting, the plate was run across instead of down into it. Around the second molar was placed a stout clasp. This was slightly soldered to the plate, and the whole then thoroughly fitted to the mouth. The articulation was next taken in the usual manner. The teeth were set as shown in Fig. 226, being attached by vulcanite. To have depended entirely upon clasps to support the case would have brought too great pressure on the teeth clasped, as the cheek is continually pushing the set downward, especially when the mouth is open. A spiral spring was therefore used on the right side. This was fastened below to a small plate, D, fitting between the second molar and second bicuspid. Above, the attachment was not so readily accomplished. The gums of the artificial molars were ground off nearly to the teeth, and the vulcanite over them well cut away to let the spring set in. Over this was stamped a piece of gold plate, the anterior and superior edges of which were nicely adjusted so as to present a smooth

FIG. 226.

surface with the vulcanite and the plate B. This sort of shield was extended back to lift the cheek free of the spring, the posterior margin being smooth and round. Behind it the food would necessarily accumulate and be difficult of removal; therefore it was contrived to be taken off and replaced at the pleasure of the wearer. Fig. 227 shows the shield with spring and plate for lower jaw. H is a heavy wire bent at a right angle to hold the front end securely in its place; G is a small pin to give additional firmness when the plate is in its position; F is a hasp which passes around the posterior part of the vulcanite and over a catch on the lingual surface of the set. This catch was driven in the vulcanite well up to the plate, out of the way of the tongue.

FIG. 227.

The set has been in use for nearly five months, and seems to fully meet all requirements."

ARTIFICIAL NOSE.—In July, 1869, a gentleman from a distant city, a lawyer by profession, applied to me for advice. His face presented the appearance indicated in Fig. 228. An examination showed the loss by disease of the soft palate, a portion of the hard palate, the vomer and turbinated bones, the nasal walls of the antra, portions of the nasal and maxillary bones, and the cartilage of the nose.

A rhinoplastic operation would not be submitted to, for various reasons—among which were, the suffering and inconvenience attending it, the disfigurement caused by it, the uncertainty of the result, and the doubt of making by such process a nose which should resemble to any extent the original appendage. An artificial nose being the only alternative, a cast of the face and nasal cavity was taken in the following manner: The nasal cavity was filled to the orifice with plaster—not in one mass, but in sections, to facilitate its removal. Before removal, however, the cast of the face was taken, the plaster coming in contact with that already in the nasal cavity at the orifice, the precaution having been taken to soap the surface to prevent the two masses from adhering. After the removal of the external mask, the sections in the nasal cavity were pushed backward, and brought out through the opening caused by the loss of the soft palate.

The sections being all brought together, a cast was made which showed the surface of all the parts adjacent to the

FIG. 228.

nasal orifice, both internal and external. Upon this plaster cast there was modeled a form of the new nose in wax, made to resemble the color of the flesh, this wax model being tried on the living face from time to time for criticism. The object of using flesh-colored wax for this model is, that the operator is enabled to judge better of the effect of his art than he could were the material in contrast with the surrounding parts. It is herein that art and mechanism triumph over surgery—it being within the power of the artist by such means to restore this feature so that, in its individual character, it shall be in perfect harmony with the surrounding features, which it is not possible to accomplish by surgery. The extra large mass which must be cut from the forehead in a rhinoplastic operation, to provide for shrinkage, renders it difficult to preserve the physiognomical relations of the nose with the face.

The model in wax having been determined upon as described, a duplicate must be made of such material as shall closely resemble the flesh and prove durable. Of all substances heretofore employed for this purpose, I know of none

Fig. 229.

which are durable that are not decidedly objectionable in appearance. All opaque substances, no matter how beautifully they may be painted in imitation, do not look like flesh. Porcelain or enamel has an advantage in its transparency, but it reflects the light, and looks like a piece of crockery. For these reasons collodion was used in this case with remarkable success—the preparation being that known to dentists under the name of "rose pearl," with some modifications in color to suit the case. With this substance a nose was made, which had the color, tone, and translucency of flesh, giving also the delicate little tracery of veins which are so often observable in the nose toward the tip. This substance possesses also the qualities of elasticity, strength, and durability; it is not easily broken, nor affected by exposure to the elements or thermal changes. The wax model, after being completed externally, was scooped out inside, so as to leave a mere shell of not more than a line in thickness. The collodion duplicate was produced by making a die of fusible metal, pressing the mass into shape, and curing it in substantially the same manner in which "rose pearl" base is worked.

Fig. 229 gives a view of the nose complete, with the at-

FIG. 230.

tachments for securing it in place. A A are pads made of vulcanite, adapted to depressions in the nasal cavity and connected with the nose by flat gold springs. The gentle pressure of these springs is sufficient to keep the nose firm in its place; at the same time their elasticity will permit its removal at pleasure. The border of the nose is brought to a thin, beveled edge, wherever it comes in contact with the cheek, and the adaptation is so accurate that at a short distance no mark of separation is visible. In many cases of the application of an artificial nose, the attachment has been so insecure as to require the patient to wear a pair of spectacles to keep it from moving. Some artificial teeth and a palate, which were also required in this case, were made independent of the nose, and it is always desirable that they be disconnected. The movement of the muscles of the face is such that the nose should be permitted to yield with them. Besides, a nose secured by an unyielding connection to a plate of teeth through an opening in the roof of the mouth must necessarily show all the movements of mastication.

Fig. 230 represents the patient with the nose attached.

The success in this case may be inferred from the following extract from a letter received from the patient soon after his return home:

"Every one here is delighted with my improvement; it gives me, I am glad to say, no discomfort, and I feel no weight. Many of my most intimate friends, after being in company with me several hours, both indoors and in full light of the sun, believed it genuine flesh, so deceptive is it. Several medical gentlemen who have seen me have said that, in all similar cases to mine, they should never again advise an operation when so neat a thing can be made."

Artificial Nose, Lip, and Obturator.—The following is from a report in "The Dental Times" of a meeting of the Pennsylvania Association of Dental Surgeons in 1864:

"The case referred to by Dr. Hoopes was one treated by him in the 1860, and published at that time in the 'American Journal of Dental Science,' an abstract of which is here appended. H. R., aged forty years, had enjoyed good health until about fifteen years ago, when he contracted primary syphilis. Four years subsequently the disease, in a tertiary form, attacked the internal surface of the nasal bone, and continued to spread for some five years, when fortunately its progress was arrested, though not until it had committed the most terrible destruction of the bones and soft parts of the face. Fig. 231 inadequately presents the appearance of the face. It may be better understood by a description.

"The lower margins of the nasal bones are destroyed, with the entire vomer, the nasal cartilage, and a portion of the septum. The left inferior turbinated bone is gone, and a portion of that of the right side. The anterior portion of

Fig. 231.

the malar bone is destroyed on the left side, nearly reaching the antrum; also the superior alveolar process, leaving a mere rim, with three molar teeth on one side and two on the other. The central portion of the palatine bones is also gone, leaving an open space about the size of a half-dollar piece. Of the soft parts the destruction has not been less extensive. The upper lip is destroyed, except at the angles of the mouth; and ulceration had taken away much of the soft tissues of the posterior nares. The muscles of the upper lip and face that are partially destroyed are the *orbicularis oris levator, labii superioris alæque nasi*, and on the left side a part of the *zygomatic and levator anguli oris*. It should be remembered that the sketch given reverses the side of the face.

"On looking inward and downward, the parts presented

FIG. 232.

a deep, large cavity; the motions of the uvula could be seen by looking into the nose, and the tongue closed the opening through the palatine bones. Of course, speech and deglutition would have been impossible, had not the patient continually kept a large piece of raw cotton in this opening. The lower lip had also begun to suffer the ravages of the fearful disease, but it was arrested at this period, and this lip presented an enlarged appearance, from the healing of a large granulated surface.

"The first step in the process of making a mechanical contrivance to hide this hideous deformity was, to make a cast in plaster of the anterior portion of the face, and another of the mouth. A gold plate was then made, fitting the roof of the mouth; and upon this were inserted all the teeth that were deficient, and this plate was clasped to the remaining molar teeth. A model of an artificial nose and upper lip was then made, as near the natural form as possible. A cast of this model was filled with hard rubber, which was then vulcanized. A gold bar was attached to the inside of the artificial nose, which was made more firm by a cross-bar. The opening through the palatine bones gave an opportunity to secure the nose to the plate; this was done by attaching a short tube to the plate and passing the bar through it. The plate was then placed in the mouth, the nose was attached to the face, and the bar was passed through the tube, which held it firmly in position. The stiff, unnatural appearance of the upper lip was hidden by a heavy artificial mustache. The connection between the artificial and natural nose was concealed by the bow of a pair of spectacles. The artificial nose was then given a lifelike color, and the illusion was complete.

"This appliance so fully answered the purpose that the wearer had, at subsequent times since its introduction, assured him that it was perfectly priceless, and that he felt, if possible, like a new man."

Artificial Nose, Lip, and Denture.—Dr. William M. Herriott made an appliance for a wounded soldier, which he describes in "The Dental Cosmos" as follows:

"Corporal Andros Guille, Company K, 97th Regiment Ohio Volunteer Infantry, aged thirty-two years, was wounded November 25, 1863, at the battle of Mission Ridge, by a fragment of shell, which carried away the entire nose to the turbinated bones, and the upper lip, with anterior portion of the alveolar process of the superior maxilla, from the right to the last two molar teeth on left. He received also other injury at the same time.

"On or about the following dates, February 11th, February 27th, and April 1st, all in 1864, three surgical operations were performed by or under the direction of William Otterson, M. D., then a brigade surgeon having in charge the hospitals at Nashville, the object being to restore the parts lost;

FIG. 233.

but the first was a failure because erysipelas set in, the others on account of sloughing and muscular tension. It was then acknowledged that surgery could not be used to better the condition of the patient, and he was left as seen in Fig. 233.

"In September, 1864, I constructed the artificial appliance which is shown in Fig. 234, in the following manner: I first took an impression of the upper part of the mouth, extending it up as far as possible in front, and from this I secured a model upon which I formed a structure to take the place of the destroyed hard parts and to act as a base for the teeth. This accomplished, I laid the patient on his back, and, having closed the nasal orifices with cotton, I took—using very soft plaster—an accurate impression of all the parts which the nose and lip were to rest upon; and, procuring a model from this, I built upon it plaster, from which I

Fig. 234.

carved the form of a nose and lip. This I used to vulcanize a nose and lip upon, which are in one piece, covering the lip with an artificial mustache, which extends so as to hide the joint of the artificial lip with the adjacent parts, and securing the piece up and back at the top with a pair of spectacles, and back at the lower part of the nose to the artificial denture, with a gum ligature. The appliance was complete, and has been worn continually since."

Artificial Nose and Obturator.—The following description of an appliance made by Professor Wildman is taken from Garretson's "Treatise on Oral Surgery":

Fig. 235 will convey an idea of the external appearance of the patient, but not fully, as the whole upper lip was cicatrized, and the left cheek depressed near the border of the cavity.

Fig. 235.

"In May, 1863, a young man," says Dr. Wildman, "aged twenty-six years, presented himself for the purpose of having an appliance made to repair a loss sustained by disease. Upon removing the black patch which he wore upon his face, and the cotton with which the cavity was filled (without the latter he could not articulate a word), I found that the entire external nose was gone; that the nasal bones, the nasal processes of the superior maxillary, also a large portion of their palatine processes, the approximal parts of the palatine processes of the palatine, and the turbinated bones had been destroyed. The soft palate, the uvula, and the tonsils were uninjured. In looking into the nasal cavity, the walls of the antrum on the left side were found deficient, and ends of the roots of the incisors exposed and decayed. The tongue was visible through the opening in the palatine arch.

"Although desirable, it was deemed unsafe to remove the diseased roots, owing to the yielding nature of the superior maxillary bones. The disease appeared to be arrested, and the parts in a sufficiently healthy condition to warrant the application of the substitute; and time has verified this, as, with the exception of the exfoliation of a small scale from one of the superior maxillary bones, about nine months since, no change has taken place up to this date.

"The first step in the operation was to procure an impression that would enable me to make a perfect model of all the parts involved, and their surroundings, in their relative positions. For this purpose plaster was best adapted, but its use was precluded by the acrid secretions in the nasal cavity; wax and paraffine was considered the best substitute, and used. Owing to the rigidity of the upper lip, I was unable to use the ordinary impression-cup with success, and was obliged to take a rough impression of the palatine arch, from which a model was made, and a metallic impression-cup swaged.

"A sufficient quantity of paraffine and wax was placed in warm water, and, with an assistant to keep it at the proper temperature, the mode of procedure was as follows: a proper quantity of the compound was placed in the cup, introduced into the mouth, and pressed up firmly against the arch; the part forced into the palatine fissure was at the same time pressed with the finger, introduced through the nasal cavity, so that it should give an accurate impression of its lateral borders. A groove was then cut in this to serve as a key, and, after oiling it, a piece of the compound was introduced through the orifice of the nasal cavity, and passed down to make the impression of the floor of the nasal cavity. When sufficiently hard it was carefully removed, the upper surface trimmed, placed in cold water to give it its greatest firmness, then introduced into the cavity, and pressed into its proper position. The metallic cup containing the impression of the palatine arch was then removed. The next step was to take an impression of the sides of the cavity, then the top, using a curved wooden spatula to press the compound in proper position, being careful to mark or key the parts that came in contact, and have their surfaces oiled, to prevent adhesion; and also that the pieces should be thinner in front than in their posterior parts, so that, when the four pieces forming the impression of the base, sides, and top were in their proper position, they would leave a tapering cavity, with its largest diameter at the front orifice. Into this orifice was forced a plug or cone of the compound, filling it completely; in the front of this piece were inserted pieces of match-sticks, to cause it to adhere to the next piece or mask. The head was now thrown back to nearly an horizontal position, wet tissue-paper was placed over the eyebrows and lashes, the face oiled, and plaster mixed thick was batted on with a brush. When set, this was removed, drawing with it the central plug or cone; the different parts were then carefully removed, and thrown into cold water to give them a consistency to bear handling without danger of injury. On this central cone all the parts were placed in their proper position, and the impression of the palatine arch was adjusted in its proper place. From this a plaster model was made, giving the upper part of the face, cavities, palatine arch, all correctly in their relative positions.

"Of the different substances—leather, wood, wax, metal enameled, and porcelain—used for making artificial noses, I gave the preference to hard rubber in this case, on account of its rigidity, strength, lightness, and less liability to injury by accident.

"To prevent derangement, it was necessary to make the appliance as simple as possible; it consisted of two pieces: the external nose, septum, and floor of the nasal cavity constituted one, having a projection passing downward into the palatine fissure, as represented in Fig. 236, A; and the obturator B, with a projection rising upward into the palatine fissure. These projections were made hollow, so that when the two parts were placed together, as in Fig. 236, there would be a cavity or box wherein the attachments could be placed.

"Models were made of the compound of paraffine and wax, which were strengthened in the weaker parts by im-

Fig. 236.

bedding small strips of metal in their substance to give sufficient firmness to admit of the necessary handling without injury. The model was applied to the patient, and the nose trimmed so as to harmonize with his features. They were then imbedded in plaster in the usual manner for vulcanite work, with the exception that a stout curved wire passed through the artificial nasal cavities, extending beyond their borders, to give strength to the rods of plaster forming these cavities in the matrix, and thus to prevent their fracture in packing.

"The two pieces were retained in position by a staple and slide-bolt. In the recess of the part of the floor of the nasal cavity projecting into the palatine fissure (A, Fig. 236) was inserted a gold staple. In the recess of the projection of the obturator passing into the palatine fissure B were the gold catch and shield of the slide-bolt. The object of this shield was to prevent any foreign substance entering the slot and obstructing the movements of the bolt, also to give a base of support to the catch. The rectangular upright of the catch was soldered to the shield, passed through it and a longitudinal slot in B, and securely fastened to a rubber slide inlaid longitudinally, and moving freely in the lingual surface of the obturator. On the anterior end of this slide was a small rounded projection, which enabled the patient, when the two parts of the appliance were placed in their proper position, with the point of a finger introduced into the mouth, to force the slide backward, thereby to pass the catch into the staple and firmly secure the apparatus, or, by drawing the slide forward, detach the parts when desirable to remove them.

"The external nose was painted with oil-color, to give it as nearly a flesh-tint as possible, although this is not attainable upon an opaque ground. Flesh being translucent, a true imitation can only be made upon a translucent ground.

"The apparatus was introduced on June 30, 1863, giving to the patient great satisfaction and comfort. His appearance was much improved, as may be judged by comparing Figs. 235 and 237, which were engraved from photographs. He breathes freely through the nose, and speaks with ease; the only imperfection in his speech is a nasal twang, and this is less now than when the instrument was first applied. The obturator at first extended too far back, and caused some irritation of the velum; this defect was readily remedied.

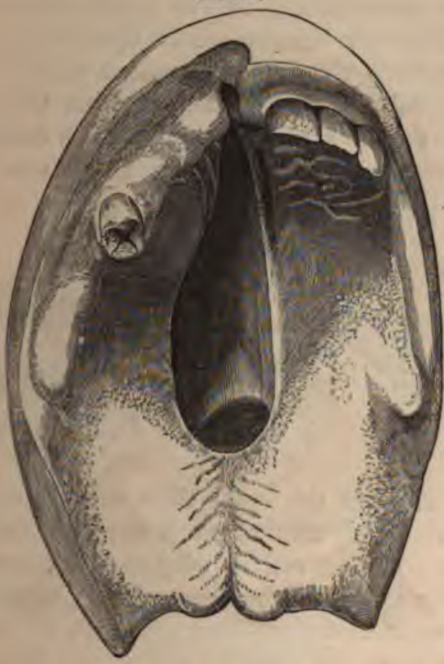
"The operation proved entirely satisfactory, with two exceptions: first, the color of the nose was not as natural as desirable, for the reason already stated; second, in deglutition and speech, when the tongue pressed forcibly against the posterior part of the obturator, an unpleasant vibratory movement of the apex of the nose was noticeable. This could have been remedied by an elastic attachment coupling the two parts of the apparatus, but this mode was objectionable by reason of its producing constant pressure upon the delicate parts, and thereby endangering absorption. A safer plan was adopted by inserting a small steel pin in the nose as near as possible to its apex, to which was attached

FIG. 237.

the bridge of a pair of spectacle-frames, these being retained in position by an elastic cord attached to the bows and passing around the head. This arrangement answered the double purpose of counteracting the vibratory movement, and the bridge of the frames concealing the upper part of the joint where the nose came in contact with the face, which was most conspicuous. This apparatus is worn with ease and comfort by the patient."

Artificial Palate and Obturator.—In 1866 there came to me a lady about twenty-five years of age, with congenital fissure of the palate, which had been operated upon about ten years before by Dr. Hulihen, of Wheeling, Virginia. The fissure of the velum was complicated with an extensive separation of the maxillæ, following the line of

Fig. 238.

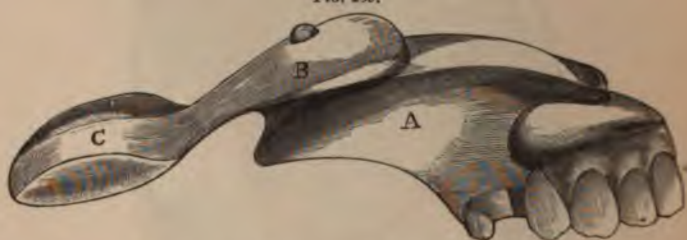


the intermaxillary suture on the right side, dividing the alveolar arch and also the lip. The lip had been operated on in early life. At sixteen years of age staphyloraphy was performed most successfully. The soft palate was united its entire length, including the uvula.

Fig. 238 is copied from a plaster cast taken at the time she came into my hands. In it are shown the fissure of the hard palate and division of the alveolar border, together with the united velum; even the marks of the sutures are distinctly visible in the cast.

For the ten years succeeding the surgical operation the patient had worn an obturator which closed the remaining opening. It was skillfully adjusted, and gave her all the benefit that it was possible to obtain from an obturator alone. But with ten years of application and an intelligence equal to the undertaking, she was unable to articulate with any more distinctness than before the operation. The father said, "If anything, she does not speak as well." There was very little mobility to the palate, and, from the closest calculation, there was a space of half an inch in breadth behind the velum, even when the pharyngeal wall was contracted

FIG. 239.



toward it. Through this space there was a constant escape of the voice. Nearly all the vowels were nasalized; *g*, *k*, *d*, *s*, and *ch* she could not make, owing to such escape.

There was apparently but one solution to the problem, which was to make an artificial extension of the palate to enable it to meet the pharyngeal wall, and thus cut off at times the communication with the nasal cavity. The appliance consisted of an obturator not very unlike the former one, filling the anterior gap, and carrying with it some artificial teeth to supply the loss of some natural ones; and attached to its posterior extremity an extension of *elastic* rubber, following down the superior surface of the palate to its posterior border and beyond to meet the pharyngeal wall.

This apparatus is shown in Fig. 239, and in Fig. 240 it is also seen *in situ*. A shows the obturator, B the elastic extension, and C the apron or palate, occupying the space in the pharynx. The same letters apply to both illustrations.

This instrument was introduced by folding the elastic

FIG. 240.

extremity together, grasping it with a pair of tweezers, and passing it through the opening in the hard palate, when it would find its natural position on the introduction of the obturator. Subsequently the patient would carry the palate through the opening with the tip of the tongue alone. It created no irritation in the pharynx, and was worn with entire comfort. The only immediate change was in the tone of voice. The vowels and some other sounds were less nasalized.

By my advice she went under the training of Professor Peabody, an elocutionist, and in a few weeks showed very marked change. She acquired the ability to articulate with perfect distinctness every sound of the English language, and in reading, with care on her part, would enunciate every word and syllable without fault.

Thirteen years have now passed, and the few teeth then remaining have succumbed to the influences which destroyed their fellows, and not a natural tooth remains in the mouth. Within the past year the obturator here described has been substituted by another bearing an entire upper set of artificial teeth, and the whole apparatus is worn with as much freedom as its predecessor, which was attached to the natural teeth. The speech has not degenerated, but rather improved in ease.

The interest in this case lies—

1. In the remarkable success attending the surgical operation where the fissure was of such extreme width.

2. In its complete failure to improve the speech or produce any other beneficent result.

3. That a piece of mechanism can be worn in the upper pharynx, and with it a person may acquire distinct articulation.

4. The pharyngeal portion of such an apparatus must be flexible, elastic, and movable.

PART III.

MAXILLARY FRACTURES.

CHAPTER XVI.

LOCATION, DIAGNOSIS, ETC.

FRACTURES of the superior maxilla are not of common occurrence, nor are they so difficult to treat as to involve complicated apparatus, or indeed in many cases any apparatus whatever. The causes, when the bone is in a healthy condition, must always be from some form of violence; while, in an unhealthy condition, so simple a matter as the extraction of a tooth may cause a fracture. Fractures of the superior maxilla rarely occur from violence where the inferior maxilla is not involved. An explosion or blow of such force as to break the upper jaw is likely to break also the lower jaw, which is still more exposed.

An exceptional case is reported by Mr. Charles Tomes, where the ascending loop of a bell-rope caught a man by the upper teeth, and both bones of the upper jaw were torn from their places downward and outward, so that they protruded from the mouth.

These fractures seldom require special treatment. When the displaced portions are replaced, they are not liable to get out of position. There being no motion to the jaw, nor any muscular attachment likely to disturb the fragments, and the bone being quite vascular, union takes place readily. The treatment therefore requires the readjustment of the fragments, the removal of any detached spiculæ that might cause irritation, and the care which would be given to a contusion.

Mr. James Salter mentions a case where, in attempting to extract an upper incisor, the whole mass corresponding to the intermaxillary bone came down, held merely by soft tissue. Upon replacing the fragment it readily united.

When for any reason apparatus seems desirable, such a splint as shown in Fig. 241, tightening the hooks with ligatures of silk or wire, or another with projecting arms and connected with a skull-cap, upon the principle shown in Fig. 66, page 134, will be all that may be required.

FIG. 241.

FRACTURES OF THE INFERIOR MAXILLA are of quite frequent occurrence, and are generally the result of direct violence. It is not surprising that the aggregate number of cases requiring treatment is large, considering the exposure of the bone, and that it is without support to sustain a severe shock. Of all the fractures the surgeon is called upon to treat, there is more difficulty in the management of those of the inferior maxilla than those of any other bone. The most prolific sources of these wounds are kicks of horses and falls from heights upon the chin. A number of cases are reported where fracture has resulted from the extraction of teeth, but such fracture has generally been confined to the alveolar process, and very rarely has there been a complete division of continuity from such cause.

There is considerable disagreement among surgeons as to the part of the bone most frequently broken. Ehrichsen thinks it occurs more commonly near the symphysis than at any other point, while Boyer makes the statement that it never occurs there, but at the weakest part of the bone, i. e., on either side of the symphysis; but as long ago as Hippocrates fracture at the symphysis was known and recognized. Garretson regards the weakest part of most inferior maxillæ, with an unbroken dental arch, as on the line of the roots of the canine teeth; but, when teeth have been extracted, the weakest part may be at the point of their removal. Gibson, of Philadelphia, was strongly inclined to the opinion that age had much to do with the location of the fracture, and that with young people it commonly occurred at the symphysis.

In a case which came under the author's treatment in 1866, of a boy about seven years of age, the fracture was at the symphysis; but, in another case of a boy eight years of age, which was treated in 1877, the fracture was near the mental foramen. Both these cases were the result of the kick of a horse. Houzelot mentions a case where there was fracture of both condyles, both coronoid processes, and also at the symphysis; and similar cases are also reported by others. Hamilton's experience would show a very large proportion as occurring in the body of the bone, forty-two out of forty-five, of which fifteen were at or near the mental foramen, and four were vertical at or near the symphysis.

Fracture of the ramus seems from the few cases reported to be quite rare. This exemption may be accounted for by the protection given by the muscles and integument, by the natural strength of the part, and by the ease with which the articulation might slip and thus break the force of the blow.

Many cases are recorded of fractures through the neck of the condyle. In one case reported by Holmes, the neck of the condyle was fractured, with displacement of the lower fragment into the meatus auditorius externus. Fractures at this point are, as a rule, most serious, leading frequently to fatal results through brain complications. There are, however, marked exceptions. Watson reports the case of a man who fell from the yard-arm of a vessel, receiving in addition to other injuries fractures of both condyles. The case recovered, but with deformity of the jaw and but limited movement. No attempt apparently had been made to prevent such a result.

Fractures of the alveoli are exceedingly common, and occur in the practice of every dentist, but are not considered a matter of much moment unless unusually extensive. Jourdain, in his primitive treatise on dentistry, makes a good deal of them, but brings nothing forward to sustain his views. The alveolus is frequently involved in fracture along through the margin. Occasionally pieces of greater or less extent are detached, containing one or more teeth; and cases have been noted where the only fracture detected was confined to this part of the jaw.

It might be supposed, from the anatomical relationship of the parts, that, when the inferior maxilla is broken anterior to the ramus, more or less serious injury might be inflicted on the inferior dental nerve and vessels; but this does not appear to be the case. Possibly, as suggested by Hamilton, the symptoms of this lesion may be hidden by the bandages or apparatus employed to retain the parts in apposition. Dr. St. George Elliott says, "I have never seen a case where there was any indication of injury to this nerve, although in treating many cases, particularly of gunshot wounds, the laceration was at times most extensive." Ehrichsen never knew a case where permanent trouble resulted from such injury. Holmes held the same views, and Middeldorpf makes the statement that it never occurs.

Nevertheless, cases of temporary or permanent paralysis, complete anesthæsia of the parts supplied, convulsive muscular movements, facial spasms, neuralgia, etc., are reported by such authors as Desirabode, Flajani, Boyer, Bérard, Heath, and others, as the result of fractures of the jaw and laceration of the nerve. Chelius, in his work (1845), states that commonly there is much bruising and injury of the soft parts, tearing of the nerves and accompanying vessels in the canal, with severe nervous symptoms, convulsive movements of the facial muscles, severe pain, deafness, or violent bleeding. We are led to believe that either his experience in the matter was very limited, or the cases that came under his obser-

FIG. 242.

vation were remarkably severe. One strongly suspects that he has drawn largely upon his imagination for his description.

Surgically, nearly all fractures of this bone are compound —that is, they communicate with the surface of the soft parts; but, with the exception of gunshot wounds, they are only compound as regards the interior of the mouth, the skin generally escaping much severe laceration. Malgaigne considers comminution in ordinary cases as rare, but Hamilton reports that nearly fifty per cent. of his cases were comminuted, and Elliott confirms this view by his own experience.

As this injury to the bone is rarely fatal *per se*, there are comparatively few specimens to be found in the medical museums. Heath was able to find but fourteen in all the

London hospitals. Fig. 242* represents a specimen which was taken from a patient who, falling from a great height, received fatal injuries. The illustration clearly indicates the location and direction these fractures often take. There is in this case, added to a double fracture of the condyle processes, an oblique fracture of the right coronoid, and also one to the left of the symphysis.

