#75

STUDIES

OF THE

INTERNAL ANATOMY OF THE FACE.

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PREFACE.

SEVERAL years ago, during practical surgical work, the observation of considerable variations in the bones of all parts of the head led the writer to doubt the sufficiency of the investigations on which the accepted anatomy of those parts is based. The idea of unvarying typical form was too much in evidence in the text-books; variation was too little accounted with. Talking over the idea with Prof. W. F. Litch, he suggested that the careful study of a series of dissections of skulls would be of the highest value and would probably settle the question decisively. Dr. Litch supplemented his suggestion by the gift of a number of undissected heads with which to begin the work.

This was the beginning of an investigation during which hundreds of skulls have been dissected and studied. This investigation completely overturned the writer's conception of what was meant and what ought to be meant by the term typical. There is, doubtless, a typical or typal form for each bone, but it is not often found in nature. If we were to photograph a thousand temporal bones, for example, and make a composite of the entire number, the composite would properly be accepted as figuring the typal temporal. It is possible, though doubtful, that in the thousand bones two or three could be found which exactly corresponded with the typal bone so pictured. This, to the writer's view, is strong testimony that the typal bone is ideal; that the actual is a variant. It is with these variants that the surgeon and dentist have practically to deal.

The results of these studies, as they developed from time to time, have been communicated to the medical and dental professions through papers read before societies and printed in the medical and dental journals. Many of these have been published in the *Dental Cosmos* and in the *Journal of the American Medical Association*. The importance of the work has been evidenced by the incorporation of more or less of the new discoveries in text-books by such authors as Gray, Gerrish, Burchard, Kirk, Marshall, McCurdy, D. Braden Kyle, etc.

The presentations of this work which have heretofore been made have been fragmentary,—rather in the form of partial reports detailing the heretofore unobserved or unrecorded facts as they were disclosed. It has, therefore, seemed well to the writer, inasmuch as the work has now progressed to a point where assurance is given of the accuracy of the conclusions, to collate and present the results in an assembled form. From the very nature of the case the work is necessarily incomplete; and this presentation is to be looked upon as not in any sense exhaustive of the subject, but merely as an exhibit of the present status of the investigation.

What is claimed for it is that it is a demonstration that typical anatomy is ideal anatomy. It also demonstrates the need for similar systematic study of the anatomical structure of the other parts of the body. For it can scarcely be doubted that the variations noted in the bony structures of the head and face will be found coupled with equal variations of the other structures. It further shows that the text-book by itself is insufficient for the thorough study of anatomy; that the only true and complete book of anatomy is the body itself;

that, therefore, the use of text-books must be supplemented by the intimate study of the body.

The writer is greatly indebted to Prof. Thomas C. Stellwagen for the use of his fine collection of infant skulls and French prepared specimens of upper and lower jaws, from the study of which many valuable points were derived ; and also to Prof. Edward C. Kirk for his valuable suggestions during the progress of this work, and for arrangements made by him for an unlimited supply of material from the dissecting rooms of the University of Pennsylvania. The writer also wishes to acknowledge his indebtedness to the late Dr. Harrison Allen and Profs. E. B. Gleason and D. Braden Kyle ; and also for the many kind suggestions received from other members both of the medical and dental professions.

The thanks of the writer are also due to Mr. Frank L. Hise for his helpful assistance in the preparation of the work for the press.

M. H. CRYER.

LANSDOWNE, PA., July 11, 1901.

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INTRODUCTORY.

Carefully conducted studies of numerous dissections prove conclusively that many of the stereotyped descriptions of the internal anatomy of the face are not justified by the facts; and that, therefore, the hard and fast rules for surgical procedures founded on these descriptions do not adequately cover the ground. In pursuance of these studies, hundreds of sections of the facial region have been cut and examined. The lesson that they teach is that the accepted descriptions are to be received as only general truths, and that they cannot be depended upon or followed literally as a guide for the surgeon or dentist. The results of these studies afford a basis for the explanation of the failure of many operations conducted on the lines of the accepted anatomical descriptions, and which have been regarded as merely the natural percentage of failure; whereas, they have probably been due to variations in the parts clearly within the limits of normality, as will be shown by many illustrations.