DISPLACEMENT.—As might be supposed, there is generally more or less displacement, depending somewhat upon the blow received, and somewhat upon the action of the muscles attached. How much of such displacement is dependent upon the first or the second of these causes is a disputed point among surgeons. Garretson says: "If the freed portion be the anterior or chin part, it will be dragged downward and backward by the action of the genio-hyoid, hyo-glossus, and digastric muscles. If it be at the line of the cuspid tooth and at the upper portion of the ramus, the fragment will be displaced inward by the action of the mylo-hyoideus, upward by the action of the masseteric, and forward by the action of the pterygoidei. If the fracture be single, and beneath the attachment of the masseter, crepitation will be present, but little displacement. If the neck of the bone is broken, the body is dragged forward by the action of the pterygoid, crepitation and mobility will be very apparent, and much pain will attend the movements of the jaw, produced by the displacing action of the temporalis." Bertrandi states that, when the fracture is near the angle, the smaller fragment is drawn backward by the pterygoid and masseter, the sterno-hyoid and digastric not having power enough over the lower fragment. Ehrichsen states that the displacement is greater in double fracture the nearer that fracture is to the symphysis. Very elaborate arguments have been made, based upon the functions of these muscles rather than upon actual and critical examination of the results of fractures.

* From Sir William Fergusson's "Practical Surgery."

In the author's experience the actual displacement has not always agreed with the theoretical.

Dr. Elliott says: "I believe with Malgaigne that undue weight has been given to the action of the muscles in producing displacement. It is admitted that in some cases muscular action no doubt plays an important part, but in the main I think it will be found that the force and direction of the blow have had the principal share in the production of this trouble. It must be remembered that the muscles below the jaw, antagonized as they are by the masseter and temporal, are, in common with those of other parts, in a passive

FIG. 243.

state until contracted through voluntary effort, and are not likely to oppose with any force efforts made to reduce them. Although theoretically the anterior fragment should be drawn downward by the hyoid and digastric muscles, yet cases have been reported where this fragment was several lines above the posterior."

I have noticed that where the fracture is oblique, or there exists any comminution, there will generally be found more or less disarrangement of the fragments. But the contrary may not hold good, for there may be considerable displacement even in vertical fractures through muscular action; and, where that action is in the same direction as the fracture, it will doubtless occur.

Heath is no doubt correct in his supposition that in double fracture, one on each side, the obliquity is generally at the expense of the outer tablet of the anterior fragment; or, in other words, the line of fracture would follow the general direction on either side of a line drawn from the center of the base of the tongue outward and forward, the lines thus forming a $\wedge$ with the base outward. Now, where fractures follow this law, their reduction, retention, and subsequent union without deformity are not matters of much difficulty. But, where the obliquity is not the same on either side, the difficulties are vastly increased. This is well shown by Fig. 243, from Heath, representing a specimen in King's College, London. Here, the obliquity not being the same on either side, great difficulty was experienced in reducing the displacement and holding the fragments in their proper relationship. In a similar case reported by Malgaigne it was found quite impossible to reduce the displacement, the case ending fatally.

Diagnoses.—The symptoms attending a fracture are rarely obscure. There is always unnatural mobility, generally crepitation, more or less pain, particularly at the seat of the fracture, a good deal of salivation, with but little hæmorrhage. There is also displacement of fragments, which the irregularity in the line of the teeth shows readily, together with contusion and laceration of integuments.

Where the diagnosis is difficult, particularly if fracture of the coronoid or condyloid process be suspected, the surgeon by passing the index-finger into the mouth well back can, in conjunction with the other hand, so manipulate the parts as to detect the fracture should any exist. This examination should be further extended to determine if there be any dislocation, particularly if from the nature of the blow such a result would be likely to occur.

In such cases there is almost always dislocation, or at least displacement. Should this occur, Ribes has described an excellent mode of reduction; in fact, it is the only way it can be successfully accomplished. The index-finger of the right hand is carried into the mouth, and the displaced fragment searched for. With the aid of the left hand, applied externally, the piece is to be replaced and held in its normal position by forcing the jaw upward against the superior maxilla.

Prognosis is generally favorable, there being but little danger to life save in those exceptional cases where the force of the blow has been sufficiently great to produce compres-

FIG. 244.

sion or concussion of the brain, and in those cases of gunshot wounds where great comminution and subsequent necrosis have exhausted the economy. Nor is there usually much deformity following this fracture, unless through the carelessness of the surgeon in charge. The simplest cases do not require special care, and do well with little treatment; indeed, there are many eminent medical men who place all their reliance upon a bandage alone.

Necrosis is not a very uncommon sequence, and most unfortunate is it for the patient when it occurs. Probably in the majority of cases of non-union and false joint, it could be traced to necrosis. Hamilton states that all his cases of non-union were the result of this disease. Heath also considers it the cause of much disfigurement.

FIG. 245.

Fig. 244 * is an illustration of the effects of necrosis in producing permanent deformity. It is that of a specimen in St. George's Hospital Museum, where union had occurred after the loss of much substance.

Figs. 245 and 246 * are taken from a model of a patient who received a kick from a horse, causing a compound com-

FIG. 246.

minuted fracture of the lower jaw. On account of necrosis the central portion was removed, producing the deformity shown in the illustrations.

Irregular union, or non-union and false joint, may also

* Heath.

occur, either from unusual difficulties in the treatment of the case, or from neglect, or from the unwillingness of the patient to submit to the necessary restraint.

Ordinarily, fractures of the lower jaw readily unite, sometimes without the aid of art. The time necessary to reëstablish bony union varies with the circumstances of the case. Boyer considers forty days sufficient, Malgaigne thirty, while Hamilton had one case where seventeen days were sufficient. In my own practice I have never seen a case where there was

FIG. 247.

positive union earlier than on the twenty-first day. Smith had a case where this reparation was delayed one hundred and thirty-seven days; Physick another where nine months were necessary; while Dupuytren met with one of three years' standing before union took place. Sometimes, however, notwithstanding all that art can do, no union will occur, and a false joint exists at the seat of fracture. This seems to have been the result upon one side of the jaw in the celebrated case of Secretary Seward.*

Fig. 247, also from Heath, represents a specimen from

* See "American Journal of Dental Science," 1868, p. 218.

University College, and is an example of fibrous union. In this case it will be seen that from the ramus on the right side to the canine on the same side the bone was replaced entirely in this way.

Figs. 248 and 249 are illustrations of a case of ununited fracture in the mental region, the result of gunshot injury received in the Crimea, and reported in the "Dental Review," 1858–'59. The symphysis, with the incisors, right canine, and one bicuspid tooth, having been carried away, the jaw was divided into two unequal portions, which when at rest remained in apposition, but when the mouth was opened

FIG. 248.

FIG. 249.

there was unequal muscular action, one piece overriding the other.

TREATMENT.—The earliest form of treatment was probably by the ligature, mentioned by Hippocrates in the fifth century B.C. It met with much favor in the early days of surgery, and has been practiced to some extent even down to our own time. No doubt there are cases where it might prove the best and simplest form of treatment; it is, however, only admissible where the neighboring teeth are firmly fixed in the jaw. The ligature, whether of metal or silk, should always be applied to at least three teeth on each side of the fracture, and will be found more useful on patients in middle life, for at that period the teeth are held most firmly. With the young they are more easily moved, and periosteal trouble is more prone to follow; while in those advanced in life they are often not sufficiently sustained by the alveoli to withstand the necessary tension.

The objections to this method of securing the fragments are, that the adjoining teeth are frequently loosened by the blow, and would be still further injured by the strain of a ligature. Even if not affected by the accident, the tendency of the ligature is to slip down about the necks of the teeth, irritate the gums, and produce loosening. Besides, in all

FIG. 250.

cases where there is strong tendency to displacement, it will be found impossible to reduce the fracture and retain it accurately in juxtaposition by ligating the teeth.

Another and better method of using a ligature is to pass it through holes drilled in the ends of the fragments. Dr. Buck, of New York, seems to have been one of the first (1847) to use this method, which was afterward adopted by Hamilton and others. Dr. Kinloch, of Charleston, S. C., treated a case successfully in this manner in 1858, using silver wire for the ligature. In 1863, Mr. Thomas, of Liverpool, adopted a new and peculiar method of securing and tightening the wires, which is illustrated in the following figures.

Fig. 250 shows a case of fracture at the symphysis.

After the holes had been drilled through the bone at A and B, "the silver wire was passed through the opening at A. Next the tubular needle was passed through B, into the open end of which the return end of the wire was introduced. Then the tubular needle was withdrawn, and with it the wire. The use of this needle is to act as a director to the internal opening of the aperture at B, and to obviate a second of delay in searching for the entrance from behind forward of either openings A and B. Afterward the end of the wire at A was inserted into the slit of the key, and twisted in three

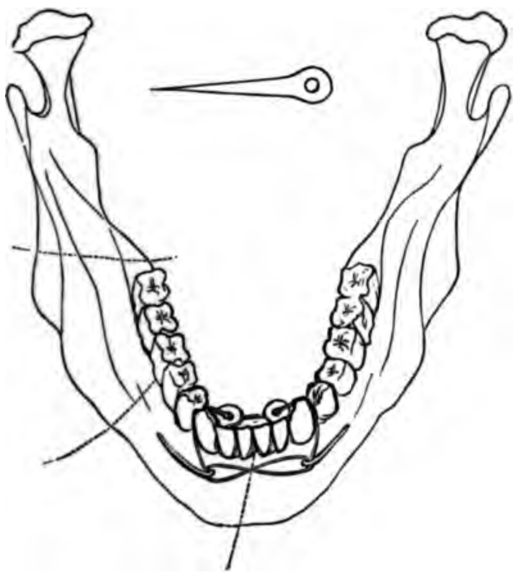
Fig. 251.

or four coils, the same being repeated with the end of wire at B, until the fracture was fixed. On the fifth day it became slackened, and required the use of the key in the coil at A or B. Either would do, though it is best to choose the smallest coil for tightening, and to notice first if the cross-piece of the wire A is well into the slit B. This case required tightening every three or four days. In twenty days the fracture was firm and united."

In Fig. 251 is shown a case where but one hole was drilled, the other end of the wire being secured between the teeth.

Mr. Wheelhouse, of Leeds, varied this operation by the use of flat-headed silver pins, which were passed through holes drilled through the broken ends of the bone. After drawing the pins through from the interior outward as far as the heads would allow, the two points were bent in opposite directions, and were drawn together and fastened by a silk ligature wound around them from side to side, as shown in Fig. 252. This illustration also shows that the ligature passed over the tops of the teeth and through a hole in the

FIG. 252.



head of each silver pin. Theoretically there would seem to be but little use for the latter part of this device.

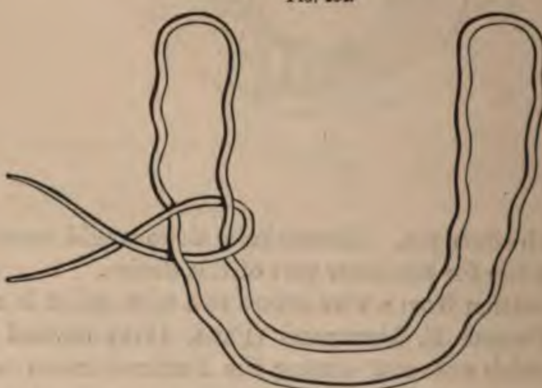
The transition from a wire suture to a wire splint is not difficult. Gunnel E. Hammond (Paris, 1870) devised an appliance which was used during the Franco-German war. But, as gunshot-wounds generally produce compound comminuted fractures, the cases where it might be used could not in the nature of things have been many. To derive the full value of this device, all or nearly all the teeth must be *in situ*, and must be sufficiently firm to assist in supporting the fragments.

Fig. 253 is an example of an ordinary case of fracture.

Fig. 253.

Fig. 254 shows the form of the wire splint, which passes behind and in front of all the teeth, and may be made in one

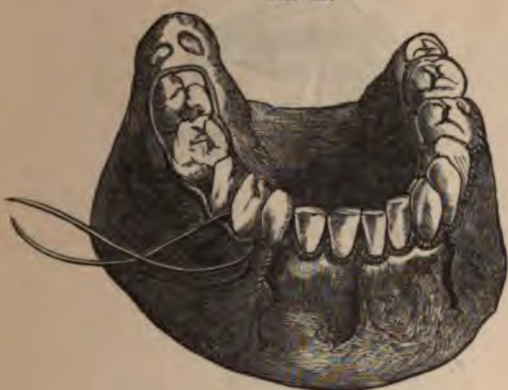
Fig. 254.



piece, as shown in the cut, or the ends may meet in front of the central incisors and be twisted together. Fig. 255 shows the application. The loop of fine binding-wire, shown in

Fig. 254, is carried around each tooth, and the ends are twisted together on the outside, including in its folds both sides of the splint-wire. No doubt cases occur from time to time where this arrangement might answer an excellent purpose, although, for reasons already mentioned, its use would be limited. Furthermore, even where the necessary teeth are *in situ* and are sufficiently firm, it would frequently be found quite impossible to get any wire between them. However, when it can be used, it presents advantages in the rigidity with which the fragments are kept in place, the

Fig. 255.



facility with which the mouth can be kept clean, and the absence of all external appliances.

Bandages.—The simplest form of treatment, as well as the most universal, is that of bandages. The origin of this practice is hidden in the darkness of bygone ages. It is but the natural act of the sufferer, that he may avoid the pain caused by the moving fragments. The first recorded use of this means is found in the works of Soranus, who lived in the second century; and from his time to the present it has been the most popular treatment for these injuries.

Syme says in his "Surgery": "The fragments are easily retained in contact by tying up with a handkerchief. Pasteboard is sometimes used, but it is generally unnecessary, and wood and cork wedges still less." In view of the multiplicity of methods to which surgeons have been obliged to resort, as described in the following pages, this remark savors of inexperience. Various ingenious forms of the bandage have been introduced, each possessing some special merit in the estimation of surgeons as applied to certain cases.

Bertrandi (1787) used the four-tailed bandage, with a hole in the center for the point of the chin to rest in; and in

FIG. 256.

conjunction with it wire ligatures were used for oblique fractures. This form of bandage is illustrated in Fig. 256.

Gibson's bandage, shown in Fig. 257, consisted of a roller from one and a half to two inches wide and eight yards long; and its application is described by Garretson as follows: "First: Place the initial extremity in front of the ear; carry down beneath the chin; pass up on the opposite side, and meet the initial by passing over the fronto-parietal region far enough back to prevent slipping; repeat this turn three times. Second: Reverse in front of and a little above the ear, and make three turns around the circumference of the vault. Third: End the third of these last turns at the occi-

FIG. 257.

put, and carry three times around the occipito-mental circumferences."

The Barton bandage, which antedated Gibson's, was applied as follows: "Place the initial extremity behind the left ear; carry it around the side of the head over the right pari-

FIG. 258.

etal bone; cross to the right over the neighborhood of the fronto-parietal suture; carry down beneath the chin; carry up on the opposite side; cross on the forehead; carry around the left parietal bone, and meet the beginning of the roller at the occipital prominence or a little below it; continue the turns until the bandage is exhausted." (See Fig. 258.)

Hamilton's method, as shown in Fig. 259, is a marked improvement over the earlier forms. It is composed of a firm leather strap, which passes under the chin and up over the head, and is tightened with a buckle. This is supported by two counter-straps made of webbing, one passing

FIG. 259.

across the forehead and the other fastened under the occiput. It has only the slight disadvantage that it requires a special shape, and can not be made at the moment of application; but this objection is common to nearly all valuable appliances. Where side-pressure can do no harm, this bandage is worthy of general adoption.

Dr. Garretson, of Philadelphia, has introduced a still simpler form, which he finds to answer every purpose in his own practice. It consists of a strip from one and a half to two inches wide, and a yard and a half long. By standing behind the patient and placing the middle of the strip under the chin, it is easily completed, as seen in Fig. 260.

A valuable adjunct to the bandage in many cases is an external splint of pasteboard or gutta-percha. It can be made

Fig. 260.

by taking a piece of binders' board cut in the shape of Fig. 261. It is then soaked in hot water until it has become sufficiently softened, bent into the shape shown in Fig. 262, and molded to the chin. When dry it makes a firm, close-fitting cap, over which the bandage is carried. This splint, with

Fig. 261.

Fig. 262.

one of the foregoing bandages, and occasionally pieces of cork or wedges between the teeth of the upper and lower jaw, constitutes the almost universal treatment of fractures of the inferior maxilla. Its popularity arises from its simplicity. The materials, or their equivalent, are nearly always at hand. Really no ingenuity whatever is required to use them. The majority of medical practitioners throughout the land, such as are nearest to the patient at the time of the accident, are neither skilled in mechanics nor ingenious. It is not surprising, then, that such simple apparatus should become the sole reliance of most practitioners. As to the results, if union is obtained without external deformity, the case is regarded as successfully treated; and yet in all but the simplest cases it will be found upon a close scrutiny by an expert that the grinding surfaces of the teeth of one or both fragments have lost their natural occlusion with their antagonists. Frequently only a moiety capable of actual contact remains, and thus more than half the power of the masticatory apparatus has been sacrificed.

The objections to the bandage and its adjuncts are, that to do their work effectually the lower jaw must be bound immovably against the upper. This prevents the patient from being properly fed, as only fluid nourishment could be received, and not even that if the dental arch be unbroken. To meet this objection, the corks or wedges were introduced; but again, when there is a strong tendency to displacement, they do not prevent it. In cases of oblique fractures the action of the bandage causes the fragments to overlap, and especially in cases of necrosis it contracts the jaw. In a majority of cases of complicated fractures in the author's practice, it has required great strength to right the pieces, and it has been almost impossible to bring them into accurate articulation with the upper jaw; and immediately upon the power being relaxed, some portion would drop out of line before even any bandage could be applied. Hamilton's objections are, that "nearly all the bandages and slings recommended for this fracture are inefficient, and are exceedingly liable to displacement. That portion of the apparatus especially which in most forms of dressing passes in front of the chin, and is made fast under the occiput, intended only to prevent the sling from sliding forward, does not fail to depress the chin, and increase the tendency to overlapping of the fragments."

This condition of things was recognized long ago, and showed the necessity of appliances operating upon an entirely different principle from any described. These principles, and the apparatus which has been devised from time to time in their application, should be more fully apprehended than they are generally by surgeons of the present day; and to this end the author has made an exhaustive investigation of this subject in all its history.

CHAPTER XVII.

INTERDENTAL SPLINTS.

INTERDENTAL splints have been the occasional recourse of surgeons for a hundred years. They were first recommended by Chopart and Desault in 1780. The earlier forms were nearly always used in conjunction with a submental compress and a clamp, which will be described hereafter. The

FIG. 263.

later forms have had a bandage sometimes for an adjunct, and at others have acted entirely by fixation within the mouth. Since the discovery of the value of gutta-percha and of vulcanized rubber, this form of apparatus has been carried to great perfection.

Dr. T. B. Gunning, of New York, seems to have been the first who used vulcanite for splints for fractured jaws. It can hardly be regarded as a remarkable invention, as the same material was then in common use among dentists for splints in regulating teeth. In 1861 he made a splint similar to Fig. 263, which held the jaws apart and covered both upper and under teeth. An opening was made in front for the reception of food, and the lower jaw was bound into the splint by a bandage over the head. The plan of this splint was the same as that made by Nasmyth and used by Liston many years before. Subsequently Dr. Gunning made other splints, which covered the lower teeth only and left the jaw free to move. These latter were made fast sometimes by

Fig. 264.

thread or wire ligatures around the teeth, and at others by screws passing into holes drilled into the teeth.

In 1864 Dr. J. B. Bean, of Atlanta, Georgia, who afterward lost his life on Mont Blanc, treated many cases of fractured jaws which occurred in the Confederate army. His interdental splint was much the same as Gunning's, but his compress and bandage were different. (See Fig. 264.) This bandage will be recognized as similar to Hamilton's, but the mental compress is made of a thin piece of wood with a suitable padding. Dr. Bean's success in forty cases which he treated was undoubtedly the result of the nice mechanical skill with which he made the interdental splint. His plan involved taking casts of both jaws, and reconstructing the model of the fractured jaw by articulating it to the model of the upper. His splint made upon such a model would produce results in accordance with his skill in restoring his model.

Dr. Wilhelm Suersen, of Berlin, reports the treatment, with an interdental splint, of a number of cases of gunshot-wounds of the jaw, which occurred during the Franco-German war of 1870. His splint was made of vulcanite upon a reconstructed plaster model, which method he de-

FIG. 265.

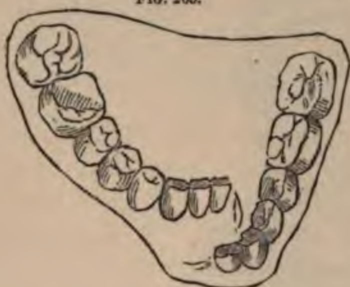
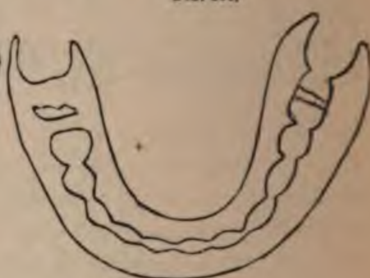


FIG. 266.



scribes as original with him, but which was the same as used by Tomes, Bean, and Gunning, and also described and published several years before that date by the author. Fig. 265 shows a case which came under his care five weeks after the accident. Fig. 266 illustrates the splint left open along the top for cleansing. After its introduction it was not removed for fourteen days. At the end of seven weeks the jaw was in a normal condition and perfectly healed.

Fig. 267 shows a case of double fracture occurring on each side near the canine teeth. The splint made for this, shown in Fig. 268, did not include the anterior fragment. When the splint was applied that portion was easily pressed into place, and remained so until the cure was complete, which occurred in about six weeks.

Fig. 269 shows a case where the anterior portion of the jaw, including six teeth, was carried away, and the remaining portion fell together, as seen in the cut. As three months had elapsed since the injury, and a callus had

FIG. 267.

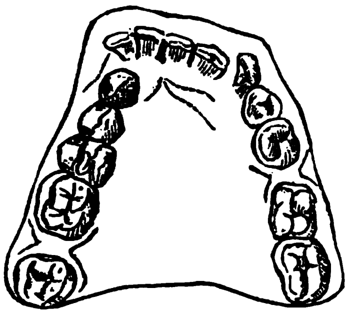
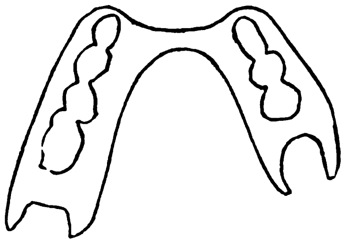


FIG. 268.



formed, replacement was undertaken gradually. The splint, Fig. 270, was made in separate halves, of vulcanite, and thickened at the approximate ends, between which a brace of hickory was used and lengthened from time to time until the jaw was restored to its normal condition.

FIG. 269.

FIG. 270.

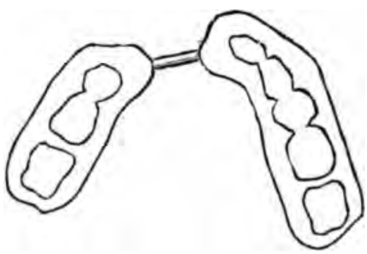


Fig. 271 shows a case of dislocation and serious displacement. "The left fragment was dislocated inward, and at the same time very much elevated, so that the bicuspids touched the hard palate." The splint (Fig. 272) and the treatment were similar to the last described case.

In his report of the above cases Dr. Suersen makes no mention of bandages or any other apparatus than that described. The author is at a loss to understand how each of these splints could unaided have retained the broken jaw immovably. It is my own experience, as well as that of others, that in only rare cases will a simple interdental splint, be it never so accurately fitted, hold the fragments immovably. Either bandages, screws, wires, or ligatures of some kind must be resorted to.

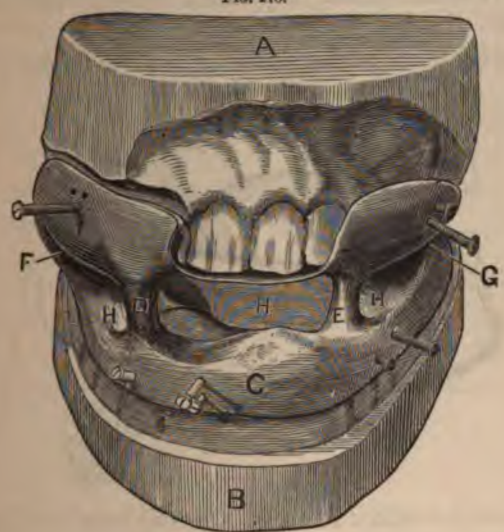
Dr. Harrison Allen treated a case in the Pennsylvania Hospital, in 1871, under extraordinary circumstances. The

FIG. 271.

FIG. 272.

patient was a laborer in whom insomnia was absolute. The first attempt at correcting the fracture was to hold the fragments in position with silver wire until the soft parts had so far recovered as to permit a chin-cap and bandage to be applied. But, in consequence of the semi-maniacal condition of the patient (apart from the mechanical difficulties always attending such cases), the wiring of the teeth was of no permanent use. Recourse was then had to a double interdental splint of vulcanite, upon the plan of Liston and Nasmyth; i. e., a plate for each jaw connected together, but leaving an opening for the reception of food. (See Fig. 273.) It was for a time held in position by means of screws placed in orifices previously drilled in the enamel of the molar teeth, after the method proposed by Gunning. But it was afterward deemed advisable to pass bolt-like screws through the entire thickness of the splint, at points corresponding to the small normally present spaces between the cervical portions of the crowns of the molar teeth. This modification held the parts as in a vise, and entirely removed them from the control of the patient. His attempts to tear the splint from

FIG. 273.



his mouth, or to dislodge it by facial contortions (which attempts were limited only by his strength), proved ineffectual. By the end of the twelfth week the screws were loosened from the lower jaw, and the parts examined. To his disappointment, the fragments were ununited. The displacement, however, did not recur. The apparatus was immediately readjusted—regardless of the remonstrances of the patient—and retained about four weeks, when the parts, being again examined, were found firmly united.

In "Guy's Hospital Reports" for 1874 is described Mr.

Henry Moon's method of treating similar fractures. In Fig. 274, letter A shows a vulcanite splint, which is secured in its place by wire ligatures passing around the teeth and tightened by twisting with a pair of pliers. This splint may be used with or without the cap B, which is fitted to the upper teeth.

The foregoing descriptions are quite sufficient to illustrate the various forms and attachments of simple interdental splints. Without doubt they fill in certain cases every requirement.

The objection to them lies in the fact that a special

FIG. 274.

splint must be made for each case, and only an ingenious and skillful mechanician is equal to it. For the battle-field, or for those who meet with such accidents beyond the range of a dentist, this method of treatment is unsuited. In such cases gutta-percha has many times been successfully used. The first use of this substance for this purpose was by Hamilton in 1849. Dr. St. George Elliott, of London, assistant surgeon of United States volunteers during the late war, says: "I believe, from much experience in the treatment of these fractures, that there is no one material or apparatus that can meet all requirements as fully as gutta-percha. It is particularly valuable in military practice, where systems of bandaging are frequently useless from gunshot comminution of the jaw, and where it is impracticable to use vulcanite splints specially adapted to the teeth.

"Where it is found desirable to use this material for the purpose, it is first heated in boiling water, taken out and worked in the hands, they being protected by occasional dipping in cold water. A sufficient amount is taken of the mass to construct the splint, say a roll about four inches long and one inch thick. While still soft and warm, this roll is introduced, one end first, as far back between the teeth on either side as possible; the other end is then bent and introduced into the mouth on the opposite side, the whole taking the form of a horseshoe. The piece is then pressed gently against the upper jaw and held there by one hand, while the other gently lifts the lower jaw into contact with the gutta-percha, forcing the points of the teeth slightly into the soft material. The gutta-percha is now left in position in the mouth until sufficiently hard to be removed without bending. This may be facilitated by cooling the outside by cloths wet in ice-water. When the material is removed from the mouth the indentations of the teeth of the lower jaw indicate their position, whether normal or not. If the displacement of the fragments is not great, they can be forced into position by building up with softened bits of gutta-percha inclined planes, so arranged as to act against the end of the fragment in the act of closing the mouth, thus forcing the parts into their proper position. I have also forced individual teeth that had been knocked out of place into line by a slight modification of the same means. When it has been ascertained that the parts of a fractured jaw are where they should be, the splint is again removed from the mouth and trimmed with a knife, and holes cut in the center and sides for the reception of nourishment and for cleansing. The splint is now returned to the mouth, and the lower jaw, being held against the upper by a bandage. The patient can now talk, and without inconvenience take his food. Of course mastication is out of the question, as the jaws are kept tightly closed until union has taken place."

Mr. Walter Campbell, of Dundee, has recently described his method of fitting a metallic splint and lining it with gutta-percha; but his process is so complicated that a better result could be obtained in less time and with less trouble by using vulcanite.

The *best treatment* involves primarily the readjustment of the fragments and *fixation;* and, secondarily, that fixation of the bone shall not interfere with its functions nor with the required dressing of any associated wound. As the function of the inferior maxilla involves movement at its articulation, it follows that the most perfect bandaging is subversive of this function, and shows the superiority even of any of the modes of wiring, where they have been successfully used.

Unquestionably, all things considered, the best apparatus yet devised is an interdental splint which operates by direct pressure on the teeth and jaws and counter-pressure on the chin. Such an apparatus is not necessary in all cases, nor is it applicable to every case of maxillary fracture. It would be of no special value in a fracture of the coronoid or condyloid processes, nor of the rami; but for nearly all cases of breaks in the body of the bone it is superior to all others, and this superiority becomes more marked the more extensive is the injury. Even in cases of necrosis of considerable extent, a properly adapted interdental splint, with its adjunct, a submental compress, will prevent contraction, and will enable the bone to retain without deviation its original relation.

The earliest record of an interdental splint is that of Chopart in 1780, either invented by him, or the record of a German method first published by him. It was made of a brace of iron or steel on either side of the jaw, covered and placed on the teeth with counter-pressure by screws against a sheet-iron or other plate under the chin. Another form used by Chopart and Desault consisted of iron or steel hooks caught on the teeth on either side of the fracture, and tightened with screws from a submental splint of sheet-iron or other material. This somewhat crude apparatus involved all the essential principles of the more finished inventions of the present day.

Rutenick, a German surgeon, in 1799 made a combination of internal and external splints, and a bandage which consisted of a semicylindrical or grooved piece of silver placed across the fracture on the teeth. This splint was held firm

FIG. 275.

FIG. 276.

against the teeth by steel hooks, one end of which rested on the plate, and being curved passed out of the mouth and straight down through holes in a horseshoe-shaped submental splint of wood. The steel hooks were drawn tight by nuts under the splint. Also to this wooden splint were attached the bands which connected with a skull-cap on the top of the head. This latter arrangement foreshadows the submental splint and bandage used by Dr. Bean.

Bush, of England, made a similar apparatus in 1822, which Malgaigne subsequently modified by using a cap of sheet-lead over the teeth; and in 1826 Houzelot added still another variation by which the submental plate was movable on a central vertical rod, and was held in any position by a screw.

FIG. 277.

Fig. 275, reduced from the "British Journal of Dental Science," 1877, illustrates substantially these various appliances. The same principle is involved in them all, and the variations or modifications are more for convenience than as

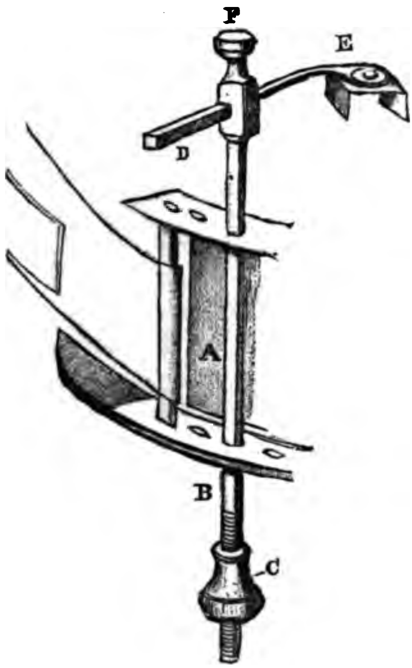
FIG. 278.

essential requisites. Lonsdale's splint was invented in 1832. He used an ivory cap over the teeth at the seat of the fracture, and his counter-pressure was derived from the lower splint in a similar manner to Houzelot's.

Fig. 276 shows a modification of this device by Mr. Berkley Hill, and Fig. 277 still another variation by the same surgeon, in using in place of the ivory cap of Lonsdale a metallic cap made from an impression of the jaws and lined with gutta-percha.

In Mr. Moon's paper, before referred to, he describes an

FIG. 279.



apparatus used by himself, which is a kind of combination of the Lonsdale splint and those which preceded it.

Fig. 278 shows an interdental splint made of metal and wired to a molar tooth on the right side, and to the canine tooth on the left side, in a case where there were three fractures. Fig. 279 shows a portion of the external apparatus. B is a vertical rod passing through the frame A and secured by the nut at the lower end. The horizontal rod D enters the mouth, and the cap E rests upon the inside splint. This rod is fixed by the screw F. Fig. 280 shows the apparatus *in situ.* The frame is made in halves, which lap on each other and permit its being narrowed as circumstances require. A horizontal plate passes under the chin, and the whole is sustained by webbing at the top of the head and at the back.

Fig. 280.

A point of interest in Mr. Moon's paper is as follows: "Mr. C. Heath, in his excellent essay on 'Injuries and Diseases of the Jaws,' quotes and coincides with the opinion of Sir W. Fergusson and other surgeons, that 'the majority of cases do well with merely the simple bandage not very tightly applied.' From this dictum, if 'doing well' means doing as well as they might do, I must—with all respect for the authority quoted—altogether dissent. . . . A properly made interdental splint tends to shorten the time required for union, averts pain, and prevents the formation of pus, which, when formed at the point of fracture, is apt to pocket in the soft parts around; and, lastly, it insures the restoration of the exact form of the unfractured jaw."

A far simpler, and I believe an equally effective, apparatus is that constructed by Mr. Hayward, of London, in 1858. He took casts of the jaw, and made a metallic plate fitted to and covering the teeth on both sides of the fracture, and to some extent the gums. From either side of this splint strong bent wires were soldered, which were curved in

FIG. 281.

such way that they passed out on each side of the mouth. (See Fig. 281.) To these arms, H H, a submental gutta-percha splint, was fastened, and the whole secured by a four-tailed bandage—although just why a bandage was necessary is not patent. Mr. Berkley Hill considers this the first attempt made to use a plate properly fitted to the teeth.

Ten years later Dr. Bullock, of Savannah, Georgia, made a similar splint of vulcanite. The arms were of stout iron

FIG. 282.

wire, and were set in the splint opposite the bicuspid teeth, and, coming out at the corners of the mouth, the ends were bent to form a loop, as shown in Fig. 282. Through these loops a strong cord was passed, which bound the submental splint under the chin. This submental splint was formed from a cigar-box cover, and should show two holes on each side, instead of one, to give it more security.

The most natural recourse for the treatment of a fracture, by one who is familiar with the mechanical details in making appliances for the mouth, is an interdental splint. Every dentist, in correcting irregularities of the teeth, makes use frequently of a great variety of interdental splints. The impressions, the models, the making and the adapting of splints, come therefore to be an almost daily practice. For this reason it is not strange that, although the treatment of fractures usually falls to the general surgeon, the most improved appliances and consequently the best method of treatment have emanated from dentists. And because of this special knowledge, we find that the inventions and the suggestions made by different ones, and original with each, bear a striking similarity to each other. This is particularly marked in the idea of taking a model of fractured jaws, and *correcting the displacement in the plaster model.* This was done by Tomes, Bean, Gunning, Suersen, and the author, and probably others, each one without the knowledge of the other, and each believing the idea to be original with himself.

THE AUTHOR'S METHOD.—For more than fifteen years I have made and used interdental splints in various forms, as the particular case seemed to require, and have experimented more or less successfully with splints made of silver, tin, vulcanite, and gutta-percha—the first three with and without gutta-percha lining.

In cases of double or triple fracture, I have always found much displacement and much difficulty in replacing the fragments, the tendency to displacement being so strong that the pieces would fall away again immediately on the force which held them being relaxed; and this has been the case also sometimes with a single fracture. The effort to reduce the fracture has at times required much ingenuity in the management of pries or levers between the fragments or against the upper teeth, while at others pieces of stout cord have been tied around certain sound teeth, and one displaced fragment pulled in one direction and another in a different one.

The failure to always get the broken jaw into its original shape, so as to either fit a gutta-percha splint or to even get a correct impression, led me to abandon any attempt thereafter to reduce the fracture prior to making the splint, and instead thereof to take an impression of the parts as they were found, and restore the jaw in the model. The same want of success in bringing the parts into exact apposition made me devise the splint shown in Fig. 283. This was entirely original with me, and its success was so great in a number of cases that it was with a shade of mortification that I afterward found that it was virtually a copy of Mr. Hayward's splint, figured on page 397.

FIG. 283.

The body of my splint has sometimes been made of vulcanite and sometimes of cast-tin. In both cases the arms have been imbedded in the body at the time of making. These arms were of steel wire one eighth of an inch in diameter, and, coming out at the corners of the mouth, passed back along the cheek on a line with the teeth. They should curve upward a little as they emerge from the mouth, to avoid pressure upon the lower lip, and should terminate near the angle of the jaw. Their stiffness was such that a bandage drawn tightly from the extreme end of one arm under the jaw to the other would bind immovably the body or interdental splint to the teeth and jaw.

Fig. 284 shows the model of a case of triple fracture, and

Fig. 285 shows the application of the splint to a reconstructed model, the same as it would be used in the mouth. It has been a favorite idea of mine that for all fractures of the body of the bone an interdental splint ought to be so nicely adjusted that the dental arch when placed in it would assume its exact original relation, *and that mastication might be performed upon the top of the splint.* In Fig. 285 are shown the indentations on the upper surface of the splint made to receive the cusps of the upper teeth; and, as such an appliance is used without binding the lower jaw against the upper, the patient is likely to use the splint to masticate upon as

FIG. 284.

soon as he has the desire to. Another advantage which this method has shown in practice is that, being accurately adapted to both lower and upper teeth, there is little tendency for it to get out of place; and, as soon as the fragments have become united enough to prevent displacement, the arms of the splint may be cut off and all external adjuncts dispensed with.

Of this apparatus Professor Hamilton very kindly says: "The vulcanized apparatus invented by Norman W. Kingsley, of this city, in point of simplicity and effectiveness, exceeds any which I have yet seen. If I were to recommend any form of apparatus constructed with a view of permitting mobility of the jaws during the process of union, it would be this, which has been employed in a number of cases at Bellevue Hospital, and in no case has failed to give satisfaction."*

I have resorted to various methods for making the submental splint or counter-compress. I have used pasteboard, gutta-percha, leather, a brass cap fitted over the chin, plaster of Paris, elastic rubber, a piece of a shingle or a cigar-box cover, etc., etc. One of the simplest as well as one of the best is a bit of thin board of a somewhat triangular form, hol-

FIG. 285.

lowed out at the back for the neck, with the rounded apex in front of the chin, and the sides standing beyond the jaw. By making a few cuts with a saw in each side, this submental splint is easily bound with a cord laced back and forth to the arms of the interdental splint. This compress may be padded with whatever is most convenient. Spongiopilin I have found to answer an excellent purpose, but it is not always at hand, and is not essential. This method of making the submental compress has, in addition to its simplicity, the advantage in cases of necrosis of making only vertical pres-

* Hamilton's "Surgery," and "Fractures and Dislocations," fifth edition.

sure, avoiding any tendency to contraction of the base of the jaw, and as a general thing giving an opportunity to treat any abscess which may have formed without removing the dressings.

Another form of submental compress is illustrated by the following case which was treated in Bellevue Hospital: The bone was broken in three places, viz., at the symphysis, between the bicuspid teeth, and at the angle, as shown in Fig. 286. There was considerable displacement of the fragments, the anterior piece containing three incisors, the canine and first bicuspid being much depressed and pushed backward;

FIG. 286.

the second or middle fragment was considerably elevated from its normal position. There was an external wound two inches in length, reaching back from the symphysis along the line of the jaw. This wound was dressed with carbolic acid and glycerine, and a four-tailed bandage applied. The next day the teeth at the anterior fracture were wired together, but the strain was so great that the wires broke after a couple of hours. The application of wires to hold the fragments was repeated from day to day for several days, but continued to fail. One week from the accident the fragment containing the molar teeth was detached. Fig. 287 represents this sequestrum full size.

Two weeks after the accident had occurred, impressions were taken preparatory to making an interdental splint. The condition in which the jaw was found at that time is well represented in Fig. 286. The splint, which is represented by Fig. 288, was applied substantially as shown in

FIG. 287.

Fig. 289. No effort was made to reset the jaw after the impressions were taken until the splint was adjusted. The fragments resumed their natural position immediately upon

FIG. 288.

the introduction of the splint and the application of the external bandage, as seen in Fig. 289. This bandage was a simple, broad, elastic rubber band, such as are for sale by stationers; it covered a pad over the chin, made of gutta-percha, softened and modeled into proper form. The elasticity of the band was such as to force the fragments into the splint and bind them firmly to it, thus allowing entire freedom to the jaw for the reception of food. The superior surface of the splint was carefully articulated to the upper teeth, and a little experience enabled the patient to masticate without difficulty. During a period of ten days after the adjustment of the splint, it was occasionally removed and kept off for some hours, in consequence of extreme tenderness of the external surface. After that time it was worn continuously (except such removals as were required for

FIG. 289.

cleansing) for two months, when union was found to have taken place, and the articulation of the teeth was correct.

Another device which I have sometimes used is illustrated by the following case of a carpenter, fifty-two years of age, who was struck by a heavy bar across the left side of the face in assisting at the launching of a vessel, March 1, 1873. The blow produced a lacerated wound of the upper lip, an inch long, situated three fourths of an inch above the right angle of the mouth; also a double fracture of the superior maxilla, and a triple fracture of the inferior maxilla. The fracture of the superior maxilla extended from behind the second bicuspid of the right side across the roof of the mouth, through the alveolar process on the left side, in the place where the first molar had been extracted; thence around in front, above the teeth, to the right side. There was also a second fracture passing between the central and lateral incisors of the right side, running along the median line, and intersecting the one before described. These two fragments, containing all the teeth anterior to the molars, were somewhat displaced, but there was little difficulty in restoring them, and none in retaining them in position.

FIG. 290.

The lower jaw was broken in three places—one fracture occurring at the right of the symphysis, the second at the left of the symphysis, and the third at the neck of the condyle of the right side. The displacement of the fragments was very marked; the anterior one, containing the two central incisors, was pulled down and backward, while the larger fragment of the right side, containing six teeth, was depressed at its anterior end, and much elevated posteriorly. The position of the fractures and the displacement is shown in Fig. 290.

The wound in the lip was closed with three silk ligatures, and a four-tailed bandage applied to the jaw; but a few days' trial proved its inefficiency, and impressions were taken preparatory to making an interdental splint. When the impression of the upper jaw was removed, it detached and displaced the loosened portions, but they were readily replaced, and required no support. The splint used in this case was an adaptation of the tongue-holder or duct-compressor, in common use among dentists. The internal portion was made of vulcanite over a reconstructed model of the jaw, and the chin-piece padded with spongiopilin, as shown in Fig. 291. Its application to the jaw is shown in Fig. 292.

The splint was applied on the 9th of March. The patient experienced no pain or discomfort from wearing it,

Fig. 291.

and ate the ordinary hospital food without difficulty. On the 20th of March he was discharged from the hospital, and on the 10th of April union was firm, with no deformity.

This device answers an excellent purpose for any fracture near the symphysis. In fact, it is not essential with it, in cases of simple fracture, that the interdental splint be made of vulcanite, for gutta-percha may be substituted. For any fracture behind the canine teeth, where there is much tendency to displacement, it does not do so well, because the internal splint and mental compress can not cover the posterior fragment and antagonize each other with sufficient rigidity. Recourse may then be had to the form shown in

Fig. 283; but fractures of the ramus, or of the coronoid or condyloid process, can receive no benefit from an interdental or any other splint except incidentally.

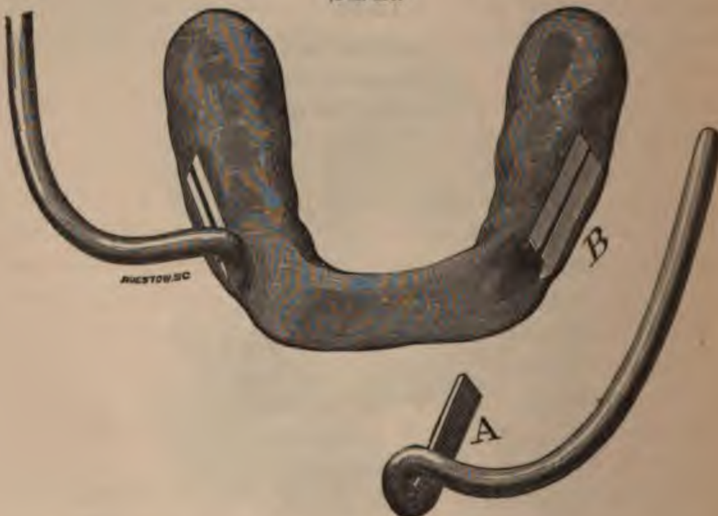
I have in other cases used an apparatus almost identical with Houzelot's, and have also resorted to various other devices, each including some form of clamp, but none of them involving any principle which is not indicated in some of the previously described inventions.

Fig. 292.

A modification has been made in the attachment of the arms, by which they can be unshipped from the splint if necessary without removing it from the mouth. This is shown in Fig. 293. The connection of the arms here with the splint is by having the end A flattened, and when used inserted into a corresponding sheath or groove in the side of the splint B. This method complicates the manufacture, and possesses no marked advantage over the others except the ease with which the arms can be detached.

My inclination in most cases is to use the form shown in Fig. 283. If the circumstances require that such an interdental splint be made, as will involve taking a cast of the jaw, then this form is quite as easily produced as any other, and fills all the requirements of the more complicated and clumsy apparatus of Moon, Lonsdale, and others. Its advantages lie entirely in the skill with which the plaster jaw is reconstructed, and the accuracy with which the splint is

Fig. 293.



made; for, if either of these qualities is wanting, a splint of this form is of no more value than gutta-percha or a more imperfect method, and may even do positive harm. I fancy that it is because interdental splints have been so bunglingly made and applied that they have met with no more favor with certain eminent surgeons who have tried them.

To a dentist, in view of the foregoing, the directions for their manufacture are very simple, as follows: Restore to position displaced fragments as far as can be done without much effort, the only object being that it makes it a little easier to take an impression. I have always used plaster for such an impression, and see no reason for using any other substance, and indeed know of no other substance as good. The impression of the deranged fragments may be taken as a whole in an impression-cup; or, if inconvenient to do so, it can be taken in sections without any cup. Either course, in my practice, has answered equally well. The only object is to obtain casts of all the fragments, either together or separate. Take also in plaster an impression and make a cast of the upper jaw. No dentist should be at all in doubt as to the relation which the fragments of the lower jaw should hold to the upper. There are invariably, even if there are but few teeth in the mouth, certain marks of abrasion on the antagonizing surfaces which identify with exactness the position which the fragment formerly sustained to the upper jaw; and like means of identification I have never failed to find even in mouths of children where there were shedding and erupting teeth; therefore there is no excuse for failing to reconstruct the model of the lower jaw, and make it identical with the original in its normal condition. Upon such a model the construction of the splint of vulcanite involves no manipulations which are not common. Sheet-wax, a single line in thickness, carefully pressed over the teeth, and to a little extent encroaching upon the gums, gives the form required. If the fracture is in front, the splint need not cover all the back teeth; but, if it be at the sides, it is better to cover all the teeth of that side. It is also better to set the casts of the upper and lower jaw in an articulator, and thus make prints of the upper teeth in the wax, to be retained in the splint.

One of the easiest things of which to make the arms is a couple of discarded excavators, flattening the ends which are to be imbedded, and curving them with much care, after the form indicated in Fig. 285. The flattened ends should be made quite broad and thoroughly imbedded in the splint, as much strain comes upon them. The subsequent steps are familiar to every dentist. In finishing, it is better to enlarge the sockets for the teeth a little, so that there will be no impinging upon the crowns when the splint is introduced, and also to make openings through the top or side against each tooth adjoining the fracture, so that it can be determined when the fragments are fully in their place. These latter holes will be convenient to use in cleansing the apparatus by inserting in them the nozzle of a syringe.

If the splint is properly made, the teeth of each fragment will follow into the indentations prepared for them without severe pressure; if they do not, it is quite as well to bind the splint to its mental compress and await events. It will probably be found a few hours later that they have regained their place without further aid. The free movement of the jaw has a tendency to work the displaced fragments into position. In a healthy subject the fracture will require but little treatment beyond the adjustment of the splint. Great relief is felt almost immediately that the parts are restored and bound in their normal position, and cleansing the mouth with suitable antiseptic washes is the principal care required.

If there are external wounds or abscesses, they will be treated according to the requirements of each case, where rules will be of little benefit, and the dressing must be left to the judgment of the one in charge.

It is quite evident from what has been written that invention in the treatment of fractures of the lower jaw, especially within the past one hundred years, has been most active, and the apparatus of to-day is but a modification of that of yesterday or of a century ago. The idea of a splint of universal accommodation seems to have possessed in some degree the mind of every inventor; but it is also evident that, the more general the application of any particular apparatus, the more clumsy it becomes.

The experience and observation of the author lead to the following conclusions: That, in the present state of the arts, the only interdental splint in the hands of the general surgeon, which can make any claim to be of universal application, is one that can be made at the moment by a person of moderate ingenuity from gutta-percha; and to Hamilton is due the credit of its first application.

When gutta-percha fails, as it has in my practice frequently, even where it was inclosed within a covering of metal, recourse must be had, I think, to one of the forms of clamps of which so many have been devised; and it is hardly wise to regard one form as certainly the best in all cases.

In a fracture at the angle, or of the ramus, or of the coronoid or condyloid process, uncomplicated by a fracture in the body of the bone, an interdental splint would be of no value, while a bandage would be clearly indicated.

As before intimated, the success of any specially made interdental splint will depend much more upon the mechanical skill and nicety of its construction than upon the peculiar principle involved in it. The best results are not likely to be obtained by using only one form of splint, without reference to the location or direction of the fractures, and success will depend quite as much upon the judicious selection of apparatus already proved as upon any effort to increase the present large variety.

PART IV.

MECHANISM OF SPEECH.

CHAPTER XVIII.

PHYSICS OF SOUND AND PHYSIOLOGY OF THE VOICE.

ARTICULATE speech is the result of vocal sounds, single or combined, continuous or interrupted, varied by pitch, volume, and intensity. It is based upon the physics of sound, a knowledge of the latter being essential to a comprehension of the mechanism of the former. All sounds, whether harmonious or discordant, are caused by the vibrations of matter. Musical sounds and noises are equally the result of vibrations; the first being the result of periodic or regular-recurring vibrations, and the second of those which are irregular, confused, non-periodic. Wherever there is sound there is motion; and, conversely, wherever there is motion there might be sound, if there were a medium by which the vibrations could be conducted to our ears, and our ears were capable of apprehending the vibrations.

As our ears are constituted, they will not appreciate a sound which is the result of less than 16 vibrations to the second, nor will they take cognizance of sound when the vibrations exceed 40,000 per second. The lowest note of the double bass in an orchestra has 40½ vibrations to the second, while occasionally an organ-pipe is introduced the note of which has but 16 to the second. The lowest C in a piano of 7 octaves has 32 vibrations, and the highest C 4,096. At 10,000 vibrations, sound becomes piercing and loses its musical character. At 32,000 to 40,000, the ear fails to take cognizance of the successive shocks. The vibrations which reach our ears may arise from a multitude of causes. They may originate in the air itself, or in some substance far removed, and be conveyed by the air to us.

The same number of vibrations always produce a sound of the same pitch, without reference to the substance or cause of motion; the duration, intensity, and quality may differ, but the pitch, with the same number of vibrations, is invariably the same. The intensity, strength, or loudness of sound is due to the amplitude of vibrations, or the distance the vibrating body traverses and the length of time the vibrations continue.

No sound, emanating from whatever cause, and heard by the ear as a single sound, is a simple sound; it is always a compound or composite one, made up of a number of tones of different intensity and pitch, together with a possible admixture of noises, which combined constitute the sound as heard. For example, if a string drawn to the proper tension to emit a sound be plucked, it will not vibrate throughout the entire length as one vibration, but will be divided and subdivided into vibrating segments of varying lengths, each of which will emit a different tone. The longest segment, producing the most ample vibration, gives the loudest tone, and also the pitch to the clang, and its sound is called the fundamental tone. The other tones made by the shorter segments mix with the fundamental tone, the higher in pitch being the overtones, and the lower in pitch the undertones; and the whole constitutes the clang which is heard as one sound. The fundamental tone is always associated with tones higher or lower in pitch, or with both, which modify it. The difference in the quality or timbre of the same musical note as emanating from different instruments, such as the violin, clarionet, and organ, is due to the different admixture of overtones and undertones with the fundamental note.

The medium through which sonorous vibrations are generally received by the ear being the air, we find such vibrations affected by the substances with which they come in contact. Soft substances will absorb sound, while hard ones, on the contrary, will reflect sound. A room hung with massive drapery will muffle and absorb sound, while one with polished walls will reflect and echo it.

One of the most interesting phenomena of the physics of sound is its augmentation or reënforcement by secondary causes. A sound emitted by one body may cause another sounding body, capable of the same number of vibrations, to become sonorous by vibration, and the sound will then be repeated, augmented, and prolonged; but the two sounding bodies must be attuned in unison. For example, a musical sound made near the strings of a piano will cause the strings in unison with it to vibrate and emit the same sound, which may be continued even after the first has ceased. A hollow body or a short tube closed at one end, containing a column of air of a certain length, can be made to resound by bringing its open end near a sounding body. The sound emitted throws the column of air into motion, and these vibrations, being identical with those of the sounding body, augment or reënforce the original note. If the column of air in such a resonating tube is not in unison with any tone of the combination or clang, no response will be heard; but, if in unison with any tone of the clang, such tone will be augmented or reënforced. Thus, a resonating body may augment the fundamental tone, or, by unison with one of the overtones or the undertones, will reënforce that to the exclusion of all others. The shape of such resonating cavities may be various; the material of which they are constituted is not important; wood, glass, metal, rubber, or putty can be formed into a resonating cavity. Resonance depends more upon the form and dimensions of the cavity than upon the substance of its walls.

The recognition of this phenomenon is the key to the mechanism of speech. Man speaks with his voice, and voice is simply sound caused by vibrations, and subject to all the laws which govern sound arising from any other source. The apparatus which produces voice is both simple and complex—simple in its action, but complicated in its structure, and still more complicated and wonderful in its results. The combined power, the compass, and the richness of tone of the human voice are unapproached by strains from any other instrument.

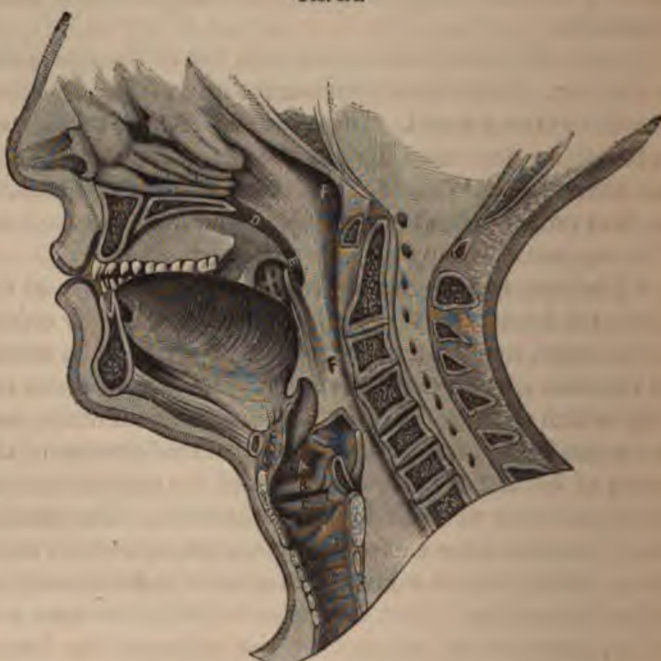
Voice is intimately connected with one of the vital functions of life. Every breath we breathe can, with slight effort, be made to utter a sound. The vocal apparatus depends upon the breathing apparatus for its action and its power. The same current of air driven from the lungs in natural respiration, will produce sound by the slightest alteration in the form of the air-passages.

"The principal organ concerned in the production of the voice is the larynx (see Fig. 294, A A). The accessory organs are the lungs, trachea, the expiratory muscles, and the mouth and resonant cavities about the face. The lungs furnish the air by which the vocal chords are thrown into vibration, and the mechanism of this action is merely a modification of the process of expiration. By the action of the expiratory muscles the intensity of vocal sounds is regulated. The trachea not only conducts the air to the larynx, but, by certain variations in its length and caliber, it may assist in modifying the pitch of the voice. Most of the variations in the tone and quality, however, are affected by the action of the larynx itself, and of the parts situated above it.

"It is impossible to give a complete account of the structure of the larynx, without going more fully than is desirable into purely anatomical details. We propose here only to refer to the situation of the vocal chords, and to indicate the modifications which they can be made to undergo, in their relations and tension, by the action of certain muscles.

"The vocal chords are stretched across the superior opening of the larynx from before backward (Fig. 294, B and C). They consist of two pairs. The superior (B), called the false vocal chords, are not concerned in the production of the voice. They are less prominent than the inferior chords (C), although they have nearly the same direction. They are covered by an excessively thin mucous membrane, which is closely ad-

FIG. 294.



herent to the subjacent tissue. The chords themselves are composed of fibers of the white inelastic variety, mixed with a few elastic fibers. The true vocal chords (C) are situated just below the superior chords. The anterior attachments are near together at the middle of the thyroid cartilage, and are immovable. Posteriorly they are attached to the movable arytenoid cartilages; and, by the action of certain muscles, their tension may be modified, and the chink of the glottis may be opened or closed. These ligaments are much larger than the false vocal chords, and they contain a very great number of elastic fibers. Like the superior ligaments, they are covered with an excessively thin and closely-adherent mucous membrane.

"Anatomists usually divide the muscles of the larynx into extrinsic and intrinsic. The extrinsic muscles are attached to the outer surface of the larynx and to adjacent organs, such as the hyoid bone and the sternum. They are concerned chiefly in the movements of elevation and depression of the larynx. The intrinsic muscles are attached to the different parts of the larynx itself, and, by their action upon the articulating cartilages, are capable of modifying the condition of the vocal chords.

"During ordinary expiration none of the intrinsic muscles seem to act, and the larynx is entirely passive, while the air is gently forced out by the elasticity of the lungs and of the thoracic walls. But as soon as an effort is made to produce a vocal sound, the appearance of the glottis undergoes a remarkable change, and it becomes modified in the most varied and interesting manner, with the different changes in pitch and intensity which the voice can be made to assume. Although it is sufficiently evident that a sound may be produced, and even that words may be articulated, with the act of inspiration, true and normal phonation is effected during expiration only." *

The trachea conducts the air from the lungs to the larynx, and reënforces the sound to some extent by vibrations of the column of air in its interior. The trachea can be elongated and shortened at will. It is shortened and its caliber increased in the production of low notes, and elongated and contracted in the higher ones. The larynx also varies in capacity in the same individual, both its length and breadth

* Flint.

being diminished in high notes and increased in low ones.

"The most important modifications of the laryngeal sounds are produced by the resonance of air in the pharynx, mouth, and nasal fossæ. This resonance is indispensable to the production of the natural notes. The velum palati is fixed by the action of its muscular fibers, so that there is a reverberation in the bucco-pharyngeal and naso-pharyngeal cavities; that is, the velum is in such a position that neither the opening into the nose nor into the mouth is closed, and all of the cavities resound (D, Fig. 294).

"As the notes are raised, the isthmus contracts, the parts immediately above the glottis are also constricted, the resonant cavity of the pharynx and mouth is reduced in size, until finally, in the highest notes of the chest register, the communication between the pharynx and the nasal fossæ is closed, and the sound is reënforced entirely by the pharynx and mouth. At the same time the tongue, a very important organ to singers, particularly in the production of high notes, is drawn back in the mouth. The point being curved downward, its base projects upward posteriorly and assists in diminishing the capacity of the cavity.

"In the changes which the pharynx thus undergoes in the production of different notes, the uvula (E) acts with the velum, and assists in the closure of the different openings. In singing up the scale, this is the mechanism, as far as the chest-notes extend. When, however, we pass into what is known as the head-voice, the velum palati is drawn forward instead of backward, and the resonance takes place chiefly in the naso-pharyngeal cavity." *

Difference of pitch in voices is due chiefly to the greater length of the vocal chords in low-pitched voices, and to their shortness in higher ones. The same note sung by a male voice and a female voice shows the difference of an octave,

* Flint.

owing to the difference in the number of vibrations. In the low chest-tones the vocal chords are elongated, and at the minimum of tension that will allow of regular vibration.

Differences in quality are due to peculiarities in the conformation of the larynx, and to variations in the size and form of the auxiliary resonant cavities. Many of the different qualities of the human voice are due to the difference in the length, breadth, and thickness of the vibrating ribbons.

Voice is produced first, and to a limited extent, by the vibration of the column of air in the larynx during the act of expiration; secondly, and principally, by vibrations of the vocal chords; and, thirdly, by resonance in the buccal and nasal cavities.

The accessory organs in producing modifications of the voice are the pharynx, the velum palati, the tongue, teeth, and lips.

The pharynx (F F, Fig. 294) may be likened to a muscular tube or bag, open and continuous below the œsophagus, open and continuous above with the nasal passages, and open also in front to the buccal cavity. Its walls are muscular, and capable of powerful contraction, even to complete closure of the passage. The pharynx executes an important office as an organ of speech—passively as a resonating cavity, and actively by the movements of its constrictor muscles. By them the upper portion of the pharynx is contracted, and its posterior wall advanced until it meets the palate, and thus throws the voice forward into the buccal cavity. This action of the pharynx can be studied with ease in cases of cleft palate. Movements which are hidden in a normal condition are then fully exposed to view. I have observed many cases where, in the effort to produce certain sounds, the superior constrictor would develop a ridge or roll of considerable magnitude horizontally across the pharynx. This pharyngeal movement, important in normal articulation, becomes an essential requisite to success when articulation with an artificial palate is attempted. In a normal condition, the posterior nasal passages are closed by the combined action of the palate and the constricted pharyngeal wall. In an abnormal condition of absence of the palate, the pharyngeal action may be made to perform the office of both.

The velum palati or soft palate is a muscular curtain, attached to the posterior edge of the bony roof of the mouth or hard palate, and hangs down as a partition between the buccal and nasal cavities, forming the double-arched boundary to the fauces, with the pendulous uvula dropping like a tassel from its center margin (Fig. 294, D E). It is composed entirely of muscular tissue, and is overlaid with mucous membrane. It moves like a valve between the buccal and nasal cavities—now against the pharynx, directing the outward current through the mouth, now against the dorsum of the tongue, directing the current through the nose, and again hanging between the extremes, dividing the current and column of sound, and permitting it to pass through both channels. In another chapter are ample illustrations of the disastrous results to articulation which follow its loss. It is only necessary to bear in mind that more than three fourths of the sounds of articulate language depend upon the integrity of the palate for their perfect enunciations.

The tongue is generally regarded as the most important organ of speech; but it is said that there are numerous instances where the tongue has been lost by accident or design, and the sufferer continued to articulate as before. In variety of movement, the tongue plays the most important part in altering the resonating capacity of the buccal tube or cavity.

The teeth, as organs of articulation, have not received the attention from dentists that their importance demands. They have been regarded by them almost universally as organs of mastication merely; and, when artificial ones were required, if the masticating ability was secured without seriously interfering with the looks, both dentist and patient were satisfied.

The neglect to recognize them as important organs of speech has arisen partly from the general ignorance in reference to the mechanism of speech, and partly because neither the entire loss of the natural teeth, nor the substitution of very inferior artificial ones, has actually destroyed articulation. Nevertheless the dentist may interfere very seriously with the comfort of both a speaker and listener by a badly arranged artificial denture.

The only remaining organs to which attention is directed in this system for the production of speech, are the cheeks and lips, nares, and nostrils; but their physiological action is not such as to require here an extended notice, further than to say that any considerable departure from a normal condition, through deformity or disease, will impair their functions. Morbid growths in the nares, destruction of the turbinated bones or the vomer, a fissured lip, or an enlarged nostril, commonly associated with a hare-lip, are all abnormal conditions affecting articulation.

Having thus made ourselves familiar with the physics of sound and the physiology of the voice, it remains to describe how voice becomes speech. Articulate language is an aggregation of definite sounds associated with definite ideas, which in the progress of time has become so complex a system that nearly every idea of the most subtile brain can be conveyed to another mind by sound alone, and from habit we come to regard the idea and the words which express it as almost identical. It is difficult to think, and impossible to reason, without our thoughts formulating themselves into words. But thoughts were not first formed into words and then uttered in speech: words are the outgrowth of the effort to express ideas by sound and the combinations of sounds. It is the natural instinct of a child to express its general wants by sound, and, as it develops in intellect and its wants become more definite, it adopts from its superiors the sounds which express its specific wants.

A remarkable illustration of how naturally a human being resorts to sounds to express its wants, without adopting the conventional form, occurred in my own family. A little daughter of mine had a nurse in infancy who was very musical, and was constantly singing or humming little strains of music. The child caught them up and associated certain notes or strains with its own wants and ideas. Until she was nearly three years of age she rarely articulated a syllable beyond "papa" and "mamma." I began to fear she never would speak. During this period all her wants were made known by harmonious strains, which we came to understand as readily as if it were our own vernacular. It was astonishing to observe to what extent and perfection this musical language of a child could be carried.

So habituated are we from infancy to interpreting sounds as expressing definite ideas, that few of us ever realize that this is one of the most wonderful functions possessed by man. All articulate speech must of necessity be acquired; there can be no natural language. The accepted arrangement of sounds is purely arbitrary, and derives its power from the common consent and use of such arrangement; in this way isolated communities tend to form dialects, and in time apparently different languages. With such an elaborate system as the speech of civilized nations has now become, expressing by sound the nicest shades and distinctions of thought, we might expect to find the mechanism of speech so complicated as to be beyond our comprehension; but the investigations of scientists within the last few years, particularly since the introduction of the laryngoscope, have cleared up and exposed the nature of vowel-sounds, which was incomprehensible for ages.

The human voice is caused by the action of the expiratory muscles driving the breath outward through the larynx. The sound produced by vibrations of the vocal chords is not a simple sound, but a clang. The buccal cavity and the nasal cavity become resonators; the palate, tongue, jaws, cheeks, lips, and nostrils being capable of altering and modifying the form and dimensions of these cavities to a very great extent; but whatever shape they assume they will have, like all other hollow bodies filled with air, their own tone-character in each different form and dimension. Consequently, as the sound passes out through the mouth, some one tone of the clang which is in unison with the tone-character of the buccal cavity at that moment will be augmented and intensified. This re-enforcement by resonance changes the quality or timbre of the laryngeal clang. "In this changed timbre consists the nature of vowel-sounds. A vowel is the timbre which results from the increase by resonance of one or more tones in the laryngeal clang." *

Pure vowel-sounds can be made only by resonance of the buccal cavity alone and in its normal integrity. Let any other cavity communicate with it, and its tone-character is destroyed, and *par consequence* the purity of its vowel-sounds; make a communication with the nasal cavity, either great or small, and pure vowel-sounds are impossible. The power to change the shape and size of the oral cavity being great, equally great is its power to change the laryngeal clang. This change of timbre in the clang may be continuous and uninterrupted within the compass of the voice, from the lowest tones to the highest; and what are called the different vowel-sounds are but points along this vocal stream which our ears distinctly mark and separate one from another.

Articulate language may adopt as many divisions of this vocal stream as the ear can distinguish, but practically it is not desirable to burden a language with *extremely nice shades of sound.* Max Müller says, "Vowels in all their varieties are really infinite in number." As a precise statement this can not be correct, and as an approximate statement it is only theoretically true. The human voice is heard only within certain limits, and practically there can be no more vowels than appreciable changes of timbre and pitch within those limits.

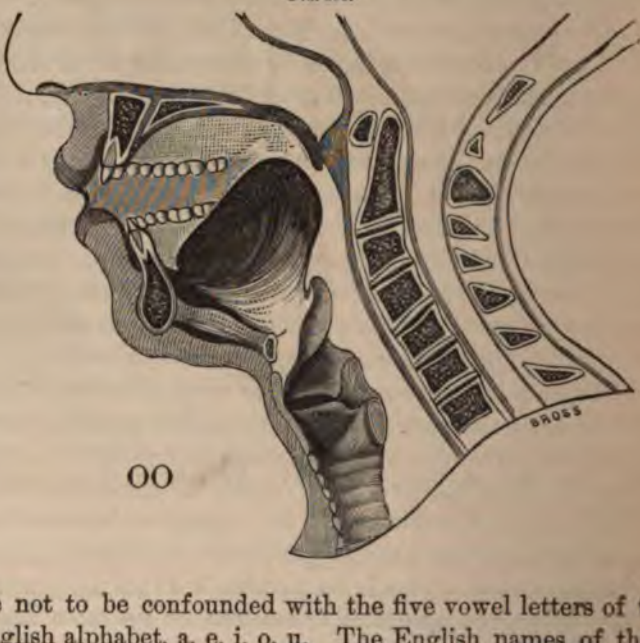
* Professor Elsberg.

CHAPTER XIX.

THE MECHANISM OF THE FORMATION OF VOWELS AND CONSONANTS.

THE five most distinctly marked vowel-sounds used in the English language are OO, O, AH, A, E.* These five vowels

FIG. 295.



OO

are not to be confounded with the five vowel letters of the English alphabet, a, e, i, o, u. The English names of these

* Dr. Bristowe, in a recent lecture before the Royal College of Surgeons, England, makes *thirteen* vowel-sounds in the English language, which he illus-

letters do not express the distinction between the principal vowels as well as the Italian pronunciation of the same letters. OO is the original Anglo-Saxon name for U. In English the sounds AH and A, which are distinctly separated in the laryngeal clang, are expressed by one letter; in Italian the same sounds are expressed by A and E. The written vowels in both languages are the same, but the spoken vowels represented by them differ; we are obliged, therefore, to

FIG. 296.

O

adopt the designations of OO, O, AH, A, E, to express in English the five principal vowels.

trates by the fundamental vowel in each of the following syllables or words: *past, pat, pet, pate, pit, peat, pauper, pot, potent, put, boot, pur, putty.* But even this illustration will not suffice to convey a clear apprehension of his designations. The words which he has chosen are not pronounced uniformly wherever English is spoken. Cultivated scholars use a different vowel in some of them from what the lecturer evidently intended. (London "Lancet," April, 1879, p. 507.)

These sounds constitute the fundamental vowels of nearly all the languages of the world. In the production of these vowels, according to Tyndall, the laryngeal clang undergoes the following changes: "For the production of U (oo in hoop) I must push my lips forward so as to make the cavity of the mouth as deep as possible, at the same time making the orifice of the mouth small. This arrangement corresponds to the deepest resonance of which the mouth is ca-

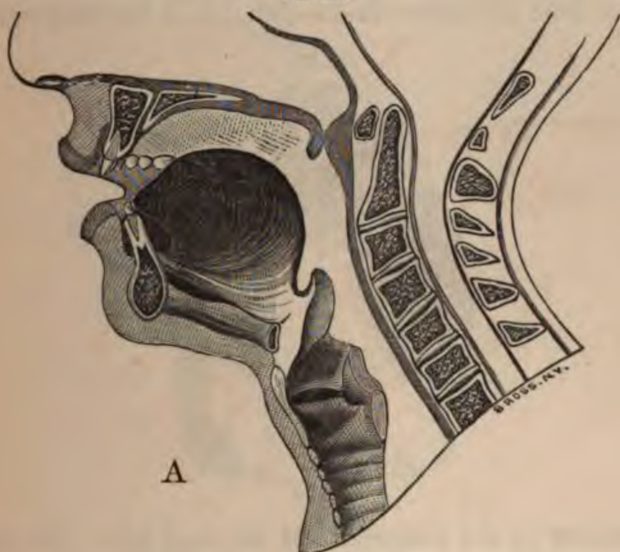
Fig. 297.

pable. The fundamental tone of the vocal chords is here reënforced, while the higher tones are thrown in the shade."

In Fig. 295 is shown the position which the tongue, palate, and lips assume in making OO. The tip of the tongue is much depressed in the floor of the mouth and its back lifted high toward the soft palate, but it does not touch the roof of the mouth at any point; the jaws are opened and the lips contracted, so that the oral cavity becomes bottle-shaped, and the passage through the nares is completely shut off by the conjunction of the palate and pharyngeal wall.

"The vowel O is pronounced when the mouth is so far opened that the fundamental tone is accompanied by its strong, higher octave." In Fig. 296 the organs are represented; the lips are not so close, and the tongue is not so much retracted at the tip nor lifted so high at the back as in the former illustration.

FIG. 298.



"In the production of the sound AH, the higher overtones come principally into play. The second tone may be entirely neglected; the third rendered feebly; the higher tones, particularly the fifth and seventh, being added strongly." In Fig. 297, illustrating the organs during this sound, we see the oral cavity distended to its greatest capacity; the mouth is wide open; the tongue lies comparatively flat, and the veil of the palate is lifted to its highest elevation. To make a resonating cavity which shall produce AH, some persons curl the sides of the tongue upward in the form of a trough, while in others the same cavity is formed with the tongue full along the median line.

"The vowel A derives its character from the third tone, to strengthen which by resonance the orifice of the mouth must be wider, and the volume of air within it smaller than in the production of O. The second tone ought to be added in moderate strength, while weak fourth and fifth tones may also be included with advantage." In Fig. 298 the marked change from AH is seen in the elevation of the tongue, and

Fig. 299.

a reduction in the dimensions of the vocal tube. We find now, for the first time thus far, the tongue touching the roof of the mouth. This contact is shown in Fig. 299 by the black patches on the alveolar border against the molar teeth. The method by which this was determined is described further on.

"To produce E, the fundamental tone must be weak, the second tone comparatively strong, the third very feeble; but the fourth, which is characteristic of this vowel, must be intense. In order to exalt the higher tones which characterize the vowel-sound E, the resonant cavity of the mouth must be small." In Fig. 300 we see the tongue lifted higher than in making any preceding vowel, and the resonant cavity, in both form and dimensions, in striking contrast with that of OO. In E, it partakes of the nature of an elongated tube. The reduction of the vocal passage is also seen in Fig. 301, where the contact of the tongue is shown to extend the whole length of the sides of the alveolar border.

Fig. 300.

The foregoing five illustrations cover the entire compass of vowels from the highest to the lowest; all the others heard by Bristowe, and more even as claimed by some, find their relative position somewhere between the extremes of E and U (OO). It will be observed that in each of the sectional illustrations the soft palate is elevated, the pharyngeal wall bulges forward, and the uvula lies in firm contact against it. This shutting off of the nasal cavity is essential to the purity of vowel-sounds. If there be any escape of breath or sound, however small, behind the curtain of the palate, the vowels will be nasalized.

This is the explanation of the peculiar vowels of the French language. In addition to those used in English, there are several which are characterized by resonance of the nasal cavity, showing that, at the time of their formation, the palate and pharyngeal wall are relaxed. These nasal vowels are essential to the perfection of the French language, but when introduced into English destroy its purity. This is a loose habit of speech among some English-speaking peo-

Fig. 301.

ple into which large communities have fallen. By a slack conjunction of the posterior border of the palate and the pharyngeal wall the whole speech is affected disagreeably.

The illustrations here used are the result of personal studies of the organs in action in many cases, and are the record of one mouth in particular with well-developed organs. The means adopted were as follows:

I made a cast of the roof of a mouth extending back and down to the boundary of the fauces, and upon this cast fitted a very thin and delicate plate of black vulcanite, covering the entire roof within the teeth and the palate. Two or ere made, duplicates of each other in the th, but varying in the palatine portion. One s is shown in Fig. 302. In this one, the sides terior or palatine portion have been cut away, a tongue extending down to the uvula; one of the s covered the whole palate, and in another the whole latine portion was cut away. When used to test articulation, one of them was painted with a film of chalk, wet up with alcohol so that it would dry quickly, and then intro-

Fig. 302.

duced into the mouth, and the sound to be experimented upon made as clearly and distinctly as possible, and the plate removed. If the tongue touched the roof of the mouth, the teeth, or the palate in any part, the white surface of the chalk was removed, exposing with the utmost distinctness the black surface in contact. The form of the contact in a given sound was delineated upon a clean plaster cast of the roof of the mouth, and the experiment continued with the same or some other sound. Those plaster casts were copied in the foregoing and following illustrations.

These experiments were repeated over and over again with the same sounds at different times and on different days, until uniformity was proved and the various plaster casts became a record of the exact position of the tongue in making these sounds. The separations of the jaws and lips were determined accurately by measurement, the varying positions of other organs by repeated observation and other tests, and all drawn to a uniform scale and here reduced. They are therefore consistent with each other. But it must be borne in mind that, even if it were possible to obtain absolutely accurate models of the organs of speech while in action, of any number of cases, it is not probable that any two of them would be exactly alike. It is not supposable that all persons in making the same sound place the active accessory organs —the tongue, palate, etc.—in the same identical position. Variations to a greater or less extent can be observed in every one. Exactly the same resonating cavity in *shape* is not likely to exist in any two jaws. With the fixed portion of any buccal cavity differing somewhat in form from every other, the changeable portions, such as the tongue and palate, adapt themselves to the circumstances and produce a resonating cavity of the same tone-character. The variations in the position of the articulating organs as seen in different persons in producing the same sound are then understood. So long as the integrity of the accessory organs is preserved a resonating cavity of like tone-character can be formed.

The limits of this chapter will not permit an analysis or explanation of the mechanism of all the sounds that combine to form articulate language. As it is intended solely for the English reader, no attempt will be made to describe such sounds as may form an important element of other languages, but which are not heard in any word in English. To a reader who is unfamiliar with a foreign language it is very difficult to convey, other than by vocal demonstration, an apprehension of those sounds which are peculiar to that language. Nor shall we undertake an investigation into certain nice distinctions of pitch, timbre, and tone, which would lead us away from our main object. We shall rather confine ourselves to the distinct sounds of the English language appreciable to nearly all ears, and represented by characters or letters. The difference between these is so well marked and the mechanism of their formation so positive that we can discover it, describe it, and illustrate it.

Articulate speech is made up of vowel and other sounds —pure, interrupted, or checked. The English language, like all other languages, is divided into vowels and so-called consonants. Authorities disagree as to the exact number of vowels for the reasons before given, and they also disagree as to the number of consonants. One reason of the disagreement is that some class all the sounds other than vowel as consonantal; others subdivide these, reducing the number of real consonants; and the disagreement is still further increased by the divisions not being always the same.

Again, there would be a difference as to the whole number of sounds to be called by any name. Accepting for the present the term *consonant* as including all sounds other than vowel, we find them classified as labial, dental, palatal, and nasal, each term bearing some relation to the locality in which the formative action takes place. There are various other divisions and subdivisions of consonants, making distinctions of great interest to the physiologist and phonologist, but which are also beyond the scope of our present purpose. These interruptions to the phonetic stream are of equal importance to articulate speech with the vowel-sounds, as the stoppage of a sound may become as distinctly associated with an idea and express it as the sound itself. This oral current, which by modifications, interruptions, and stops forms the consonants, is not a vocal stream like that of the vowels, but it is a breath-current driven from the lungs in the same manner, sometimes accompanied by vocal vibrations and sometimes not; nearly one half of the consonants are formed without voice, and are simply breath-currents of greater or less force, modified by resonance or interrupted by the accessory organs. Every breath-consonant in the English language has its associated vocal fellow; i. e., in every instance in which a breath-sound becomes an element in our language,

Fig. 303.

there is another element added by vocalizing a like breath-current.

There are three definite points along the vocal pathway

Fig. 304.

where the voice is brought to a complete stop. They are the posterior margin of the palate, the alveolar border, and the lips. Figs. 303, 304, and 305 illustrate these positions. In Fig. 303 the root of the tongue is brought into firm contact with the palate; in Fig. 304 the tip of the tongue is in contact with the alveolar border immediately behind the front teeth; and in Fig. 305 the contact is by closing the lips.

There is no better way of making a description of the consonants appreciated than by beginning with the simplest articulate sound of childhood.

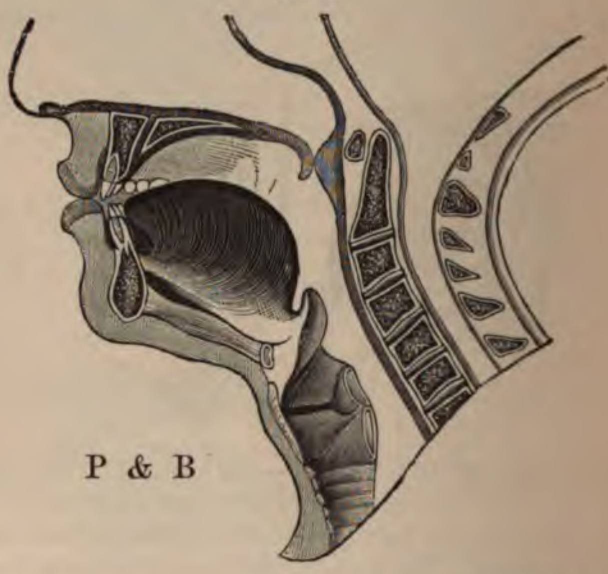
The first title applied to a parent is the easiest and most natural for infancy to pronounce. Papa is simply the sound of P joined to the vowel AH. The vowel-sound has been described; and, to produce the sound of P, we have only to

FIG. 305.

stop the sound of AH by closing the lips. In making the sound of AH (see Fig. 297) all the principal as well as the accessory organs are in their most easy, natural, and unrestrained position. The sound of AH is but the natural voice of the child flowing out of the mouth, when it is stopped by closing the lips and suddenly opening them to allow the force of breath-current to expend itself, and the sound of P is the result. It makes no difference whether the movement of the lips follows or precedes the emission of sound; the P lies in the act of closing and opening the lips joined to a vowel-sound. Repeat this shutting of the lips upon the sound of AH with sufficient rapidity, and we have *Papa*, the simplest and easiest word in the English language that a child can utter. (See Fig. 306.)

P is not simply a check or stoppage of a vowel; it must have an associated breath-current for its completion. If it follows or checks the flow of a vowel, the lips must be opened to permit the escape of a little puff of breath, or the P is not complete. When P begins a syllable this puff passes instantly and undistinguished into the vowel which follows.

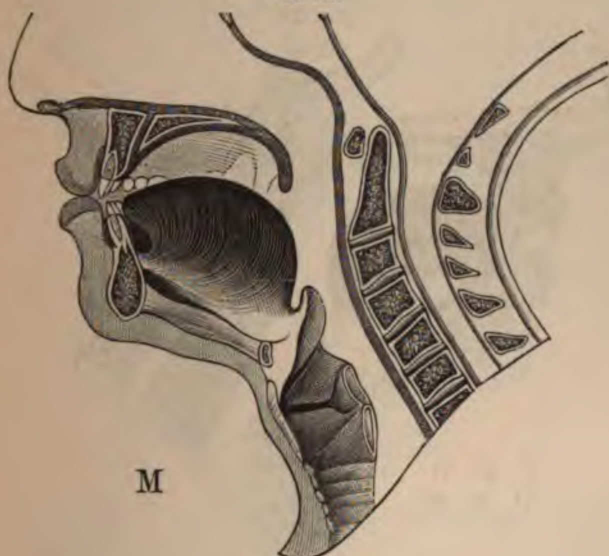
FIG. 306.



P is a breath-consonant, and its associate vocal fellow is B. Its formation is identical with that of P until the lips are closed, but after the closure the sound is not stopped, but continued in the buccal cavity, which is the distinctive characteristic of B. It is not important that the sound be prolonged after the closure of the lips, but it is essential that it be momentarily heard in the confined buccal cavity. As an experiment the sound can be prolonged, but only until the buccal cavity becomes filled with air, when it ceases. Like P, it matters not whether it precede or follow the vowel with which it is connected; its value is the same. B is a vocal consonant.

In the formation of both P and B (see Fig. 306) the palate and pharyngeal wall are in contact. Escape by way of the nostrils must be impossible, or the characteristic sound of B made by filling up the buccal cavity is lost.

FIG. 307.



Let the palate drop at the time of making B, and permit the sound to pass out at the nostrils, and M is the result. M is a vocal-nasal consonant, and its formation is identical with P and B in the closure of the lips, either preceding or following a vowel. Physiologically the difference between B and M lies solely in the position of the palate (see Fig. 307). We thus see that P is the result of the complete stoppage of a vocal stream by the lips; B is a stoppage by the lips, but the sound continued in the buccal cavity; M, the same stoppage of a vocal stream by the lips, but the sound directed through the nasal passages where it may be prolonged indefinitely. Any one interested in this subject can verify these experiments upon himself; indeed, it is almost a daily occurrence that we meet some acquaintance whose Ms are all turned into Bs, by a stoppage of the nasal passages from cold or otherwise.

These sounds are called labial because the lips are prin-

FIG. 308.

cipally concerned in their formation; the tongue does not necessarily come in contact with the roof of the mouth in their enunciation. The mechanism of their production is confined to the lips and palate, and any contact of the tongue with the roof at the time is only incidental and dependent upon the vowel-sound with which either of these consonants is joined. Thus in PAH or MAH there is no contact; but in PE and ME, the tongue will touch the roof at the sides, as seen in Fig. 301.

In considering the second class of consonant-sounds, termed *dental*, we may use another illustration from the child's vocabulary—TA-TA. This syllable is as simple as papa, and its only difference is that in papa the lips stop the emission of sound, while in TA-TA the vocal sound or vowel AH is stopped by placing the end of the tongue upon the gum immediately behind the front teeth, as shown in Figs. 308 and 309. The only physiological difference between P

Fig. 309.

and T is that the current is stopped by the lips in the first, and by the tongue in the second. In all other respects they are equal. Make the vowel AH and interrupt it rapidly as described, and we have the continued sound of TA-TA. In Fig. 309 we see that the conjunction of the tongue with the gum is not only in front at its tip, but extends the whole length of the alveolar border or dental arch. To make the sound of T, it must be in contact for this entire distance.

If the vowel-sound were made with the tongue in contact only at the tip, and the sound escaping at the sides, L would be produced instead. It is this entire contact and escape only at the tip which gives the peculiar sound of T. This sound will be more readily apprehended, perhaps, by placing it after the vowel, as in *at*. T we call a breath-consonant, the same as P, because the voice is not concerned in the formation of either. As we found B was the vocal associate of P, so do we find the vocal fellow of T to be D, and bearing the same relation. B was the filling up of the

Fig. 310.

N

oral cavity with voice while the lips were closed either at the beginning or ending of a syllable; so is D formed by filling up the contracted oral cavity with voice, while the tongue is in contact with the roof of the mouth, as seen in Figs. 308 and 309.

We see here, also, the palate and pharyngeal wall are in contact, preventing all escape by way of the nose, and the sound of D may be continued until it fills the oral cavity, when it must cease by limitation of space. But if now the palate be relaxed, so that the sound can escape through the nares, it may be continued so long as the lungs can furnish the power to vibrate the vocal chords, but it is no longer D, but N (see Fig. 310). The relaxation of the palate and pharyngeal wall change D into N, and, conversely, any enforced stoppage of the nasal outlet turns N into D. In my experiments I found that the surface of tongue-contact with the roof was greater in N than in T or D (see Fig. 311); but I attribute this to the fact that N can be more easily prolonged than either of the others, and the contact is

FIG. 311.

likely to become more general. This is probably more accidental than essential.

The third distinctly-marked point at which the vocal current is interrupted is the posterior part of the oral cavity, and, like the other two, its function is the making of three sounds—a breath, a vocal, and a nasal sound. Thus, when the extreme back of the tongue is brought into contact with the soft palate in front of and above the uvula, closing the passage to the mouth, and at the same moment the upper part of the pharynx is advanced to meet the palate behind, and stop egress by the nares, the organs are in position to make K or G. In the *cul de sac* thus formed above the larynx, the breath or voice accumulates. If breath only, the sudden relaxation of the tongue produces an explosion which is the sound of K. If the cavity be filled with voice until the relaxation comes, the sound will be G. These sounds are so intimately related that it is often difficult to distinguish between Ko and Go, when spoken by persons of loose habits of enunciation. The essential requisite of G is that

Fig. 312.

the sound be heard in the throat prior to its union with a vowel, or if it follows a vowel, as in *hog*, it must be made in the same way as above described. In Fig. 312 is illustrated the position above described. In my own case, I found that the tongue-contact with the soft palate was greater in making G than in K, and this is indicated in the illustration by a line showing the tongue at a higher elevation. The difference is also seen in two other views, Figs. 313 and 314. Neverthe-

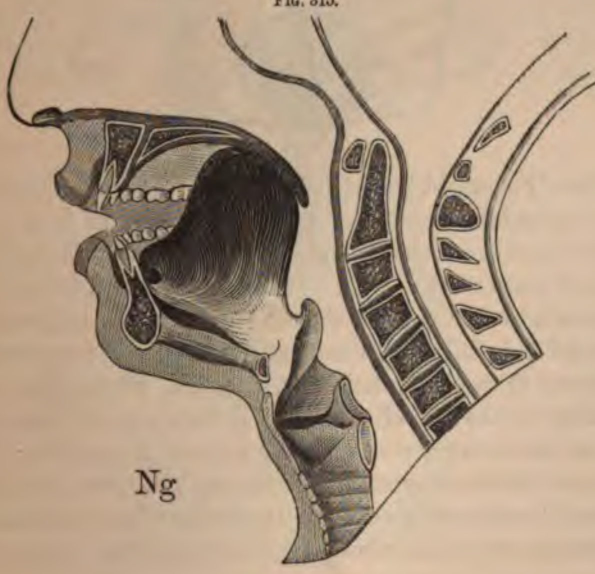
Fig. 313.

Fig. 314.

less, there is no physiological difference between them. A perfect G can be made with the limited contact of K.

The nasal sound of this group is NG, and is the result of

Fig. 315.

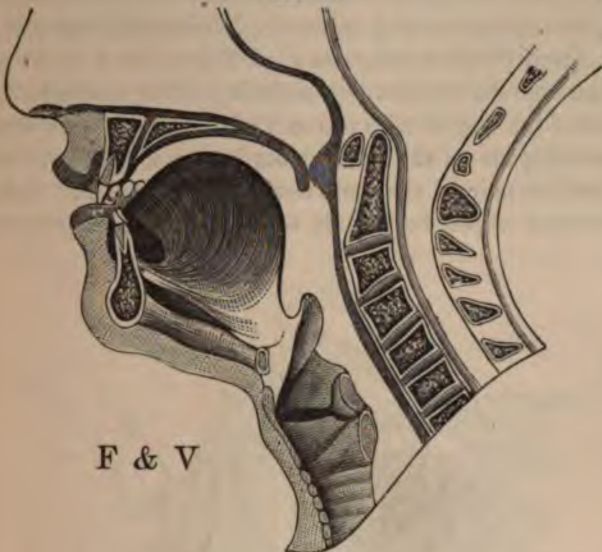


the relaxation of the pharyngeal wall, while the tongue and palate are in continued contact. The sound which would otherwise be G is thus nasalized, and becomes a distinct elementary sound, for which our alphabet furnishes no character, and the only method of expressing it is by the combination of N and G, this being the sound given when those two letters are combined. The surface contact is also greater, as shown in Figs. 315 and 316, but this greater contact is not essential; it is only incidental.

FIG. 316.

There is another class of sounds which form an important part of articulate language of a different character from those we have been considering, and which are made principally in the front part of the mouth. Instead of being interruptions or checks to vowel-sounds, they are continuous, and may be prolonged indefinitely. They are the result of a current of air driven through a small aperture, and are vocal or not, according to the sound desired. For example: Place the edge of the lower lip against the edge of the upper front teeth, and drive a current of air through between the teeth, or through a narrow aperture between the edge of the teeth and the lip, and F is the result. The termination of a vowel-

FIG. 317.



sound by a breath-sound in this manner forms a syllable with F, or the reverse; beginning a vocal sound by a breath-sound in this manner produces the same result. We can change F

FIG. 318.

into V by vocalizing the breath. The two are formed exactly alike; the current of air past the teeth being with voice in one, and without in the other. In Figs. 317 and 318 are seen the positions of the various organs during their production, the contact of the tongue with the roof of the mouth being limited to a small space on the alveolar border, near the back teeth.

Another pair of the same character is S and Z. S is one of the most important sounds of the English language, and

FIG. 319.

a defect in its enunciation is more noticeable often than any other sound. It is simply a current of air driven through a narrow chink, producing a hissing sound, the counterpart of which is frequently heard arising from a variety of causes outside of human speech. Place the tongue against the upper gum in the same way and position as when T is formed, but relaxing the end or tip and making a narrow passage for escape, as in Figs. 319 and 320. The sound of

S is formed by a current of air driven through this chink. Its corresponding fellow, Z, is a vocal sound, and is made with the tongue and other organs in exactly the same position; but the breath-current is vocalized in one, and unvocalized in the other.

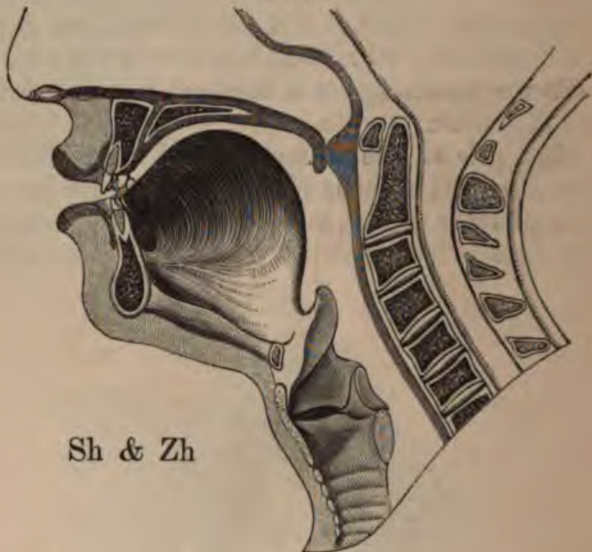
A third pair of like character is SH and ZH—SH as found in *hush*, ZH as found in *azure*. These are not combinations of other sounds, as of S and H, but distinct elementary sounds for which our alphabet has no separate

FIG. 320.

characters, SH being breath and ZH vocal. The aperture for these sounds is similar to that of S, but wider and higher up in the roof of the mouth, which seems to take away the sharp, hissing sound characteristic of S. (See Figs. 321 and 322.) There is considerable latitude in making this sound, and its pitch may be varied considerably without seeming to affect its importance. For example, the lips may be held as in P, or they may be considerably protruded. The advanced position seems to be the easier and more natural, but the result for purposes of speech is essentially the same.

A fourth pair of the same kind is found in the two

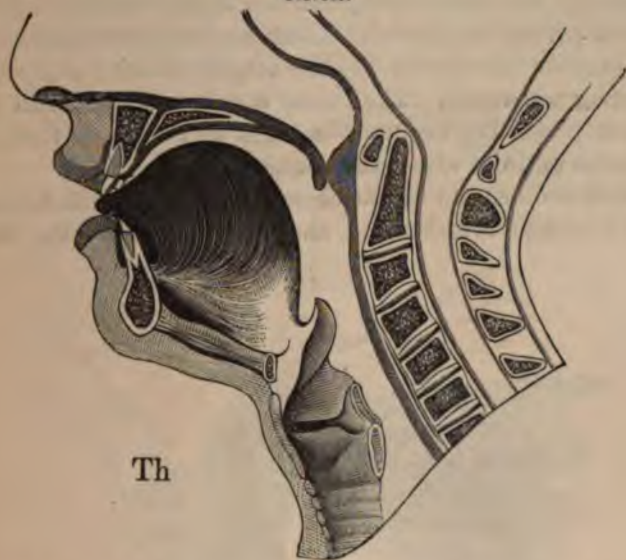
FIG. 321.



sounds of Th as heard in *thin* and *thou*, the former being breath and the latter vocal. In its formation, the tongue lies close to the gum against the back teeth, and the aperture in

FIG. 322.

Fig. 323.



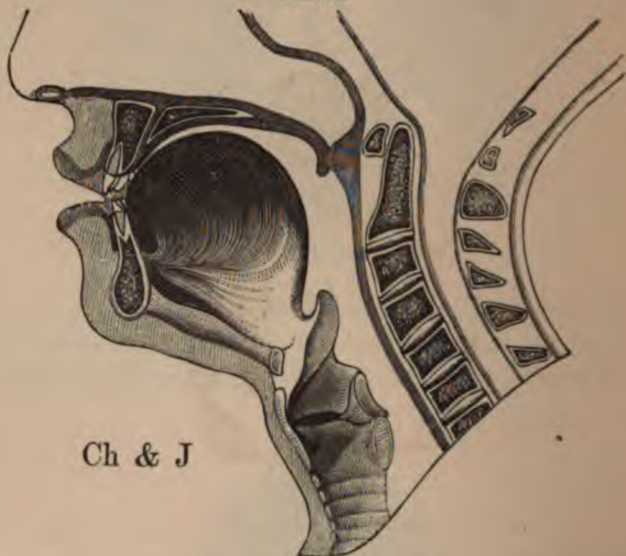
front is broad, similar to that in Sh, but the tongue is more advanced and lies closer to the front teeth and adjacent gum. (See Figs. 323 and 324.) In Fig. 324, the firm contact is

Fig. 324.

shown by the solid black, and the lighter contact by the shaded portion of the cut. There may be some latitude in the position of the tip of the tongue without materially affecting the result. The sound can be produced with the tongue projecting beyond the edges of the upper teeth, or retracted entirely within the dental border.

Still another pair of like character is formed with Ch and J; Ch being a breath-sound, and J its vocal associate. It is

Fig. 325.



Ch & J

claimed by some that these are not distinct sounds, but combinations of others already described, the former being made up of T Sh, and the latter of D Zh, but I found the tongue-contact to be higher up and farther back, as shown in Figs. 325 and 326, and therefore give them a separate description. Practically it is of no consequence whether they be distinct sounds or a combination; the mechanism is so nearly the same as to be difficult to decide.

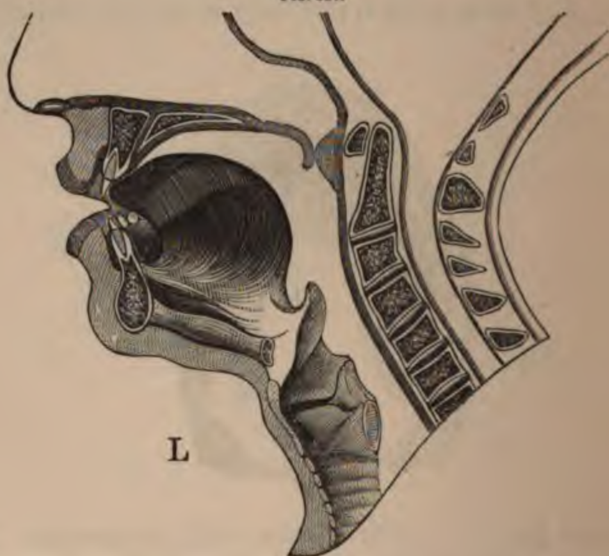
H, which usually remains unclassified, strictly belongs as much to the same group we are considering as F, S, or Sh. It is an aspirate (rough or hard breathing) made in the throat, and can not be specially illustrated. Its natural vocal associate is the vowel AH, and together they form a pair belonging to the class under consideration. In the minds of some, H seems to have been misapprehended in its formation and association with other sounds. It appears to be the result of forcing the breath sufficient to create an audible current of air prior to the vibration of the vocal chords, and nothing more. Any other value it may have is derived entirely by

FIG. 326.

resonance from the cavity or tube which it traverses. To produce the sound of H, there is not required any change in the position of the vocal organs from that which will admit of quiet breathing. For example, a whistle may be placed between the lips, and all the respiration may pass through it without audible sound; it is only when force is used to create more rapid vibrations of air that the sound is heard. H is the sound of an air-current without vocal vibrations, which sound is modified by resonance the same as the vowels.

This explanation of H is the explanation of the formation of whispered speech which by some has been considered mysterious. The only audible sound in whispering is that of a forced current of air; and the formation out of it of syllables and words is by resonance without voice, the resonating changes in the buccal and nasal cavities being identical with those when the vocal chords vibrate. It requires more lung-power to produce this audible current of air than it does to produce sound by vibration of the vocal chords when they are under tension, and for this reason whispering is more

FIG. 327.



tiresome than speaking. A little reflection will show that in whispered speech there can be no double consonants, such as we call vocal and breath consonants. Vocal consonants can not exist in true whispered speech; consequently, whispered language is deprived of eight elements which enter into articulate speech. Papa and Baba in whisper are the same, so are also Ko and Go, etc.

We have thus described all the so-called consonantal sounds of the English language save two, and arranged them in two classes, the first class consisting of three groups of trios, and the second class of six pairs. The two exceptions to this classification are L and R, both of which partake as much of the vowel character as the consonantal, and are usually called semi-vowels.

L is produced by holding the tip of the tongue in contact with the gum as in T, but relaxing it at the sides, and uttering through this passage the vocal current. In Fig. 327 this relaxation of the sides is shown by a lighter band across the tongue. In Fig. 328 this contact with the roof of the

Fig. 328.

mouth is seen to be only in front. L also receives some characteristic augmentation from the vibrations of the sides of the tongue as the current passes. Physiologically the sounds of L and D are so nearly alike that D is confined in the mouth and L escapes at the sides of the tongue, all the other organs being in the same position. Their near relationship is readily observed by the ease with which they are both sounded in words where they come together, as in "handle"; the L then takes the place of a vowel, the two sounds blending without the interposition of a vowel. During its production the palate and pharyngeal wall must be in contact, or the sound will be imperfect. Although not entirely destroyed, it will be nasalized by the escape.

In Fig. 329 is shown the position of the tongue in making the sound of R. The oral cavity at the time of the formation of this sound corresponds with that in the production of the vowel AH. In fact, many people sound R so slightly that it is little if anything more than the vowel AH. But the formation of R requires that the tip of the tongue should be

Fig. 329.

pointed upward and vibrated while the current is passing. With some the tip of the tongue is distinctly felt against the roof of the mouth during these vibrations; while with others it is below, as represented in the illustrations. Neither does it seem requisite that the tongue should be pointed to the same locality in the roof—it may be farther forward or farther back. The sound of R is produced by the rapid interruption of the voice, in the above-described manner, in the middle of the mouth. In some languages this sound is much more marked and distinct than it is generally made in English. With some English-speaking people it is an affectation of refinement to banish it almost entirely.

The foregoing explanation comprises nearly all the distinct sounds which form the English language. The sounds of the other letters of the alphabet not here named are either repetitions or combinations of those described, or are not so distinctive in their mechanism as to be illustrated by diagrams. For example, C is a repetition of K, or S, as it is used either hard or soft. G soft is the same as J, and W is

FIG. 330.

so nearly the vowel "OO"* that a diagram can not illustrate any appreciable variation. X is a combination of K and S, etc., etc.

The foregoing descriptions and diagrams are not advanced as the only method by which the different sounds they illustrate can be produced. They are nevertheless believed to be

* Bristowe says: "The sound of the English vocal *W* differs from the vocal *OO* mainly in the fact that the fundamental vowel-sound is produced in the larynx, and receives its coloring from the oral cavity; while the distinctive sound of the consonant, though also colored by the resonance of the oral cavity, is manufactured at the labial orifice."

the arrangements of the various organs which are universally found to be the easiest, and most in conformity with physiological function. As a scientific experiment, many of the sounds can be perfectly produced or closely imitated in some other way. For example, S can be made with the tip of the tongue curled backward in the roof of the mouth, T may be made with the tongue placed at various points, etc., and even musical instruments and machines can be made to produce vowels, and to a limited degree consonants. Children do not place their organs for articulation as the result of scientific teaching, but as the result (not the cause) of the effort to imitate the sound; and, as the action of the organs acquired in that way is almost universally identical, it proves the one to be normal and the variations abnormal.

I have adopted the usual divisions and designations of vowels, consonants, and semi-vowels, but it is a classification that will hardly satisfy any one who becomes familiar with the subject. Of the so-called consonants, nearly one half are not *consonant*—i. e., *with sound* (vocal sound) or *sounding with.* P, B, T, D, K, and G are called *mutes;* but B, D, and G are certainly not mute, nor are P, T, or K any more mute than F, Th, or others.

The table on page 457 shows a classification more in accordance with their mechanism. This table, proceeding from right to left, may represent the oral tube or cavity from the vocal chords to the lips inclusive, and the sections indicate the points along the line where the sounds are made or checked.

The following explanation of the mechanism of vocal articulation supposes the normal integrity of all the organs concerned, each fulfilling its natural function. In the production of all the vowel-sounds of the English language the veil of the soft palate is elevated and hugs the posterior wall of the pharynx. This is essential to the formation of resonating cavities of uniform tone-character. Consequently, if the palate be destroyed or congenitally absent, a new resonating cavity is exposed, and the tone-character of the buccal cavity is changed. These sounds can no longer be made in the same way, and in many cases can not be made in their purity at all. In some other languages, the French, for example, nasalized vowels and other nasal sounds form an important part of the speech, but when such sounds are introduced into the English they destroy its purity.

	Contact of both Lips.	Teeth and Lip.	Tongue and Teeth.	Tongue and Gum.	Tongue and Gum.	Tongue and Gum.	Tongue and Roof.	Tongue and Palate.	Throat.
Breath................	P	F	Th	T	S	Sh	Ch	K	H
Vocal.................	B	V	Th	D	Z	Zh	J	G	Ah
Nasal.................	M			N				Ng	
				First position.	Second position.	Third position.			

A dissertation on the mechanism of speech would be left incomplete if it were confined to articulation with normal organs alone. It is a remarkable provision of nature that in many cases destruction of an organ does not involve a destruction of the function performed by it, and this is notably the case with vocal articulation. The teeth may be suddenly destroyed, and at first the effect seems disastrous; but very shortly the lips and tongue accommodate themselves to the change, and the function of the teeth in articulation is nearly or quite regained. The palate, which performs such an important office, may be destroyed, and its loss compensated for in a great measure by an increased activity of the pharyngeal muscles and a new use of the muscles of the nostrils. The phenomena in abnormal articulation are often truly remarkable. In my practice of treating congenital and accidental lesions of the hard and soft palate, I have seen nearly every conceivable variety of deformity and have observed the phenomena. In congenital cases the absence of the palate is often compensated by an extraordinary use of other organs in a manner that would seem impossible. The inability on the part of some to make this compensation gives greater variety to the phenomena, so much so that it is quite impossible to declare by an observation of a defective palate without the aid of the ear what its effect is upon the individual's speech. Neither the size nor the extent of the deformity will determine the effect upon articulation because of this compensation by other organs. A few examples from practice will illustrate these points:

A lady, about thirty years of age, belonging to the higher grades of society, of intelligence and education suited to her station, came to me for treatment. The fissure of the palate was confined to the velum, the apex of the cleft reaching only to the edge of the hard palate. I wrote upon a slip of paper the following syllables: GO, KO, SO, HO, JO, DO, CHO, NO, TO, and repeated them on the slip several times promiscuously, and handed it to her to pronounce aloud as distinctly as possible. Of the whole list, HO, JO, and NO were the only ones that could with certainty be distinguished. All the rest were alike pronounced NO. No difference whatever appeared between her GO, KO, and SO. Theoretically, the S and CH were in her power to make perfectly, and D and J approximately, and K and G the only ones theoretically impossible. No amount of training from infancy had served to develop these sounds, which came to her only after the introduction of an apparatus.

In another case, of an Irish girl in the lower walks of life, nineteen years of age, with a fissure exactly similar to the foregoing, the same experiment was tried, with additional syllables of a more complicated character—such as ist, idst, ox, etc. This experiment was tried before the introduction of any instrument, in the presence of a number of surgeons, who were only governed by their hearing in determining her pronunciation. Every syllable was so distinct that it was not mistaken by any one. In this exercise the listeners were not aided by any knowledge of the syllable before it was spoken by the patient. The only criticism was the nasalization which, when she came to read or in conversation, made her speech disagreeable. Theoretically, her K and G should have been entirely wanting, but they were so clear that she was not mistaken in a single instance.

A third case was as follows:

A father brought his son to me—a young man of mature years, who had fissure of the soft palate only. I was not favorably impressed with the intellectual development of the young man. He seemed stupid, and had but little realization of his own condition. His speech was very bad—much worse than most cases where the fissure is no larger than his. His reading was a monotonous, half-idiotic sound, with but little distinction of vowels, consonants, syllables, or words. After two or three interviews I came to the conclusion that it would be hopeless to expect any improvement from him in the use of an artificial palate, and I frankly told the father that I could not encourage the undertaking. Upon being urged for reasons, I stated them as delicately as possible, as being based on what seemed to me to be defective mental power. But such an intimation was not to be listened to by the fond parent, who saw no reason why "his boy" should not have an artificial palate as well as any one else, as he was ready to pay for it. After a complete understanding by them of what would be necessary for him to do for himself after my work was done, I made and adjusted the appliance. Within the same hour after its introduction, I set him before me and directed him to imitate exactly every motion of my lips and every sound of my voice. After a half hour's training he enunciated every sound of the English language with all the distinctness and precision of one with well-formed organs. This he would do under my dictation, executing my will almost as if he had no will of his own. Not only sounds, but words and sentences were repeated with clearness and distinctness; and I began to repent the discouragement I had given them. But passing from my dictation, he dropped into his former habit of monotonous indistinctness, and I became less hopeful of ultimate results.

Another case was that of a young lady, sixteen years of age, unusually bright and intelligent, with fine musical and artistic taste. The fissure extended through both hard and soft palates to the base of the alveolar ridge. Externally there was a hare-lip, which had been operated upon in infancy. With this patient K, G, and S were impossible. By no effort could she make any sound approximating to K or G, and her effort to make S was a gurgle in the throat. CH was unattainable, as well as such combinations as ist, dst, ks, etc. So sensitive was she to the defect that she kept herself from society, and was growing morbid under her affliction. Realizing her utter inability to pronounce some words, she finally formed the habit of avoiding the use of such words in her conversation, and either used synonyms or expressed the idea by a differently constructed sentence. I constructed an apparatus for her, and three years afterward she read before the same company of surgeons before referred to. She had conquered every sound singly and in its more complex combinations except S, and this was still made in the throat. It was nevertheless made distinctly, and could not be mistaken for any other sound; but it was made improperly, and was wanting in the sharpness which characterizes S. K and G were perfect, and the former nasalization of the vowels had passed away.

An entirely different manifestation from any of the preceding was that of a man thirty-five years of age, who had double fissure of the palate complicated with double hare-lip. The lip had been very skillfully operated upon in early life. He had grown a heavy beard and mustache, and as the suture of the lip was on the median line the parting of the mustache was natural and graceful, and there was no external suggestion of any deformity. The intermaxillary bone had been removed, and all the incisor teeth, leaving a wide gap between the two sides of the maxillæ, covered in front by the lip.

Fig. 331.

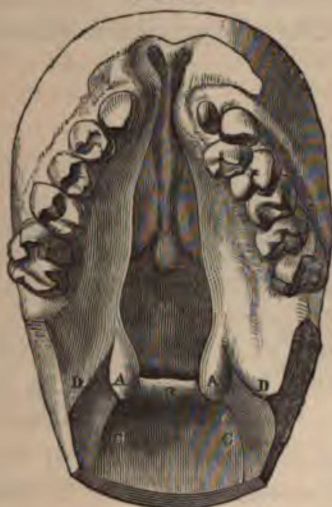


Fig. 331 represents a model of the mouth referred to. A A shows the bifurcated uvula at the extremity of the remnants of the soft palate, which is here shown as drawn up under the action of the *levatores palati*. B is the superior pharyngeal constrictor, drawn forward and in contact with the uvulæ. C C shows the palato-pharyngeal muscles, the borders of the pharynx, and D D the palato-glossus. The vomer and turbinated bones are seen exposed in the anterior part of the nasal cavity.

In this case, the sounds of TH, T, D, S, Z, SH, ZH, CH, and J were entirely wanting. His speech was so bad that in giving him a passage to read before an audience not a word of all he read was understood by his hearers; and yet this man could pronounce the sounds of K and G with the utmost clearness and distinctness, not to be misapprehended or misunderstood. The phenomenon was a mystery to me until, in my further experiments with him, I discovered that he brought the root of the tongue and the advanced pharyngeal wall into contact. The absence of so important an organ in normal articulation was here compensated for by a little greater activity of the pharyngeal constrictor and the tongue.

Fig. 332.

This action of the superior constrictor of the pharynx could be very plainly observed by tickling it with a camel's-hair pencil when the patient's mouth was open, when it would develop into a strongly marked ridge or cord horizontally across the pharynx.

The formation of a *cul de sac* above the vocal chords, essential to the production of K or G without the interposition of the palate, is shown in Fig. 332. The sounds of T, D, etc., were impossible because the necessary obstruction to the tongue in their formation was wanting, and art must be resorted to, to supply a barrier.

Altogether the most extensive deformity of this kind, and the one having the most disastrous influence on the speech that I have ever seen, was a young man upon whom Professor J. L. Little, of the College of Physicians and Surgeons, New York, operated for compound hare-lip, and who afterward came into my hands for an artificial palate. The patient was nineteen years of age, and up to that period no operation had ever been performed upon the lip. The deformity was horrible. The intermaxillary bone with its integument was suspended from the septum of the nose nearly at its tip, and behind it there was no upper lip whatever. There was no roof to the mouth from front to rear; the gap was the widest I had ever seen. So also was the distance across the jaw from the outside of the molar teeth, and the distance between the canines, the greatest I have ever measured. Dr. Little was very successful in his operation on the lip, removing the deformity entirely. Previous to the introduction of an artificial palate, the following-described experiment was tried in the presence of a number of well-known surgeons: I wrote upon a slip of paper the following syllables, which the patient pronounced to the best of his ability, repeating each one several times: BO, SO, TO, HO, MO, FO, KO, PO, GO, DO, ZO, JO, NO, VO, CHO, THO, SHO, RO. The sound given by him to each of these syllables was written by the gentlemen present as nearly as they could be understood. A comparison of the various records showed that the only unmistakable syllables of the whole list were KO, GO, and HO—all throat-sounds. Of the doubtful ones, NO and MO were interchangeable, and so were LO and RO; and, of all the others, no sound that he gave was any clew to the syllable he was trying to pronounce. The explanation of his inability is not difficult. It was quite impossible for him to make the labial sounds when he had no upper lip, and, in the short time which had elapsed since Dr. Little's operation, he had not learned to use it; and the absence of any alveolar ridge in front prevented the formation of all dental and other sounds made in that locality.

One of the most peculiar features of this case was the production of K and G. In all other cases of similar character the action of the superior constrictor of the pharynx could be seen when irritated and examined, but I could excite no visible action in him, and to ascertain where the conjunction was which formed those sounds I tried the following experiment: Pulling the tongue forward, I painted the back wall of the pharynx with some chalk and water and required him to articulate K or G; and then pulling the tongue again forward, the contact was marked by a transfer of the chalk to the tongue, but at a lower point than I had ever seen before in any person. It was not the superior constrictor, but the middle constrictor, which was in action, and at a point a little above the glottis.

The foregoing examples are sufficient to illustrate the variety of phenomena observed with congenital cleft-palate people.

In cases of such persons as have lost the whole or a portion of the palate by accident or disease, the result is an immediate convincing proof of how articulation is normally accomplished. Any considerable perforation or loss of the roof of the mouth makes recognizable speech impossible. Such people, after a time, overcome some of the difficulties, partly by a use of the nasal constrictors and partly by an increased activity of the pharyngeal constrictors. But as these lesions generally occur in adult life, the sufferers rarely acquire the same facility seen sometimes in congenital cases. Nevertheless, a simple apparatus filling or covering the perforation restores normal articulation immediately.

PART V.

THE ÆSTHETICS OF DENTISTRY.

CHAPTER XX.

ART CULTURE IN DENTAL PRACTICE.

The title of this chapter may suggest to some the discussion of only ideal or imaginative subjects. Its object, however, is no mere poetic exaltation of dentistry, but rather a treatise on a preëminently practical branch of mechanical surgery.

"In no department of dental practice does the want of that taste which indicates artistic culture become so manifest as in the failure to restore the natural expression by the replacement of lost dental organs. It is unquestionable that the majority of the profession, engaged in this branch of practice, have given more thought and labor to the best methods of restoring impaired functions—securing comfort, usefulness, and durability in artificial dentures—than to the equally important question of correlation of the substitutes with the general physical characteristics of the patient. To this account are to be charged the unseemly incongruities constantly staring the observer in the face from mouths whose lost organs have been replaced in disregard of this universal law. No matter how anatomically correct, or how skillfully adapted for speech and mastication, an artificial denture may be, yet if it bear not the relation demanded by age, temperament, facial contour, etc., it can not be otherwise than that its artificiality will be apparent to every beholder.

"This law of correlation—harmony—running through nature, attracts and enchants us by an infinite diversity of manifestations; the failure to recognize its demands by art is correspondingly abhorrent to our sensibilities. In the social gathering, a lady who appreciates the law of harmony delights the eye by the taste displayed in her attire; another, though more elaborately and expensively adorned, yet failing to harmonize the details of her costume, attracts attention only by the impression of incongruity. We hear frequently from a lady who is selecting a bonnet, or from a gentleman purchasing a hat or other article of wearing apparel, the question to a friend, Does this become me? the query indicating the recognition that, however exquisite the material or excellent the manufacture of the article, a certain law of fitness prevails, the failure to comply with which makes the wearer appear ridiculous. We meet in the street one the color of whose hair we expect, by the law of association, to be fair or sandy; and, if otherwise, a wig or a dye is instantly suggested.

"There is a relation between the physical form and the voice, from which we are led to infer in advance the character of the tones which from any given individual may be expected. This law of association, in any case, having led us to anticipate a bass voice, the anomaly, should a falsetto greet us, is almost ludicrous.

"So, not to multiply examples, the dullest observer learns instinctively the demands of this great law of correlation. The artist's success depends upon the extent of his perception of it. The botanist esteems it a guide-post in his investigations. The comparative anatomist regards it as a fundamental principle. The scientist, in every direction of research, knows its importance. To the dentist, the extent of its recognition determines his status as a mere mechanic or an artist.

"A broad, square face, or an oval; a large, coarse-featured man, or a delicately organized woman; a miss of eighteen, or a matron of fifty; a brunette or a blonde—these and other varieties present as many differing types, with teeth, in size, shape, color, density, etc., corresponding. If, then, teeth correlated in their characteristics to those which nature assigns to one class be inserted in the mouth of one whose physical organization demands a different order, the effect can not be otherwise than displeasing to the eye, whether the observer be skilled in perception, or intuitively recognizes inharmony without understanding the cause. A careful observation and record of these distinguishing characteristics—correlations—would go far toward establishing prosthetic and æsthetic dentistry as 'exact' sciences. There is as rich a field thus opened, and as worthy of culture, as those which are attracting so many to microscopic and other investigations of the tissues; an opportunity as promising as that which incites others to perfection in structural prosthetics; and a reward in professional status and pecuniary remuneration, not less deserved than that which is accorded to superiority in any other branch of practice." *

Theoretically, dentistry is a science and an art. Practically, to a very great extent, it has been empiricism in place of science, and bungling mechanism in place of art. Nevertheless, it has established its claims to be a science by its investigations, and by its organized system of practice; but, as an art capable of taking rank as one of the fine arts it seldom finds an advocate, and still more seldom a practitioner. The dental surgeon assumes for his department a position of superiority, and consigns the other to the workshop, where the only idea of art comprehends ordinary mechanics. As a consequence, artistic dentistry has never risen, except in rare individual cases, to anything above mechanical dentistry, and the very term by which the department is known is used as one of reproach. In every assemblage, public or private, on the street, in the drawing-room, or wherever we may turn,

* Dr. James W. White, "Dental Cosmos," 1872.

we see displayed the disgraceful productions of these dental mechanics. It becomes a serious question whether the *art of dentistry*, aside from some methods in operating on the natural teeth, has, with all the inventions and improvements of the last decade, made any advance. The operative department has assumed to be the department *par excellence* and *per se*, and we see the results in the education of a new professional generation, who ignore any knowledge of prosthetic dentistry as unworthy their talents; not realizing that a mastery of all its elements will do more to perfect their skill even in the one department, than any other course that could be pursued.

It can be demonstrated beyond a peradventure that these ignored and despised branches of dental practice are capable of high idealization, taking rank with sculpture and other branches of fine art; capable of appealing (though in a more limited manner) to the same sentiments and emotions, and requiring for their expression the identical talent and imagination which characterize the sister arts. With the ancient Greeks, all works which exhibited skill were called works of art, and to the present day the term art, in its broad signification, is applied to every skillful physical or intellectual performance. In this sense, music, poetry, painting, sculpture, architecture, dancing, oratory, medicine, and surgery are equally arts.

In this broad sense every operation in dentistry is an art. But as the arts have multiplied, terms of distinction have become necessary; as fine arts and mechanic arts, with all their subdivisions. All that ministers to the æsthetic sense, stimulating the imagination, belongs to the fine arts; all that contributes to the physical comfort, and the utilitarian progress of mankind, we class as mechanic art.

The mechanic arts may demand consummate skill for their execution; they may require for their development rare inventive faculties, and their combinations of mechanical principles and powers may be truly wonderful; but their individual works require but little effort of the brain in their reproduction. Education in skillful manual labor, without the capacity to originate a single new idea, is all that is required. The laws which govern their reproduction are those of mathematics, and to be able to copy a given form with exactness is the sum of the talent required. They may be directly of more practical value to mankind, but they make no appeal to the finer emotions of our being. In all that excites the imagination, that calls into action the affections, or leads the mind away from the contemplation of the material and sensual, they are dumb.

The ideal arts, on the contrary, furnish this gratification, and wheresoever art falls short of this requirement it can make no higher claims than that of mechanism. For illustration: It is easy to conceive, in this day of cunning workmanship, that it would be possible to make out of cast iron an artificial denture—teeth, gums, and base of the same metal—which would fulfill perfectly all the utilitarian requirements of such an appliance. It might be accurately fitted to the jaw, and admirably articulated with the antagonizing teeth. For comfort in wearing, and for power of mastication, it would be all that was desired, and yet it would not have one element of dental art in its construction. It would be purely a mechanical performance, and come under the head of dental mechanics.

In that common and every-day operation in dental practice, called "taking the bite"—particularly when there is an entire upper and under denture to be supplied—there is required, for its highest success, a talent far greater than that exercised by the sculptor upon the same limited locality. Aside from the inherent good taste, or appreciation of the beautiful, on the part of the operator, there must be some knowledge of physiognomy, of facial expression, of the harmonious relations of one feature with another, and of symmetrical proportions; besides the judgment to decide upon the best method for purposes of utility. All the details in making an artificial denture, such as taking an impression, making plaster casts, making dies, swaging plates and fitting them to the gums, are all purely mechanical processes. All these may be perfectly carried out by one who has no appreciation whatever of the beautiful, of harmonious proportions, colors, or sounds; but, in the one process of taking the bite —no matter whether the plate or base is gold, silver, platina, or gutta-percha—none but an artist can go through its various stages successfully.

Dental practice, by an inherent law and by common consent, is divided, in the main, into two departments: one, commonly termed the "operative" or "surgical," which is made to include all efforts for the preservation of the natural teeth, and all surgical operations in the buccal cavity; the other, called "mechanical" (but in place of which I much prefer "prosthetic," as more appropriate), includes the making of all appliances for the correction of deformities of the buccal cavity, but principally the making and inserting of artificial teeth. In the practice of surgical dentistry, as has been before intimated, there has grown up an unwarrantable assumption that all that was refined and cultivated, all that was worthy the exercise of our noblest faculties in the pursuit of our profession, was to be found in this department, and that mere mechanics, wholly unqualified by education in science and art, were deemed capable of practicing the other. The only performance of surgical dentistry which requires a talent and skill equal to the mechanic arts is the introduction of fillings into the cavities of decay, and this skill is mere manual dexterity, guided by good judgment; its highest achievements at the present day are in the so-called contour fillings made of gold, in which an attempt is made to restore the form of a tooth injured by accident or decay.

Every tooth has an individual character and expression, not only in harmony with every other in the same mouth, but by the same divine law, when in a normal condition, in harmony with the features and character of the creature, be he animal or man. These physical characteristics are so marked and prominent that the merest novice has no difficulty, as a rule, in locating any human tooth that has been removed from its fellows; and yet, of the attempts at restoration of any large portion of the crowns of teeth by dentists, there are few that bear any very close resemblance to the original form of the lost part. If a cast were taken of these restorations, and examined separately, how few would identify them as being any portion of any tooth! The cusps, the depressions, the sutures, the easy and graceful outlines, and all that marks the individual teeth, are wanting. With the same portion of a natural tooth, even duplicated in another material, as a perfect copy in plaster, there would be no hesitation in identifying its locality with a tolerable certainty; but a cast taken of many a restoration would not be suspected of its original application.

The skill, therefore, exercised in every operation on the natural teeth is purely mechanical, and in æsthetic culture bears no comparison with its associated department. No performance of the dentist can make any pretension to be a fine art, *separate and distinct from all others;* but, as a subdivision or specialty of one of the arts, dentistry is entitled to a consideration which it has never received.

Prosthetic dentistry, as an art, is a department of sculpture. *Form* in individual members, *form* in grouping and arrangement, and *form* as a medium of expression, are equally the distinguishing characteristics of both sculpture and dentistry. Every effort of the brain in the production of a statue is spent upon the clay model. It is this which the artist studies, and, as he knows that every variation of the form changes the expression, and that expression is a key to the character, so does he bend with all earnestness to every detail, building up here and depressing there, swelling out this muscle and relaxing that, until in satisfaction his work is consummated. This model in clay is the end of the artist's labor; the mechanic now takes it out of his hands, and every succeeding operation, until it appears the finished marble, is only one of mechanism. In like manner, the conception and execution of a properly devised artificial denture admits of the work of the artist and of the mechanic, with the line as distinctly drawn.

In the construction of an artificial denture everything that relates to its appearance belongs to art; everything that affects its utility is controlled by mechanism. It is not only possible, therefore, but very common to see artificial teeth that are worn with great comfort, and may be as serviceable as any that can be made, and not a single element of true art has entered into their construction. The adaptation to the jaws, and the articulation for masticating purposes, in these days of plastic materials, involve no skill beyond that possessed by many a mechanic; but the form and color of the teeth selected, their arrangement with each other, and the adaptation of the whole to the demands of the unimpaired features, present an appearance which is a grim satire upon dentistry as an art.

Reference has already been made to the knowledge, skill, and good taste required in "taking the bite." This process is, in fact, the very first step in making an artificial denture which calls for æsthetic culture. Its mechanical details are very simple, but its possible artistic results are wonderful.

With the trial-plates, of whatever material, adapted to the gums, a very simple method is to take some small blocks of any soft wood, say a half inch in length and width by less than that in thickness, and secure them to the trial-plate in the locality of the bicuspids. It will be found more convenient to place the side of the wood, and not the end, in contact with the plate, as it will be easier to split off shavings or chips when placed in this way, and thus reduce on trial any unnecessary height. For sticking these blocks, a preparation of common rosin two parts, and beeswax one part, will be serviceable. One block will be required for each side of the upper plate, and also one for each side of the lower, and the blocks of each plate must be so placed as to antagonize with the blocks of the opposite plate when all are in the mouth. The plates may be then adjusted and some estimate made of the probable required length, or rather height. These will be likely to be too long, but can be readily reduced as before indicated; when the result is approximately reached, a rim of soft wax may be formed on each plate. Common beeswax, or wax with some paraffine added, will be easily manipulated. The plates must be readjusted to the mouth, and the patient directed to close the jaws until the blocks come in contact; after which, in the mouth and out of the mouth, as is most convenient, the external form of the wax will be so manipulated as to produce upon the external features the desired contour and expression. The author attributes so much importance to these mechanical details, and in his own practice intends to be so very precise in the results, that he rarely requires another sitting from the patient for the purpose of "trying in the teeth," before they are completed. Even for the greatest utility of the piece, without any reference to its artistic appearance, all the time and care should be here given that is required to insure absolute precision of length and fullness, and these steps can be so carefully conducted that, on the final adjustment of the completed dentures, not the slightest alteration in the articulating surfaces will be necessary. But in an artistic view this sitting of the patient is the all-important one; for, as before stated, the wax must be worked up to the exact contour of the completed denture. It will not do to leave it to the guesswork of an assistant, or to the half-forgotten memories of a hurried observation. The artistic effects must be produced in the wax and retained in the duplicating denture, and this can not be done at lightning-speed. It requires calmness, deliberation, and repeated trials of the wax forms. The author has in many instances spent a half day over one patient at this important sitting, and been rewarded with an ultimate result that not only gratified himself, but the patient and the friends.

During this process but little aid can be obtained from the patient, by an anxious coöperation or by any suggestions. It is far better that the patient remain in ignorance of the importance of this sitting. The attempted and well-meant efforts of the patient generally end in failure to the operator, and, if this coöperation is discovered, it is better to adroitly lead the mind away to the contemplation of some other subject. Patients under these circumstances have a most perverse way of doing just what neither they nor the operator desire. Therefore it is that a result which shall determine final precision can only come in the mind of the operator from repeated adjustments, and with some movements of the mouth and cheeks to show muscular action and expression. Before the dismissal of the patient, the center of the lips, and also the line of their parting, should be marked on the wax; and, in the final arrangement of the teeth, it is preferable, as a general rule, that the cutting edge of the superior central incisors correspond with the line of the separation of the lips when in repose. This will always insure the exposure of the teeth when the mouth is in action, without presenting them unduly.

After the bite is completed, the immediate subsequent steps can be conducted by a skilled mechanician, and will vary somewhat with different individuals; but the instruction in that branch of mechanics is already so ample in various text-books, that it is unnecessary to follow it. We will rather turn back and again consider the same process, but solely from the æsthetic aspect.

In the patient before us we find a countenance deformed by the entire loss of the teeth, superior and inferior; alveolar processes more or less absorbed, wasted and unsupported muscles, sunken cheeks and lips, and a nose whose cartilaginous portion has lost its hereditary character. With the wax and props between the jaws, as before described, the first step will be to decide upon the profile. This is not only primary in the order of the work, but it is of primary importance. It is the central point around which all the modeling revolves, and becomes the standard which governs all the other features. The profile well chosen, all the other features will be made to harmonize with it, and according to the profile will correspond in form the beauty of all the other features. No face was ever repulsive where the profile was beautiful, and no face can be made beautiful where the profile is ugly. This outline can be determined better by having some standard of beauty in the mind as an ideal toward which we are working. This idea of a standard, or typal face, is not a mere whim of the fancy, which allows each individual to select, construct, or adopt such a one as his refined or perverted taste might choose, but it is one which belongs to a perfectly balanced intellectual and physical head—one which, in its elements and characteristics, is not uncommon in nature at the present day, and one which existed and has been accepted as such from the earliest historic times.

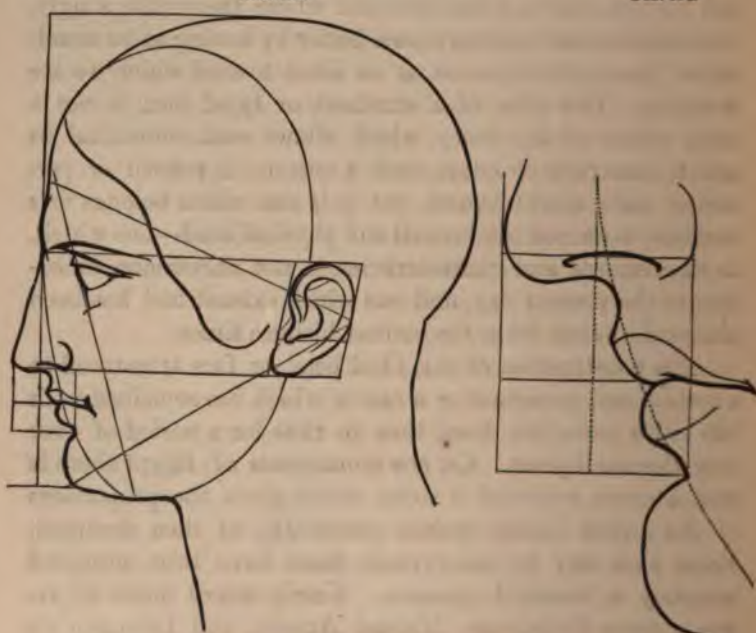
The construction of this ideal head or face is reduced to a system and governed by a canon, which has remained with but little variations from time to time for a period of over four thousand years. On the monuments of Egypt there is such a canon recorded in stone, which gives the proportions of the entire human system externally, as then accepted. From that day to the present there have been proposed probably a hundred systems. Nearly every artist of renown, from Polycletus, Michael Angelo, and Leonardo da Vinci, down to our contemporaries, Page and Story, has suggested slight variations. But through all this criticism of the whole figure, the proportions of the individual features of the face and head have remained substantially unchanged.

The following system for drawing the profile head is taken from Wiegall's "Art of Figure-Drawing":

"First draw a vertical line, equal in length to the height of the intended head, and then draw two straight lines at right angles to it, at its extremities; these two horizontal lines will touch the top of the head and the lowest point of the chin respectively. Divide the vertical line into four equal portions (see Figs. 333 and 334).

"The first portion marks the vertical distance between the top of the head and the front roots of the hair;

FIG. 333. FIG. 334.



"The second, that from the hair to the root of the nose (between the eyes);

"The third, the length from thence to the bottom of the nose;

"The fourth, that from the bottom of the nose to the bottom of the chin.

"Bisect this fourth portion, and the point of bisection determines the lower point of the under lip.

"Again, divide this last part (i. e., from the nose to the front of the under lip) into three portions:

"The lowest portion determines the thickness of the under lip;

"The next above determines the thickness of the upper lip;

"The uppermost, which is rather longer than the middle one, determines the distance between the nose and the upper lip.

"These points being determined on the vertical line, next draw between the horizontal lines, but touching only the lower one, an oval, the larger diameter of which, being vertical, is to be equal to the length of the vertical line from its top to the point marking the opening of the mouth or the top of the upper lip, and its lesser diameter equal to three fourths of the larger, and let it be placed so that the extremity of its lesser diameter may touch the vertical line a little above the point marked for the roots of the nose. If this oval be carefully drawn, in its course it will pass somewhat behind the front opening of the mouth and the middle of the upper lip, and through the commencement of the chin under the lip; it will determine the angle of the under jaw (not its course); and it will pass through the center of the ear.

"From the point on the vertical line opposite the upper lip, draw a straight line perpendicular to the vertical, and meeting the oval; the bisection of this straight line will give the commencement of the upper lip.

"The projection of the nose before the vertical is nearly equal to the distance from the bottom of the nose (where it intersects the vertical) to the opening of the mouth.

"The vertical dividing the nose equally, the width of the wing of the nose is equal to its projection in front of the nostril.

"If a straight line, parallel to the vertical, be drawn somewhat behind the wing of the nose, and intersecting the oval below the under lip, the point of intersection is the commencement of the chin.

"The length of the mouth is equal and parallel to the projection of the nose before the face.

"The length of the ear is equal to that of the nose, and its place is found by its center being in the oval (distant at the length of *two* noses from the facial line); therefore, by its being parallel with the nose, and equidistant from the top of the head as the nose is with the nose.

"The highest part of the head lies immediately over the top of the ear.

"A line drawn from the middle of the forehead to the middle of the chin will give the inclination of the eye, the position of which is further determined by the top of the eyelid being opposite the root of the nose.

"And if upon the straight line, drawn from the middle of the back of the ear to the middle of the forehead, an equilateral triangle be drawn, its vertex determines the point of the chin."

A comparison of a few leading types with this ideal profile will enable us to make a better application of the knowledge to the practice of dentistry. Fig. 335 is a drawing of the head of the Apollo Belvedere, a masterpiece of Greek art, which has been accepted as a standard of male beauty for hundreds of years. The object of the artist in the representation was evidently the portrayal of the highest type of physical rather than intellectual beauty, and the character of this deity gave him abundant opportunity. The general line of the forehead and nose is the same. In many of the Greek statues it is a single straight or nearly straight line from the tip of the nose to the top of the forehead, and it is this line that forms the distinctive characteristic of the Grecian profile. But the parts to which special attention is called are the nose, mouth, and chin. None of these features will admit of any material modification without detracting from their beauty. Fuseli, a celebrated lecturer on art, said: "Shorten the nose of the Apollo by but the tenth of an inch, and the god is destroyed." Observe, therefore, the relation that the nose bears to the upper lip, and also the relation of the upper to the lower. The nostrils take the general direction of the mouth; were they to be raised at their posterior boundary, it would give the face a sneering and contemptuous look; or, were they drawn down, it would give a surly and morose expression. The relative proportions of the features are substantially the same as those adopted by all artists. The chief elements of beauty are, a

FIG. 335.

FIG. 336.

short, finely curved, and prominent upper lip; a full, round, but less prominent lower lip; and a strongly marked depression at the base of the lower lip, giving roundness and character to the chin.

The next illustration, Fig. 336, is that of another Grecian divinity, a head of Medusa. In many respects it is the most remarkable female head I have ever seen. The analysis of this profile shows that it possesses the same general characteristics; and these characteristics of the lower part of the face are elements of beauty wherever found. Thus, while at the present day the pure Greek type is very rarely seen, we nevertheless do see, in all handsome profiles, very much the same outline in the lower part of the face that has been indicated; the variations being in the upper half of the face, and not in the lower.

An additional illustration is shown in Fig. 337, a drawing from life of another type of profile of not uncommon occurrence. Indeed, if I were to describe the American type, I should be as much inclined to give that name to this form of features as to any other, it being quite as universal as any other type which is distinctive, and which possesses the elements of beauty. The proportions are much the same as in the preceding illustrations, and, to a considerable extent, the

Fig. 337.

Fig. 338.

characteristics of beauty in the lower part of the face are the same. I present here another drawing, Fig. 338, of the same face some months after the loss of the upper and lower teeth, and here we mark the beginning of that deformity which it is our duty to remedy. The mouth is sunken, the lips compressed, the end of the nose flattened, the nostrils drawn down, and the whole line of beauty in the lower part of the face gone. It will be interesting to follow this development a little further, and Fig. 339 is another drawing of identically the same face in all the minutiæ of detail, except the region around the mouth. Here is exhibited that wonderful transformation from youth and beauty to age and ugliness; and all those peculiarities which were noticed in the earlier stages are still more strikingly developed. The last drawing shows the face shortened a quarter of an inch in the life-size, and yet that very limited change throws the whole out of balance. It is now in the power of the dentist to remodel this face, and it is important to carefully consider whether any greater improvement can be made than simply restoring the features to their original form and position. I think the more it is studied, the more certain will be the conclusion that the original form in this case harmonizes better with the upper features than any change it is possible to

FIG. 339.

make. I experimented upon the patient from whom these illustrations are taken, and found that any material variation from the original form showed a want of correspondence between the lower half of the face and the upper.

In contrast with this last, let us examine one of the ugly developments of nature, and one in which, when the change that we have been considering takes place, and which we call deformity, we find is really a step toward comeliness. This face, Fig. 340, will be readily recognized as a type of many, and one which, at first glance, seems to have hardly a redeeming feature; and yet, when analyzed, it is only the lower half of the face that is decidedly ugly. It is only the cartilaginous and movable part of the nose, together with the two lips, which give this beastly look. The forehead is not bad, neither is the chin. It is worth considering what can be attempted here for improvement. To make a mouth like the mouth of the Apollo would be impossible. Such a mouth, in conjunction with other features, which we can not alter, would only be making a deformity of a beautiful individual member. There is, however, no danger of committing such an error; the features can only be manipulated to a limited extent. But we can depress the lower end of the

FIG. 340.

FIG. 341.

nose, raise the nostrils, retract and shorten the lips, and shorten and improve the face by raising and advancing the chin. Instead of attempting, in a case like this, where all the teeth have been lost, and the alveolar processes absorbed, to restore the features to their original position, as we would in a former illustration, we should study to avoid that, and at the same time study to avoid the appearance of a sunken mouth. Fig. 341 will show such a result. It is the same face as in Fig. 340, but with the chin raised a quarter of an inch. The advantage gained is decided; in the former case the same process produced deformity.

But we do not always get improvements by the absorption of processes and the retreating of lips. It is not uncommon to find the upper lip less prominent than the lower, and that, too, when the teeth are fully developed underneath. In such a case it is manifestly desirable, if the free movement of the muscles of the upper lip will permit, to advance it to the line of beauty.

The movements of the mouth must also be carefully studied, for it is possible to produce a most desirable change to be observed when the mouth is in repose, but when seen in action the expression from overstrained and unduly taxed muscles is disagreeable. In modeling, therefore, great respect must be paid to expression, for a pleasing expression is of far more consequence than a scientifically beautiful outline or contour. This leads very naturally to the steps to be followed subsequent to the establishment of the profile.

The extraction of the canine teeth, with their long roots, destroys the expression of the face more than that of any other teeth. The roots of these teeth support the wings of the nose, and, when extracted, allow that feature to be disagreeably drawn down, together with the formation of a deep wrinkle immediately behind it. The wax model will require in many cases to be well carried up at this point, or this feature will not be restored. But avoid making the crowns of the canine teeth too prominent. These crowns lie under the corners of the mouth, and there is hardly anything more disagreeable than to see the corners of the mouth strained when in repose, or revealing when opened two tiger-like fangs. Be careful also not to strain the upper lip so that its beautifully curved line is obliterated, and the mouth present only a straight incision.

Preserve also the groove which should indicate the median line below the nasal septum, which is also a mark of beauty. With the lower lip, also, use the utmost care that only its edge be advanced, and that it be entirely undisturbed at its junction with the chin; and, if possible, at the corner of the mouth let the lower lip fall within the upper. And, lastly, consider the support and consequent form which will be given to the cheeks. If all the processes which have already been indicated have been skillfully performed, this last will be comparatively easy of accomplishment. With all the other features in harmony, and only sunken cheeks to fill out to correspond, the labor will be light. But here, too, there is danger of exaggeration. It is not difficult to build out to an excess, and suggest a swollen face or a morsel of something foreign in the mouth.

In the restoration of the features after the teeth have been for a long time removed, the cheeks and the lips not having been supported meantime by art, both the comfort of the patient and the necessity of preserving the identity would suggest that the entire restoration be not accomplished at once. In like manner, when the features are to be remodeled, and the muscles taxed beyond their original development, the change can be made gradually with ease, and without sacrifice of expression. The muscles must be allowed freedom of action, and it will sometimes be quite difficult to permit this, and at the same time give the most desirable form. It will be borne in mind, however, that the muscles can be developed into a use which is not common with them, and certain expectations for the future may be predicated on this fact. A striking illustration of the extent to which a displacement of the muscles and consequent building out of the cheek can be carried, will be found on page 324, in the report of a case where the side of the face from the orbit to the lower jaw was lifted from its natural resting-place to the extent of three quarters of an inch.

The foregoing remarks upon the remodeling of the features and restoration of expression must be regarded as only suggestive. Definite rules can not be given; the art can only be acquired by observation and experience.

"This branch of æsthetics must, of necessity, be worked out by every one for himself. He will succeed or fail just in proportion as he has the ability to observe the hundreds of models which are perpetually before him, and as he has the further and rarer ability to apply his observation to the special cases that are in his laboratory. Imitation of nature is the rule. Limitations of art, and individual capacity, make the exact observance of this rule comparatively rare. We replace the sixteen teeth with only fourteen, and often make them shorter and every way smaller than the natural organs. We do not make the grinding surfaces interlock with such deep cusps as in nature. At one time we can not avoid an unnatural fullness of artificial gum; at other times, the contraction of the absorbed arch compels the setting of molar teeth nearer the median line than the original teeth. Notwithstanding these and many other disadvantages, the perfection of the dento-ceramic art is such, that a skilled artist, who is quick to observe what nature requires, can in the majority of cases falling under his care supply the lost dental organs with great accuracy, and preserve that higher order of beauty which grows out of the harmony of his work with the expression of the face and entire person. But no dentist can give to his work this kind of beauty, who does not systematically study the natural organs as they daily present themselves in the operating chair.

"Few patients would object to the pressure of a roll of wax (two inches long and about a half inch thick) against the closed teeth. A model from this impression would give the size, form, arrangement, and articulation of all except the molar teeth. A well-matched porcelain tooth (more than one might be required) would add to these data the color of teeth and gum. To this add also the age, sex, physical characteristics of the face, and the physical temperament. If the dentist would have a case and books for the registration of one such carefully made observation every week, he would, at the end of two years, have a collection which, as a practical guide in the selection and arrangement of artificial teeth, would prove of incalculable value. These fixed records of minute details are made still more useful by a habit of close observation in society. In this way a set style or mannerism may be avoided, which so often stamps dental work with meaningless uniformity of expression." *

In all these efforts the law of harmony must not be forgotten. A skinny forehead, angular eyebrows, hollow eyes, and depressed temples, associated with full lips, plump cheeks, and a well-developed chin, will strike even an ordinary observer as an incongruity. In the study of human faces, the student of nature will find new and pleasing wonders continually; and, to carry out the law of harmony, his highest powers of discrimination will be in constant requisition. He will find, to his astonishment, that what might be termed mechanical symmetry is lacking in every face. So accustomed do we become to the general configuration of the human head, that we rarely if ever view it critically. A close comparison of one side with the other of almost any face will detect grave departures from uniformity. A straight line from the center of the forehead to the center of the chin will not necessarily bisect the nose, showing that the median line is not a straight line, but a curve. Neither the eyes nor the eyebrows will occupy the same angle to the median line; one side will be higher than the other, and the same is true of the mouth. The distance from the corner of the mouth to the outward corner of the eye will not measure the same on both sides. The horizontal circumference of the skull being ovoid, the face does not occupy the precise front, it being longer from the anterior median line to the posterior median line on one side than the other. By standing behind a person and looking over the head, thus bringing the face reversed to the eye, these deviations from mechanical perfection may be more readily noticed. By such observation we may learn that a slight variation in the fullness of the cheeks will harmonize better with the surrounding features of that side than if both were equally plump.

* Professor Austen.

In making an artificial denture, the next step which demands æsthetic culture, after taking the bite, is the selection and arrangement of the teeth.

The making of artificial teeth is purely the performance of a sculptor. To produce the original model, when the market is to be supplied with duplicates, calls into exercise the same talents. To *copy* carefully the various forms of teeth as they are presented is art, only in a limited sense. To carve an imitation of a natural denture—not a copy of any specific presentation—which will possess, in each individual tooth, a character in harmony with the whole number, and with the face; to so arrange the whole as to assist in the very best expression of the surrounding features; and, in addition, to give them the color and tone of nature, is an artistic accomplishment in the highest sense. Copying is simply a mechanical achievement; in all larger objects the perfection of the duplicate can be ascertained by measurement: machines are now made to duplicate almost any irregular form that is required. In smaller objects, a correct eye to detect variations takes the place of instruments.

A copy admits of no ideal embellishment. In making a copy there is no liberty; but, in creating an imitation, the mind works with a freedom from all restraint. The true artist therefore rises above a mere copyist, and brings forth his *imitation*—which is in fact a new creation, and not the copy absolutely of anything. In the production of artificial teeth to supply the market, but little art is required. The exercise of good judgment in the selection of natural organs to be duplicated in form and color, does not call into use the highest artistic talent. Artificial teeth, when made by manufacturers, should be in appearance, so far as they will be exposed in service, strictly copies from nature. We say *copies*, because the manufacturer can not by any possibility take cognizance of the peculiarities of the individual for whom they will be used. He can not, therefore, indulge in an imitation, and benefit the dentist so much as by strictly duplicating nature, in a full variety, and leaving to the dentist to hide as far as possible the individual incongruities by an artistic arrangement. It is somewhat surprising that the manufacturers have produced such admirable imitations of nature as are now often found in the market, when the demand for their productions has come from a class of men who were, to a considerable extent, devoid of æsthetic culture. Taking the profession as a whole, the manufacturers have probably in this respect been the educators, rather than the followers. This is evidently reversing the natural order of things. Manufacturers are but commercial men actuated by the love of gain, governed by the laws of trade—demand and supply; and it is a shameful comment upon a profession of the pretensions of dentistry, that a trade which cares only to supply what is demanded, should have the credit of teaching a profession its own wants. Manufacturers make what will sell, and it is not to be wondered at that the market is filled with inferior productions, so long as there is a sale for them. But it is to be wondered at that a profession which is brought into daily contact with the natural teeth, and should be distinguished for its good taste, are such partial observers as not to detect the inferiority.

This lack of cultivation is evidenced in other ways besides the one referred to. In a majority of the publications where engravings of the teeth are used as illustrations, the forms are positively ugly; and it is not the fault of the engraver: he follows copy closely, even to the imperfections. In the illustrations of the correction of irregular dentures, the models furnished the engraver, while conveying some notion of the change which has occurred, show in a majority of instances a disregard of the form of the teeth which would otherwise make the illustration much more effective. It is easy to see in many cases that the impression from which the model was made was taken in wax, and all the defects made by the draft of the wax in the removal are shown in the model—left untouched, and carefully copied by the engraver. This lack of appreciation of the beautiful, graceful, and true lies clearly with him who furnishes the model.

The beneficial influences upon the mind of having it fully impressed with an ideal standard are not inconsiderable. It becomes a great help in the determination of any type to be used or adapted to any given case. With the mind thoroughly conversant with any given standard of excellence, it becomes very easy, by the laws of the association of ideas, to make or select teeth with such deviations from it as may be desirable. It will be remembered that the most pleasing forms in nature are those with the softest and most graceful outlines; hard and angular forms do not give pleasure, except by contrast.

In the development of the natural teeth the laws of harmony as universal in uninterrupted nature are beautifully illustrated. In the youth from twelve years old and upward, the features of the face present their most charming appearance; all the lines are soft and rounded; sharpness and angularity come on with maturity and old age. The teeth obey the same law. In youth, immediately after their full eruption, they present their most perfect appearance; their cutting edges and grinding surfaces are beautifully modeled; but as age advances the abrasion from the antagonizing teeth, together with the almost imperceptible friction of one against another in the same row, continually act so as to modify this form. Thus, in taking the extremes, we find the perfection of full development in the youth changed to a mere stump, without beauty, in old age.

To describe all the types that are found in nature, and which may be in perfect harmony with the surrounding features, would be impossible. It would be assumption to give any one as possessing all excellence; but, as in art there may be a standard or ideal, accepted by a majority of cultivated people, so we may present a type which shall combine the beauties of many, and from which deviations may be made as circumstances require.

In Fig. 342, Nos. 1, 2, 3, 4, and 5 show the front view of two canines, a central and lateral incisor, and a bicuspid. They are drawn larger than nature, to render their peculiarities more forcible. It will be seen that neither in their outlines nor any portion of their surface are there straight lines or angles; every portion of the surface presents that easy and graceful contour which an artist loves to dwell upon. The outlines of the incisors, which are less undulating than those of any other, are still far from square or angular. Each side is unlike any other side, and the cutting edge, which becomes square from abrasion as age advances, is, when fully devel-

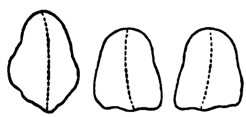
FIG. 342.

oped, curved and wavy; and this line, fuller in the center and depressed each side, is continued up the face of the tooth, forming a gentle ridge perpendicularly along its surface.

The narrower and rounder parts of the tooth will also be observed; the changes from the flatter portions coming not by regular inclination, but at a point about two thirds the length of the crown from the cutting edge, the outline dips by a graceful sweep into a depression, which is common to all well-formed teeth. This line of beauty is very often neglected in artificial teeth; when arranged in a denture with the shape as given by the mold, the spaces between them have the appearance of being made with a separating file, so perfectly uniform are they.

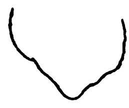
All the teeth anterior to the molars have a ridge more or less perceptible running perpendicularly along the face of the tooth; this is sometimes very faint in the incisors, but is shown very bold and in striking contrast in the canines. In the incisors it always assumes a curve with an inclination toward the median line; but, with the canines, this order is reversed, and the ridge curves the other way, as in Fig. 343. The central and lateral incisors, as any ordinary observer will have noticed, are very much the same in their general contour; the principal difference being, that the laterals are not

FIG. 343.



quite as wide in proportion to their length, and are about one third narrower than the centrals.

In Nos. 2 and 5 are represented two types of canines. No. 2 harmonizes better with the incisor shown here than does No. 5. No. 5 would be more appropriately classed with longer and slimmer associates. The characteristics of canine teeth are equally developed in both. The same graceful lines of beauty that marked the incisors are here also seen—the same depression on the sides of the upper third—the chief difference being that the canines at that point are rounder and bolder than the incisors; but, below the upper third, the difference is radical. The central ridge is very prominent and terminates in a cusp, and the wavy line of the cutting edge of the incisors is duplicated, one on each side of the cusp, thus: The posterior approximal surface is distinguished by a symmetrically formed tubercle, more or less defined, but most certainly a mark of beauty. This tubercle is better delineated in No. 7, which is a profile view of No. 2. In No. 5, this tubercle,



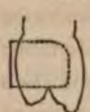
with its corresponding prominence on the anterior approximal surface, is developed higher up on the tooth, which constitutes the main difference in the two types. In Nos. 1 and 8 we have a pure type of a bicuspid, the resemblance to the canine being easily seen—the same bold surface, cusp, undulated outline, and posterior tubercle; the chief deviation in the external appearance being in a pretty well-defined tubercle on the anterior approximal surface, and a relative reduction in size.

The characteristics of these three classes of teeth, viz., incisors, canines, and bicuspids, are not confined to their front view. Their profiles are equally peculiar, as shown in Nos. 6, 7, and 8. The central face of the incisor shows a regular curve. The canine has no less than three different planes or curves; the boundary between the upper third and that below being marked by a decided prominence, while at the corresponding point on the bicuspid the profile is flat and the main fullness is below. The peculiarities thus pointed out are all that concern the appearance of artificial teeth.

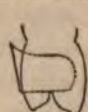
The second bicuspid does not differ materially from the first, except that in nature it is generally smaller; and the molars are placed so far back as not to call for any especial criticism upon their appearance.

In passing we desire to call attention to a point that is almost always overlooked by the mere mechanical dentist. The profile of the lingual surface is almost invariably *curved*, very *rarely* straight.

These teeth are oftener used to pass a clasp around than any other, and, in a majority of instances, the clasp at that point is made *flat;* and of course fits the teeth very inadequately. The trouble arises from a supposition that the model is perfect, whereas if the impression is taken in wax, the model is sure to be faulty, and it is very often the case even with plaster impressions; and again, a lack of observation as to the real form, so that the model may be trimmed if defective.



or thus.



It is not to be expected that the artist, be he manufacturer or dentist, will conform strictly to the forms before illustrated to any great extent. The instances in which one peculiar shape is the very best that could be selected as adapted to all the requirements of the case are few, compared with the whole number. In the type presented we find a beauty of form that is rarely seen except in youth. The undulation of the cutting edges of the incisors soon gives way, in the friction of antagonism, to a line more nearly square with the sides of the teeth. Any one of but limited observation has noticed, in many cases, the serrated edges of the incisors, both superior and inferior, immediately after eruption, and also that in a little time this peculiarity has passed away. This wearing away of the antagonizing ends of the teeth is the most natural modification of the perfect form of the tooth, and is common to them all. A great variety of forms can be made, all harmonizing with what we see in nature, by taking a well-developed type, and producing the appearances above indicated. Thus, by cutting off the ends of the teeth as exhibited in the illustration, we give the semblance of age, and that without in the least changing the form of the upper portion.

By having the mind clearly impressed with an ideal standard, appropriate selections from a ready-made stock will be more easily made; or, when the desired form is not supplied, changes may be secured to a limited extent by grinding. One thing is to be especially avoided, mannerism. The adoption in all cases of any type, or its variations, however excellent, can only end in deformity. Too many artists are mere mannerists, either by carrying some single idea of their own into all their works, or, what is more common, copying the modes and peculiarities of genius, and thus caricaturing rather than imitating nature. Mannerism is always an evidence of weakness.

For a complete knowledge of probable and possible variations, the student must be a close observer of nature. His standard of beauty will finally be the result of the rejection of Nature's defects, and the combination of her excellences. Imitate Nature rather than attempt to copy her. A copy of any one presentation would not probably convey as pleasing an impression as an adaptation of an imitation by an artist who had thoroughly studied the requirements of the case.

That method of making artificial teeth which requires for success the possession of the highest order of artistic talent, is undoubtedly carving. In this case the artist can not to any extent copy Nature; he is compelled to imitate her, and upon that art which conceals art his success depends. Not only must he carve each individual member with a character which shall harmonize with the external features, but the arrangement (or "grouping," as an artist would term it) must be the result of most careful study.

There is another style of work which requires a lower order of talent, but in which the results are in many cases quite equal to the best efforts at carving. Continuous-gum work, known as the invention of Dr. John Allen, is the result of the arrangement of single teeth in any desired form, and the completion of the operation by forming around them an artificial gum. No doubt, if the teeth in the market were, in form, color, and variety, all that is needed to meet the requirements, this method of forming an artificial denture would be all that art demands. It would then possess all the merit of carved work, and in some respects afford even greater opportunity for artistic display, being also much easier of accomplishment. As it is, the same taste and study are required in grouping as in carved blocks.

Absolute rules can not be given for this art. Suggestions only can be made which may prove a valuable aid. It must be borne in mind that we are not dealing with the natural organs, and some allowances and deviations must be made for that almost imperceptible difference in appearance that exists in the artificial ones, even when they are the most perfect of their class. Well-formed natural teeth please the eye when symmetrically placed even close together in the arch. Artificial teeth under like arrangement nearly always betray their origin.

The following suggestions to the painter are equally pertinent and applicable to the dental artist:

"Nature never repeats herself, even in two sides of a leaf. Such precision belongs to machine-work; and, in studying nature, we learn that variety is no less necessary to a pleasing composition than unity. To the grace and beauty of the whole work, harmony is indispensable. Without harmony each part may fail of the effect intended, however true in design. There must be harmony of line, harmony of grouping, harmony of light and shade, harmony of coloring, harmony of expression; each part must be so adapted as to correspond to the rest. The attitude must be in keeping with the expression; the color, with the subject treated; and the accessories must be true both to the character and the age represented: an harmonious whole is always more or less pleasing in itself, independent of subject or style."

The application of these principles for a number of years in the arrangement of artificial teeth, has satisfied the writer that in no other way can so pleasing effects be produced.

The gratification of the eye by a judicious deviation from uniformity is nowhere more strikingly illustrated than in landscape gardening. The traveler who is familiar with the ancient parks or gardens of the Continent of Europe, laid out with all the regularity of squares on a chess-board, the trees and shrubbery often trimmed or twisted into fantastic shapes unlike the free growth of nature, experiences a sense of great relief in visiting the parks of England, where the art in the arrangement is less mechanical and more concealed. This formality and stiffness is not displeasing at first to the uncultivated, but the eye soon wearies of it, and seeks relief in variety. It is this action of the mind we must consult in the arrangement of artificial teeth; and, in doing so, it does not follow that the mind will be able to recognize the cause of that which gratifies it. The æsthetic sense may be fully satisfied without being aware of the true reasons of the satisfaction.

We have shown the undulations of line manifest in every view of each tooth. To harmonize with this character we must avoid straight lines in the arrangement of the whole. The teeth ought to be so placed that their cutting or grinding ends will not all be upon the same level. There is no

Fig. 344.

better way of arriving at a correct taste or judgment in this arrangement than by an observation of the most symmetrically developed skulls at our command, and by a comparison of such with those of a lower order.

By universal consent, the highest type of physical and intellectual beauty is accorded to the Caucasian race, and the skull shown in Fig. 344 is one that may be studied with profit. Our attention will be particularly drawn to the general uprightness or vertical line of the profile, and the correspondence of the teeth with that line. In teeth and jaws harmoniously developed, with such a well-developed cranium as here shown, there is found the highest standard of beauty in the arrangement of the teeth. The six or eight front teeth—all that are particularly exposed to view in life—neither protrude nor recede; there is no marked peculiarity about their position which would suggest the possibility of improvement. The canine teeth, which in many skulls are so large or so prominent as to suggest the origin of their

FIG. 345.

name, are here moderate in size, close within the circle, and inconspicuous. Any material deviation from such an arrangement in an otherwise symmetrically developed skull will nearly always incline to deformity. By cutting off the cranium from the maxillary portion, by an imaginary line passing from the condyloid process through the socket of the eye, it will be seen that the relation of the brain in size to the lower part of the face is as two to one; i. e., that two thirds of the skull is given to the brain, and but one third to the jaws.

Passing now to the skull of a negro, as shown in Fig. 345, we see a marked change in all the points to which our attention was given in the Caucasian. The cranium is diminished proportionately; the maxillary apparatus is increased. The profile is much inclined; the jaws protrude; the teeth correspond with this protrusion, and the canine teeth are larger and more conspicuous. Drawing a line from the condyle to the eye, as in the former case, we find the skull

FIG. 346.

nearly equally divided. Evidently the intellectual qualities are more feeble, and the animal more pronounced.

Our next illustration is from an order below the human, and yet with strikingly similar characteristics. Fig. 346 represents the skull of a gorilla, which may be accepted as the extreme of the Caucasian. Here the relation between the cranium and jaws is exactly reversed. The brain occupies one third of the skull, and the jaws two thirds. Equally marked is the great increase in size, prominence, and power of the canine tooth.

Attention has been thus particularly given to the canine teeth, because their size and position in the arch affect the expression of the face more than those of any other teeth. There are many instances in the setting of artificial teeth that require a variation in the position of the canines, to correspond with general but marked peculiarities of physiognomy; but caution and good taste must be exercised in this determination, or characteristics belonging to the inferior races, or to mere animals, will be portrayed.

The line of the cutting edges, as before stated, must not be a straight line. Fig. 347, copied from a well-developed upper jaw, is evidently the type toward which we should approximate. This view shows that line to be a double curve, dropping in front and elevated at the back. The

FIG. 347.

same line marks the edge of the most beautiful upper lip, being doubled to represent the whole lip, and is familiarly known as the form of "Cupid's bow."

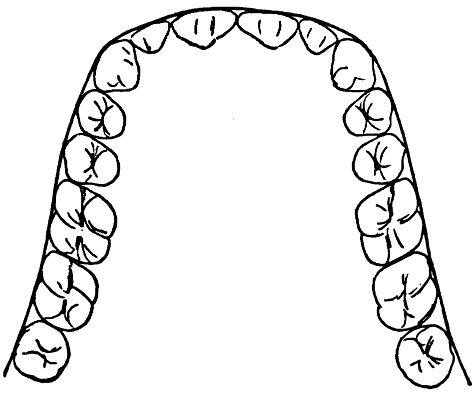
The line of the lower jaw is the same as that of the upper jaw from the last tooth forward to, and including, the bicuspids; and from thence, in the lower jaw, it curves upward, thus making provision for the natural lap of the superior incisors over the inferiors. Fig. 348 shows a type of a lower jaw which articulates with the foregoing upper one, in which the difference of line is clearly manifest.

There is a wide range admissible in the curve of the dental arch, between the extremes of a semicircle and a parallelogram. The width of the normal curve must be determined by the surrounding features. There can be no fixed standard; otherwise the characteristic features of races and families would be destroyed. Fig. 349 shows a departure from a regular curve which is sometimes admissible. Such an arrangement is probably the best for masticating purposes, but would be objectionable in some cases on account of the fullness of the canines, which might give an unpleasant expression. If the denture were for a rugged face, full

FIG. 348.

of strong lines and marked character, it might be admissible to make the canines still more prominent; but, in the face of a delicate lady, with the features rounded and symmetrical, even so much prominence as is shown in this drawing would be inadmissible. The more regular the features, the more difficult it is to avoid regularity in setting artificial teeth without producing deformity; for deformity is only relative, and what would deform one would enhance beauty in another. But there are some other peculiarities about this drawing that it is well to copy to a considerable extent, and those are the lines that flow back from the canines to the last molar. It will be observed that the two bicuspids and the adjoining two molars are nearly on a straight line, and that the third molars stand wider apart; thus, at the back the teeth curve outward rather than inward —the very reverse of a semicircle. When the arch is wide at the bicuspids in a person of delicate form, the effect is very disagreeable. The best width of an artificial denture

FIG. 349.



in any given case must be governed by utilitarian rather than æsthetic influences; nevertheless, the width at the back being decided upon for masticating purposes, the form of the arch in front is often quite under our control.

For the position of teeth in the arch, an almost indefinite variety is admissible; comprehending their rotation on their axes, the spaces which separate them, and deviations from a uniform curve. Artificial teeth will always look better if placed so that the form of each is clearly relieved against the shadow of the spaces between them. A compact row in an aged person, where there are many external evidences that nature is giving way, strikes almost any one as an incongruity.

With age we see a shifting of position of the natural teeth, which is in perfect harmony with the wasting of muscle and tissue which characterizes advanced life. For the best artistic effect, the spaces between the teeth should not be uniform in width, but there may be comparative uniformity in the two sides of the mouth. In general, the central incisors will look better if nearly or quite in contact, but may be relieved by a space between them and the laterals. The canine may or may not be separated from the lateral by a decided space, but a considerable vacancy may be left between the canine and bicuspid without any detriment to beauty.

In addition to the variety that may be caused by a judicious distribution of spaces, a very good effect upon the expression will be caused by the partial rotation of a tooth, or by giving prominence to one or more in the arch.

For natural expression, the central incisors and canines must occupy a fixed and unalterable location. The centrals control the *profile* of the mouth, while the canines support and give character to its *corner;* the two most important points in the whole arrangement. There can be but little or no deviation admissible in the location of these teeth, but a partial twisting or a different inclination may often be resorted to with good effect. The central incisors will, however, generally appear better by having them stand with their flat faces on a line with each other; but the canines may be rotated slightly, in either the same or opposite directions, without disfigurement.

The lateral incisors and bicuspids should occupy positions subordinate to the canines and centrals. Considerable latitude may be shown in placing the lateral. It may have a greater inclination toward the median line than the others, or it may be twisted more on its axis; the anterior corner of the cutting edge may be thrown forward of the central, or the whole tooth may stand within the arch; either method carried to a limited extent will add to the naturalness of the effect. The bicuspids should stand within a curved line formed by the centrals, canines, and molars, partially hidden by the prominence of the canine.

The foregoing remarks apply entirely to the construction of an upper denture, but are of greater force when entire upper and lower dentures are to be supplied. The character decided upon for the upper will govern the character to be given to the lower set. Where any great number of the natural teeth remain upon the lower jaw, and an entire upper set is to be supplied, the character of the lower teeth will influence the form and arrangement of the artificial ones, and thus the suggestions before made will be modified to meet the case. Perfect harmony would therefore require that noticeable defects or irregularities in the lower natural teeth should be imitated, in a modified form, in the construction of the upper. Thus, marked irregularities of position below will indicate an irregular arrangement above, but not necessarily to the same extent. Permanent discolorations on the surface of the natural teeth would also indicate a modified imitation of the same on the artificial.*

It is the comparative perfection of artificial teeth, together with their stiffness and formality, which, even if the color be appropriate, betrays them in persons of full age. Tricks or devices may be justifiably resorted to in such cases. The grinding of the cutting edges, to produce the appearance of a natural tooth broken or bruised by abrasion, is such a device, and may be adopted occasionally with much benefit. Not that there is any intrinsic beauty in a broken tooth, nor that there is any charm in its contrast with a perfect one; but the eye is so accustomed to see these slight defects in the

* In 1852 I was called upon to insert an upper set of teeth where the natural lower teeth were sound, but stained by long neglect, in marked and irregular spots over the surface. After finding myself unable to remove the discolorations, I resolved to imitate them, and carved a set of teeth and stained them in the baking with a preparation of *terra di sienne*. After they had been worn a year they were exhibited in the mouth of the patient to the Jurors at the "World's Fair," in New York, in 1853, and elicited their highest commendation. (*Vide* Jurors' report.)

natural teeth, that it comes to regard them as only allied to nature.

The insertion of gold fillings in exposed portions of the teeth is another trick which can sometimes be made available with propriety. In the construction of a partial set, where there are fillings in the natural teeth which are exposed to the ordinary observer, harmony suggests that there be no large number of artificial teeth inserted, perfect in their form and appearance. It is then eminently proper to adopt this device, but the filling should not be conspicuous or obtrusive. In making an entire set, this trick has little to recommend it. The means at our command in such cases are sufficient to enable us to conceal our art without resorting to the questionable device of suggesting to the mind decay, and thus induce the inference that the organs are natural. In the case of the partial set, harmony with the exposed natural teeth may require it; but in an entire set it is of doubtful propriety.

The manufacture of porcelain teeth is one of the most difficult of arts, and when in its infancy its best results were found among the few dentists who had to some extent obtained the mastery over the most refractory of ingredients, and who had the ambition and genius to excel in carving; but the difficulties to be overcome were such as naturally to deter others from the desire to obtain knowledge under such adverse circumstances; and, in due time, the manufacturers perfected their wares, so that none but an exceptional few could have excelled them. The average dentist is therefore not only compelled to accept such as the market affords, but it is more than probable that his patient will be better served by a judicious selection coming from his own cultivated taste than by any attempt of his own to manufacture them.

With gum teeth for plate-work, there is but little latitude for artistic effect consistent with the mechanical execution; with blocks made for rubber there is still less freedom of arrangement for the operator. Single teeth without gums are the only ones that will permit us to exercise our taste unlimitedly.

In entire sets, where the absorption of the alveolar process necessitates a substitute to restore the contour, we find ourselves limited at present to three methods, viz.: the English method of forming the gum of vulcanite, the same as the base; a platina plate with a continuous porcelain gum; and celluloid; the continuous gum, as has been before remarked, presenting advantages in an artistic point of view which are thus far unequaled. Some effort has been made by the manufacturers to furnish an imitation of the continuous porcelain gum in a form adapted to a plastic base; and, considering all the mechanical difficulties to be overcome, their efforts have resulted in considerable success.

Far more artistic talent, as well as mechanical skill, is required in making from a mold a block of several teeth joined by a gum, than in the production of single teeth. The suggestions heretofore made as to their arrangement apply here with the same force to the manufacturer as to the dentist in his adaptations to a special case. Many of the sections made for vulcanite show conclusively that the artist who modeled them could never have studied nature very long nor very closely. There is often displayed far more of the artist's invention than his imitation. Many of the little details which go far to influence the appearance of the whole are neglected. For instance, the teeth will often be fused together with particles of the tooth body left between them before baking; and it is equally common to find the beauty of the teeth in their form ruined by a V-shaped separation between them, terminating in contact with the gum, half way up the tooth; or, again, to find the central and lateral with such a space on one side and the corresponding space filled up. The point of gum between the teeth is often pale and indistinct. In these blocks the individuality of the tooth should be especially clear, brought out by a clean and well-defined space, and the color of the gum between in sharp contrast, or the *tout ensemble* will betray the porcelain character of the material used.

Professor Austen says: "Artificial teeth should imitate the natural organs; yet there is a perfection of form and arrangement which it is not advisable to imitate. To disarm suspicion as to their artificial character, it is often desirable to impart a measure of irregularity. An overlapping lateral, a missing bicuspid, a worn canine, an incisor, bicuspid, or molar apparently decayed and filled with gold, an exposed neck from absorption of the alveolus, are among the legitimate devices of the skillful mechanician who has the 'art to conceal art.' If there are any defective natural teeth remaining to be matched, still higher art is required. A perfect porcelain incisor is no fit companion for one that is partly broken, decayed, and discolored; and since no art can make the defective tooth perfect, and yet the patient retains it, there is no alternative but to give so much imperfection to the artificial one as shall take away that striking contrast which so painfully offends our æsthetic sense of fitness."

It is questionable whether any suggestions or criticism upon the color and tone of artificial teeth will be of any benefit to the student. That it is, in many respects, of equal or more importance than individual form, is undoubted; for, with an artificial denture faulty in form and bad in arrangement, if the tone and color exhibit good taste in the selection, it is a redeeming trait, and worthy of praise. But the faintest shades are of so much importance in this matter, and they are so undefinable, the names of colors and their variations often conveying a different idea from what was intended, that it is impossible to give more than the general suggestions of good taste. Fair teeth are admissible in younger persons; deeper hues are required for the aged. While we sometimes find in old persons natural teeth very fair to look upon, there is a seeming incongruity about it which we are not justified in imitating. It is safer to err upon the side of inserting those of a deeper tone than is really required, excepting when some of the natural teeth remain, and then faithfully matching or at least selecting a color that harmonizes, and will not be obtrusive or conspicuous. The canine teeth in nature are less translucent and more deeply shaded than the incisors or bicuspids. This should certainly be imitated so far as the canines are concerned; but, in the opinion of the writer, we shall produce a better effect with artificial teeth by *not* inserting bicuspids of lighter shade than the canines. The artificial tooth does not absorb the light as does the natural one, and when placed in shadow as the bicuspids *in situ*, they are rendered more conspicuous. Where natural teeth of divers colors are scattered, and the vacancies are to be supplied, it is our duty to harmonize in color each artificial tooth with its natural neighbor.*

It will be manifest that it is simply impossible to carry all the foregoing suggestions into practice with some of the methods of constructing sets of teeth now in use. One of the greatest difficulties to overcome is the scientific one, viz., to discover and combine in just proportions the materials which will produce this wonderful imitation. In no other art with which the writer is acquainted have imitations of nature been carried even now to such perfection. The making of artificial flowers has perhaps come the nearest to it. Certain it is that, of the materials which chemistry has already furnished us, it is possible to obtain most wonderful results. The color of a tooth is dependent principally upon

* I was required on one occasion to insert the four superior incisors. One of the canines was of exceedingly fair color; the other was very much discolored by a black amalgam filling on its anterior approximal surface, which the patient on no account would have disturbed. A block was made in which the side of the lateral incisor next the discolored canine was deeply stained with platina, and a most excellent imitation in color was produced, and the other teeth were vari-colored, grading in shade from one canine to the other. The effect was very good, destroying the conspicuousness which the discolored canine would have shown in contact with an unstained associate.

the proportion of its ingredients; its tone upon the action of the fire in burning or baking. The fault of many of the porcelain teeth of this country is the crudeness or rawness in their appearance—a lack of translucency, which a little more heat would very much improve. It would blend the colors more perfectly, give them more vitality, and soften down the hard and angular lines of the mold. It is perfectly in the power of our manufacturers, with the materials now in use, to make a general improvement.

One thing which is much wanted is to increase the variety of darker shades; not by hurrying into the market a lot of poorly baked blue or yellow teeth, but by a careful imitation of those organs in persons who have been habitually neglectful, until their teeth have acquired a tone or color which can not be removed. While the dentist at large is dependent upon the manufacturer, he must cultivate his taste until he is able to select the most suitable shade which is prepared for him. When one or more of the front teeth are remaining, either above or below, in a fair state of preservation, a tolerably correct idea may be gathered of what is needed; and careful observation made of just such cases, as well as of all partial sets, taking into consideration the age, complexion, etc., will do much to improve his judgment and enable him to make suitable adaptations when he has no such help.

When we consider the infinite variety of the human countenance, and the equally infinite diversity in form of the jaws which a dentist sees (no two being exactly alike), and then consider that there are thousands with a conformation of jaw peculiar to each, who are wearing artificial teeth of exactly the same size, shape, and color, in fact all cast in the same mold, and really belonging to but one individual, we begin to realize the paucity of our resources.

In the loss of the teeth, the absorption of the processes, and the wasting away of the muscles and tissues, as we have seen, the greatest possible detriment is caused to the expression of the human countenance. The complete restoration of these features, with all their power of expression, by art —art so consummate in the selection, arrangement, and adaptation of its means as to defy detection—is one of the crowning glories of dentistry as an art.

CHAPTER XXI.

ANATOMY AND PHYSIOLOGY OF EXPRESSION.

To no one does the study of the human face, in its various forms and aspects, recommend itself with more force than to the dental practitioner; for, called upon as he is, not only to relieve suffering humanity from the greatest pain to which flesh is heir, but also to repair the ravages of decay, either in efforts directed toward the preservation of the natural organs, or, when these are lost, to supply artificial substitutes, if he is not as quick to perceive and as able to retain in his memory the nice shades of expression of the same face, and the characteristic points of resemblance or difference between various individuals, as the sculptor or painter, he will fail in many essential particulars to meet all the just and proper demands upon him.

Apart from this general interest shared by all in the human face, it is important that those engaged in certain departments of life should become thoroughly acquainted with the mechanism, so to speak, by which the record is made. To the speaker, whether in the pulpit, at the bar, or on the stage, *gesture* is all-important; to the artist, whether as a painter or sculptor, *expression* is everything; and last, though not least, to the dentist a faithful discharge of duty demands that he should, in the performance of his operations on the teeth, invariably endeavor to *preserve* the natural expression of the face, or when the ravages of decay have eventuated in the loss of the dental organs, that the lost expression should be *restored* by the introduction of properly constructed and adapted artificial substitutes. To each and all of these, and particularly to the latter, if they desire to attain the highest possible point of excellence, an intimate acquaintance with the ANATOMY AND PHYSIOLOGY OF EXPRESSION is indispensable.

It is generally conceded that the proportionate relation of the bones of the face to those of the cranium has much to do with the moral and mental qualities of the individual; in other words, that a high order of intellect is usually manifested by those in whom the cranium is large, the forehead broad and high, and the bones of the face small; while the animal propensities are generally evinced in a marked degree, and preponderate over the intellectual, in those with depressed foreheads, compressed temples, and large and massive jaws. The opposite extreme is sometimes presented, in which the bones of the face are so disproportionately small, in comparison with the cranium, as to constitute a marked deformity. Again, a want of harmony between the different bones of the face is occasionally presented; as, for instance, when the inferior maxilla is very large and massive, or unusually small, in comparison with the superior maxilla, or *vice versa*. This hypertrophied or atrophied condition may occur in any of the bones, and of course when existing will mar the harmony of the surrounding parts.

In extreme old age, the atrophied condition of the jaws, due to the gradual loss of all the teeth and the absorption of the alveolar processes, produces that decided alteration in the features of the aged with which we are all so familiar. The change which invariably takes place in the angle of the lower jaw in consequence of the disappearance of the teeth and processes causes the chin to project, and when the jaws are closed the nose and chin approximate each other. Even when apart, the falling in of the lips so encroaches upon the oral cavity as to make it too small for the tongue, and thus renders the speech feeble and indistinct. It is here that the

… field for artistic labor, … pression of the face, but … rough which the wants and … made known to others.

… of the bony framework, and … one or the other of the two great … eyes and mouth, there are a num… … action the varying play of the fea…

ANATOMY …

To no on… rious forms… than to th… only to… which… eith… na…

Fig. 350.

Old Age.

Fig. 351 illustrates the principal muscles of the face concerned in expression. The *Occipito-frontalis* (A A) consists of two broad but fleshy bellies, with an intervening aponeurosis resting upon the arch of the skull, and over which it slides; the posterior portion of the muscle arises from the superior curved line of the occipital bone. The principal parts of the anterior fibers are inserted, or blend with the corrugator supercilii, and the superior margin of the orbicularis palpebrarum. The minor portions of the right and left frontal muscles unite together some distance above the root of the nose, and are inserted at this point and send down fibers ous with the pyramidalis nasæ. *Function:* elevates the eyebrows, and induces the s of the forehead.

ator Supercilii (1, 1) lies under the occipito-

Fig. 351.

A. Occipito-Frontalis.

1. Corrugator Supercilii.
2. Pyramidalis Nasi.
3. Orbicularis Palpebrarum.
4. Levator Labii Superioris.
5. Zygomaticus.
6. Levator Labii Proprius.
7. Compressor Nasi.
8. Depressor Alæ Nasi.
9. Nasalis Labii Superioris.
10. Orbicularis Oris.
11. Levator Anguli Oris.
12. Triangularis Oris.
13. Quadratus Menti.
14. Levatores Menti.
15. Platysma Myoides.
16. Buccinator.

frontalis, and is a small, pyramidal muscle, arising from the inner extremity of the superciliary ridge; its fibers proceed outward from their origin and blend with those of the occipito-frontalis and orbicularis palpebrarum. *Function:* It draws the eyebrows and eyelids inward, and produces the vertical wrinkles of the forehead.

The *Pyramidalis Nasi* (2) is usually regarded as a prolonged slip of the occipito-frontalis, which continues downward on the bridge of the nose, where it blends with the compressor nasi. *Function:* It draws down the inner angle of the eyebrows, and produces the transverse wrinkles on the bridge of the nose.

The *Orbicularis Palpebrarum* (3, 3) consists of a thin, flat plane of elliptical fibers, which extend around the whole circumference of the orbit and eyelids. It spreads outward on the temple and downward on the cheek, but the only fixed points of attachment to the bone are at the inner margin of the orbit. *Function:* It closes the eyelids.

The *Levator Labii Superioris Alæque Nasi* (4, 4) is a thin, triangular muscle, arising from the upper part of the nasal process of the superior maxilla by a pointed extremity, and, as it descends along the side of the nose, gradually increases in breadth, and then divides into two slips, one of which is inserted into the ala of the nose, and the other blends with the orbicularis oris. *Function:* It elevates the upper lip and ala of the nose, and dilates to a considerable extent the latter organ.

The *Zygomaticus, Major and Minor* (5, 5), arise, the latter in front of the former, from the malar bone, and then pass downward and outward to the upper lip and angle of the mouth, where their fibers blend with the orbicularis oris. *Function:* They raise the upper lip and draw the corners of the mouth outward, as in laughing. By these muscles the corners of the mouth are raised in smiling, so as to form the dimple; in laughter, still higher, so as to swell the cheek, wrinkle the eyelids, and compress the eyes, even until the tears begin to flow.

The *Levator Labii Superioris Proprius* (6, 6) arises from the lower margin of the orbit, where it is attached partly to the superior maxilla, and partly to the malar bone; its fibers pass downward and inward, and blend with the upper part of the orbicularis oris. *Function:* It is the proper elevator of the upper lip, and at the same time carries it a little inward.

The *Compressor Nasi* (7, 7) arises narrow and fleshy from the canine fossæ of the superior maxilla, and its fibers continuing upward and inward expand into a thin aponeurosis, which unites on the dorsum of the nose with that of the muscle of the opposite side. *Function:* The compressors may act either as dilators or as constrictors of the nares.

Depressor Labii Superioris Alæque Nasi (8), covered by the orbicularis oris, arises from the myrtiform fossæ of the superior maxilla, as a short radiating muscle, whose fibers diverge upward and outward; the ascending fibers terminate in the septum and back part of the ala of the nose; the others curve forward and blend with the upper portion of the orbicularis oris. *Function:* It draws the upper lip and ala of the nose downward, and thereby constricts the anterior nares.

The *Orbicularis Oris* (10, 10) is a great sphincter muscle surrounding the mouth, and, although it has no bony origin or insertion, as we have found, a large number of muscles arising from the different bones of the face center here and blend their fibers with those of this muscle. *Function:* It closes the lips.

The *Levator Anguli Oris* (11), covered by the preceding and the zygomatici muscles, arises from the canine fossæ just below the infra-orbital foramen, and its fibers pass downward and outward to be inserted into the orbicularis oris at the angle of the mouth. *Function:* It raises the angle of the mouth and draws it inward.

The *Depressor Anguli Oris* (12) arises from the external oblique line of the lower jaw by a broad base, and its fibers converge as they pass upward to be inserted into the angle of the mouth, where they unite with the orbicularis oris, the zygomaticus major, and the levator anguli oris. *Function:*

It draws the corners of the mouth downward, and is the antagonist of the muscles just named; when they all act together, the mouth is drawn backward.

The *Depressor Labii Inferioris* (13) arises from the oblique line of the inferior maxilla, just in front of the anterior mental foramen; it is a quadrilateral-shaped muscle, and its fibers pass upward and outward to be inserted into the lower lip. *Function:* It draws the lower lip downward and a little outward.

The *Levator Labii Inferioris* (14) arises from the incisive fossæ of the lower jaw external to the symphysis; the fibers pass downward and a little forward to be inserted into the chin. *Function:* It raises and protrudes the lower lip.

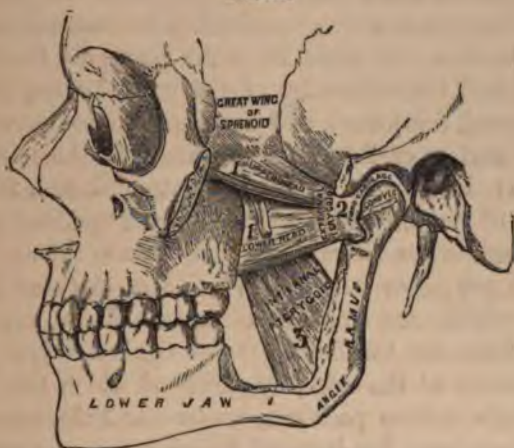
The *Buccinator* (16, 16) is a broad, thin muscle, arising from the outer border of the pterygo-maxillary ligament, and the external surface of the alveolar processes of the upper and lower jaw, commencing at the first molar tooth and passing backward. The fibers of the muscles converge, and are inserted into the angle of the mouth and the upper and lower lips. *Function:* It compresses the cheek, so as to assist mainly in driving air from the oral cavity, as in blowing on wind-instruments.

While the muscles already described as the superficial muscles of the face are mainly concerned in the varying expressions of the countenance, it must be remembered that those deep-seated muscles, the temporal, masseter, and external and internal pterygoid, which are the active agents in the comminution of food, sometimes play an important part in expression. This is markedly manifest in the aged after the loss of the dental organs, with whom the shortening of the face, the protrusion of the jaw, and the approximation of the nose and chin, under such circumstances, are due to the contraction of these muscles, and the influence which they exert in modifying the shape of the lower jaw, by altering the angle which the *ramus* forms with the body of the bone in early manhood. Considerations such as these indicate the propriety of a brief description of these muscles, in connection with the subject under consideration. The first of these—

The *Temporalis*, arises from the entire temporal fossæ, and forms a broad, radiating muscle, whose fibers, as they descend, converge into a flat tendon, which is inserted into the inner surface of the coronoid process of the lower jaw. *Function:* It raises the lower jaw.

The *Masseter* is a quadrilateral-shaped muscle, which

FIG. 352.



arises from the malar process of the superior maxillæ and the zygomatic arch, and is inserted into the posterior third of the outer surface of the body of the lower jaw, and the ramus from the coronoid process to the angle. It has two planes of fibers, superficial and deep. The first pass downward and backward, the second downward and forward. *Function:* It draws the lower jaw upward and forward, or upward and backward.

The Pterygoidei are illustrated in Fig. 352. The *Pterygoideus Externus* arises by two heads (1, 1) from the pterygoid ridge of the great ala of the sphenoid bone, the outer surface of the external plate of the pterygoid process, and part of the tuberosity of the palate-bone; and its fibers pass horizontally backward and outward, to be inserted (2) into the neck of the condyle of the lower jaw. *Function:* When the two muscles act together, they draw the inferior maxilla directly forward, so as to make the lower front teeth project beyond those of the upper. The protrusion of the chin in those who have lost their teeth is greatly due to this fact. The lateral sliding motion of the lower jaw in mastication is effected by the alternate contraction of the muscles of the right and left sides.

The *Pterygoideus Internus* (3), like the masseter, is quadrilateral in form, and arises from the pterygoid fossa of the sphenoid and the tuberosity of the palate-bones; its fibers pass outward, downward, and backward, to be inserted into the inner surface of the ramus and angle of the lower jaw. *Function:* It draws the lower jaw upward, and, from the obliquity of its fibers, also assists the pterygoideus externus in carrying the jaw forward and from side to side.

There are other muscles, in addition to those just described, which are somewhat concerned in expression. Among these are the depressors of the lower jaw and the other muscles of the neck, by means of which the head is thrown into various positions, under the influence of the different passions; but it would be foreign to the subject to present even a brief description of them. It is proper, however, to refer to the ocular group of muscles, for the eye is not only one of the most prominent features of the face, but also one of the most expressive. When the rest of the face is so completely under the control of the will that it is impossible to determine what is passing in the mind of another, the eye frequently reveals everything. So true is this that, when the tongue says one thing and the eye another, men of observation and experience invariably believe the latter. It is the position of the organ, whether in the sidelong, upward, or downward glance, the fixed, prolonged gaze, or the rest-less, roving motion, that serves as a key, unlocking to the mind of the attentive observer that which another is striving to conceal. The muscles by which these varied movements of the organ are effected are six in number, and consist of two groups, the first of which are four straight muscles, the *rectus superior*, *inferior*, *externus*, and *internus;* the second group is formed by two oblique muscles, the *obliquus superior* and *inferior*. In addition to moving the eye upward and downward and from side to side, if all the muscles of either group act together, a retraction of the eyeball is induced by the contraction of the *Recti*, or a protrusion of the ball by similar action on the part of the oblique. Squinting or strabismus, either convergent, looking inward, or divergent, looking outward, which gives such a peculiar expression to the face, is due to a want of harmonious action in the ocular group, and may be caused by overaction or paralysis of a muscle from cerebral disturbance, or it may be the result of imitation. The *levator palpebræ*, which is included in this group, is the elevator of the eyelid.

The great lines of character are the lines of the zygomatic muscle, coming from above, and of the triangular muscle, coming from the chin; and the moving point toward which they all act is the corner of the mouth. In cheerful emotions they all rise toward the eye, which becomes full and distended. In the depressing passions the features sink, the eye is languid, and the whole countenance has a serious, thoughtful cast.

Dr. Holmes says: "All parts of the face doubtless have their fixed relations to each other and to the character of the person to whom the face belongs. But there is one feature, and especially one part of that feature, which more than any other facial sign reveals the nature of the individual. The feature is the *mouth*, and the portion referred to is the *corner*. A circle of half an inch radius, having its center at the junction of the two lips, will indicate the chief focus of the expression."

The orbicularis is the opponent of all the muscles which are concentrated from various points to the lips; and it is by the successive action and relaxation of these antagonistic muscles that so much and so varied expression is given to the mouth. It tremblingly yields to the superior force of its counteracting muscle, both in joy and in grief. It relaxes pleasantly in smiling. It is drawn down more powerfully by its opponent muscles in weeping. This is the largest and strongest muscle of the face; it antagonizes all the rest, and, from an opening as wide as the mouth can acquire, it shuts it at pleasure, so closely as to retain the breath against all the force of the lungs. The union of so many muscles at the angles of the lips produces that fullness about the mouth remarkable in those who are thin and muscular. In the child or youth whose face is plump, they make the dimple in the cheek.

The bones determine the general form of the face; one great muscle, the masseter, gives the rounding of the cheek; the rest are delicate and movable muscles, and the character of the face centers around the mouth and nostrils where those muscles converge. A thin and delicate face gains in expression where the cheek is hollow, and at the angle of the mouth where the lines are strong. In a full face these lines are obliterated, and the delicate turns of thought and feeling are lost. All but the more violent expressions of passion are buried in the mass.

The muscles described, like the bony framework on which they rest, would be without motion but for their connection with the brain, through the medium of special nerves, whose function is to give to the various parts of the face that vitality and ever-changing expression which constitute the charming attraction of the human countenance.

Of the twelve pairs of cranial nerves, five pairs are concerned in expression, and three of them are distributed to and give motion to the muscles of the eye. Thus the *third pair of nerves*, or the *motor oculi*, sends branches to all of these muscles, with the exception of the motor externus and the obliquus superior, to the first of which pass the *fourth pair*, or *motor externus nerve*, and the second is connected with the *sixth pair*, or *nervus pathetici*.

The *fifth* and *seventh pairs* of nerves are distributed to the muscles of the face; the latter, also named *portio dura*, or *facial*, emerges from the stylo-mastoid foramen, and then, passing through the parotid gland, is eventually distributed *exclusively* to the superficial muscles in the form of a plexus, named *pes anserinus*. It is purely a motor nerve, upon the integrity of which the expression of the countenance and the varied play of the features depend. This has been demonstrated in the most satisfactory manner by experiments on animals and in pathological conditions in man. Strange as it may appear now, it was formerly supposed that the painful affection named *tic-douloureux* was seated in this nerve, and resection of it at the stylo-mastoid foramen was frequently performed for the relief of patients, but with no other result than inducing paralysis of the superficial muscles and loss of expression on the side of the face operated upon, the patients being unable to close the eyelid, elevate the ala nasi, or move the cheek or that side of the lips, and yet at the same time still suffering as much from the disease. Paralysis of this nerve is sometimes induced by cerebral disturbance or the presence of a tumor beneath the ear, and is usually denominated Bell's palsy, on account of the true nature of the affection having been made known by Sir Charles Bell, to whose genius and laborious experimental research the world is greatly indebted, not only for their knowledge of this disease, but also for much that is known at present of the nervous system. Paralysis of the *portio dura* does not affect in the slightest degree the function of the temporal masseter or pterygoid muscles (and therefore interfere with mastication), as they derive their nerve-force from the *motor branch* of the *fifth pair*. The dependency of these muscles on the motor branch of the fifth can be readily demonstrated by divisions of the nerve on each side in animals, when the lower jaw at once falls, and the subject operated upon is rendered incapable of raising the jaw or masticating its food. If the nerve of one side only is cut, the parallelism of the jaw is destroyed; or, in other words, the muscles of the side operated upon, being paralyzed, fail to bring the jaw in contact with the upper, while on the sound side it is effected as usual.

Presuming that sufficient has been said with regard to the points already touched upon, we will now pass to the consideration of some of the expressions presented by the countenance when under the influence of the different passions that affect the mind of man. It is impossible to describe all of these; and the attempt, at best, in the consideration of those to which attention will be directed, must of necessity be merely suggestive of an interesting and instructive subject of study.

All the facial expressions may be classified under two heads—the exhilarating and the depressing. The angle of the mouth and the inner extremities of the eyebrows, as points where a number of muscles concenter, are the most movable parts of the face, and on their changes expression chiefly depends. No better illustration of this fact can be afforded than in the caricature, with which every one is familiar, representing two faces joined together, in one of which the *elevation* of the angles of the mouth gives a most joyous expression to the face; on reversing or turning the picture upside down, however, depression of the same mouth at the angles produces a correspondingly despondent expression in the other face.

In *laughter*, the various muscles which have been described as inserted into the *orbicularis oris* have entirely overcome the action of that muscle, whose function is to close the lips. When a ludicrous idea enters the mind, as a general thing it is in vain to try to keep the mouth closed. The antagonistic muscles concentering there exert a force beyond all control, and frequently the more determined the effort not to give way to the inclination, the more marked and explosive eventually becomes the demonstration. The *elevator* muscles, inserted in the upper lip and the angles of the mouth as the active agents in drawing the mouth upward, produce a fullness of the cheeks which, pressing upon the lower eyelids, throws the skin into wrinkles under them. At the same time the teeth are exposed; while by the contraction of the *orbicularis palpebrarum* the eyes are almost concealed, and, by compression of the lachrymal

FIG. 353.

Laughter.

gland, frequently suffused with tears. Together with this, the agitation of the muscles of the throat, neck, chest, and diaphragm produces audible cachinnations. The corners of the mouth that are thus raised in laughter are distorted in pride, drawn backward in rage, drop lower in grief, and in palsy fall quite down.

In the reverse of this, or *weeping*, the lips are drawn apart by the converging muscles; but, in place of the elevation of the corners of the mouth, they are now drawn downward by the *depressor anguli oris;* the nostrils, at the same time, are dilated, and the tears flow profusely from under the convulsively closed eyelids over the flushed cheeks; while the veins of the forehead are distended and the inner part of the eyebrows is drawn upward and inward by the combined action of the *corrugator supercilii* and the *occipito-frontalis*. The muscles of the throat, chest, and diaphragm are spasmodically affected, and the respiration is frequently interrupted by sobs.

Bodily *pain*, the manifestation of which in the face of patients is frequently an important means of diagnosis, not only in children, but those of a larger growth, is a condition that particularly claims attention from a professional and

FIG. 354.

Crying.

humanitarian point of view. Here let me say, in passing, that pain is by no means what it is usually regarded, an unmixed evil. Paradoxical as the statement may appear, it is frequently a blessing rather than a curse, as it is the chief means by which we become aware that some important organ is diseased. Without such intimation, the part affected might have become disorganized to such an extent as not only to destroy the function of the organ, but also to place life itself in jeopardy. This applies with peculiar force to those organs which it is our duty to save; for it is the unpleasant sensation of pain which generally drives our patients to us, and it is the various manifestations induced by the pain endured which enables the experienced practitioner to determine the nature and extent of the difficulty.

In extreme pain (except in cases where the patient is suffering from periodontitis, when the occlusion of the jaws intensifies the suffering), the teeth are brought together with great force and ground against each other by the temporal, masseter, and pterygoid muscles; the saliva frequently flows in large quantities from the mouth, which is drawn open

FIG. 355.

Extreme Pain.

laterally; the face flushed, the veins distended, the nostrils dilated, the eyebrows raised, the forehead thrown into horizontal wrinkles, the eyelids widely opened, and the tears coursing over the cheeks, betray in the most unmistakable manner the suffering endured.

In *joy*, the face is lighted up with a smile by the gentle elevation of the eyebrows, the lively and sparkling appearance of the eye, and the pleasant expression of the mouth, which, without being separated, is drawn aside at the corners.

In *fear*, the head sinks backward between the elevated shoulders; the eyes are fixed and staring; the eyebrows are raised to their utmost by the *occipito-frontalis*, which, in addition to a contracted state of the scalp, causes the hair to stand on end; the face is ghastly pale, and the cheeks are hollow, shrunken, and in convulsive motion, like lips which are wide open, owing to the dropping of the lower jaw; the breathing is short, labored, and spasmodic.

FIG. 356.

Fear and Terror.

In *rage* (see Fig. 357), the inflamed and glaring eyeballs, owing to the contraction of the *oblique* muscles, seem ready to dart from their sockets; the brow is thrown into deep vertical wrinkles by the *corrugators;* the nostrils are dilated; while, through the clinched teeth but open mouth, words of hate are delivered with emphatic force.

It is claimed by physiognomists that the true character may be read in the countenance. Whether or not physiognomy is yet reduced to so exact a science as this statement would indicate, certain it is that the natural characteristics of mankind are very strongly marked in the face; and so generally is this accepted as a truth, that first impressions received are acted upon with a very strong faith in their correctness. The nature of an individual is often refined by external influences, until the face is no longer a complete index to it; but even then the physical conformation is slowly modified and ultimately harmonizes with it. The growth of nations in Christianity and civilization abundantly proves this fact. Nations whose early history shows them to have been but very little above the brutes, in their gross

FIG. 357.

Rage.

sensualism and savage ferocity, and whose countenances bore the marks of their natures, have, as they advanced in refinement, developed also into beauty and comeliness. Individual cases like this take place in a single generation, and instances are not rare which are within the knowledge of any observer.

A knowledge of physiognomy can only come in its fullness from long-continued observation of the infinite variety of faces which we are continually meeting. The harmonious relations of one feature with another must be so fully comprehended, that it will be possible to restore a lost part, in all its perfection, by a knowledge of what is demanded by those features remaining. No single feature of the face is more capable of changing the entire expression than the teeth. This is markedly evident when a classic face, which in repose excites admiration on account of the symmetry and regularity of the features and the purity of the skin, has not only the illusion dispelled at once, but a feeling of loathing induced, by a smile revealing, in place of pearls, blackened and crumbling snags; while, on the other hand, a very ordinary and homely face, when lighted up by a smile which uncovers clean, white, regular, and symmetrical teeth, becomes pleasing and attractive.

The general appearance of the face is not merely affected by the condition, presence, or absence of the front teeth, but the hollow, sunken cheek reveals in the most unmistakable manner the loss of bicuspids and molars. The symmetry of the face in this way is frequently destroyed by the inexcusable extraction of these teeth because a proper valuation is not placed upon them as masticatory organs, and on the score of appearance, by practitioners and patients, it being supposed that, as back teeth, their absence will never be noticed.

In the introduction of artificial teeth, the greatest care of course should be exercised to preserve or restore the natural appearance of the face. To do this with any prospect of success, however, it is important that the anatomy and physiology of expression should be made a careful object of study. It is important, for instance, that the teeth should be so arranged as not to give a sunken appearance to the mouth, or to make it so prominent as to obliterate the groove or depression in the middle of the upper lip, the concavity which naturally belongs to the space between the lower lip and chin, and the lines which the action of the muscles creates on each side of the mouth, extending from the wings of the nose to the corners of the lips.

All artists and physiognomists agree that the mouth presents a greater variety of expressions than any other feature.

In portrait-sculpture the mouth is the feature of all others for denoting expression. Neither the eyes, nose, forehead, ears, nor chin, or all combined, have the power of conveying that of which the mouth is capable. It speaks, even without utterance, of every emotion of the heart; love, anger, pride, scorn and contempt, equally with joy and sorrow, have their insignia stamped upon the mouth. These changes are so rapid, and their continuance so evanescent, that the phrase "catch the expression" is often used with but little idea of its full signification. These various movements around the angle of the mouth require careful observation for their full comprehension; and it must have already become apparent that this knowledge is of vital importance to him who would succeed in the art of dentistry, and that without it the consummation of excellence can never be attained.

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