Anatomical Variations. No man who spends any considerable portion of his time in the study of anatomy—that is, in actual dissections—can fail to note how great is the number of anatomical variations he meets with. So common are these that it cannot be said with exactness which are typical anatomy and which are anatomical variations. In other words, anatomy as a study is not to be classed among the exact sciences. It is not meant by this that there is not such a basis of anatomical science that general rules cannot be laid down, but the more closely the subject is studied the more variations as to details are recorded. To be sure, given the mandible of an animal, a femur, or even a tarsal bone, the nature of the associated bones, their sizes, positions, and forms can be deduced. Admitting this, however, there are still as many variations in the internal anatomy as there are differences in the external appearances.

Especially is this true of the anatomy of the human head, as it is modified by climate, race, age, disease, occupation, and many other conditions.

Climate. Climate and consequently environment have a great influence in modifying the development of the bones of the head, as is demonstrated in the differing formations of the skulls of the great races of the world; and more markedly in branches of the same race living under diverse climatic and social conditions.

Age. The changes produced by age are very marked. The skull consists of bones of both cartilaginous and membranous origin. In the fetus and infant these bones are soft and yielding; they receive deposits of calcic material, becoming harder and harder as age advances until the degeneration of senility sets in. In the jaws, constant changes are caused by the development, eruption, and loss of teeth and the consequent alterations of the alveolar process.

Disease. Disease causes anatomical changes in the bony structures as well as in the other tissues of the body. In the presence of some disorders of the nutritive system, the bones may fail to become infiltrated with a sufficient quantity of calcic material, which would have the effect of leaving them soft and yielding; or, on the other hand, an undue proportion of calcium salts may be incorporated into the bones, with the opposite effect of making them hard and unyielding, thus modifying the physiological functions in which they are concerned.

Occupation, Diet, etc. Occupation will modify the shape and character of the face and head, especially in youth. Those who are studious and pass an indoor life are likely to have a more delicate development of the face, with a larger brain-case than those who are brought up to a laborious outdoor life. The mastication of coarser foods will develop the muscles of mastication and their bony attachments. Numerous other facts might be cited to show the influence of personal habit upon the course of anatomical development.

Asymmetry. There are even variations in the same individual in the shape, size, and markings of the two sides of the face. In the bilateral bones such as the frontal, sphenoid, vomer, ethmoid, and mandible, one side is usually found to differ from the other. In the homonymous bones, as the maxillæ, the malar, the lachrymal, the turbinate, and the palate bones, the same variations are observed. This being the case, it will be readily understood that the internal openings and spaces, as the mouth, the nasal chambers, the orbits, the maxillary, frontal, and sphenoidal sinuses, the ethmoidal and other cells, will differ accordingly.

Diagnostic Importance. It is clear that variations of the nature referred to must have a direct bearing on the diagnosis of morbid conditions for which there is no plainly readable outward explanation, and even more so on the performance of operations for their relief. A knowledge of these variations will point the way to an understanding of many otherwise obscure and doubtful lesions. It will also show why, for example, following the typical anatomy, the surgeon seeking to open into the antrum will occasionally enter the nasal cavity instead. It would seem that to the surgeon, and more especially to the dentist, such information is a necessity.

The main object of this volume is to present a digest of some newly revealed facts relating to the internal anatomy of the face,—facts which have an important bearing on all surgical operations involving this region, and especially on the work of the dentist and the rhinologist. In this view, the aim will be to call attention to misconceptions of the actual conditions, to correct errors which, having found currency, have been commonly accepted, and more especially to enforce the idea that a blind following of typical descriptions is likely to lead to disaster.

GENERAL CONSIDERATIONS.

Anatomical Structures. The anatomical bony structures of the facial region include the framework of the external face and the walls of the various cavities and air spaces of the internal face. As with other bones, they consist of a cortical outer wall inclosing cancellated tissue, the latter being extremely fine and delicate in many cases, in some instances becoming so attenuated as to almost be lost. The exterior cortical surfaces are covered with a true periosteum, while the interior surfaces, those looking toward the internal cavities, as the mouth, nasal chamber, the frontal, maxillary, and sphenoidal sinuses, and the ethmoidal cells, are covered by a mucoperiosteum. From these characteristics, the former are known as non-mucous, and the latter as mucous or mucoid surfaces. It is important to consider the difference in these surfaces in the treatment of some of the diseases of the bones.

The dense exterior or non-mucous surface is roughened at various points for the attachment of muscles. The exterior cortical portion varies in thickness according to the amount of work to which it is subjected or the protection it has to afford. The greatest thickness is found in the mandible, the active bone of mastication, which occupies a position in the face where it is peculiarly exposed to the effects of external forces, as blows, etc.

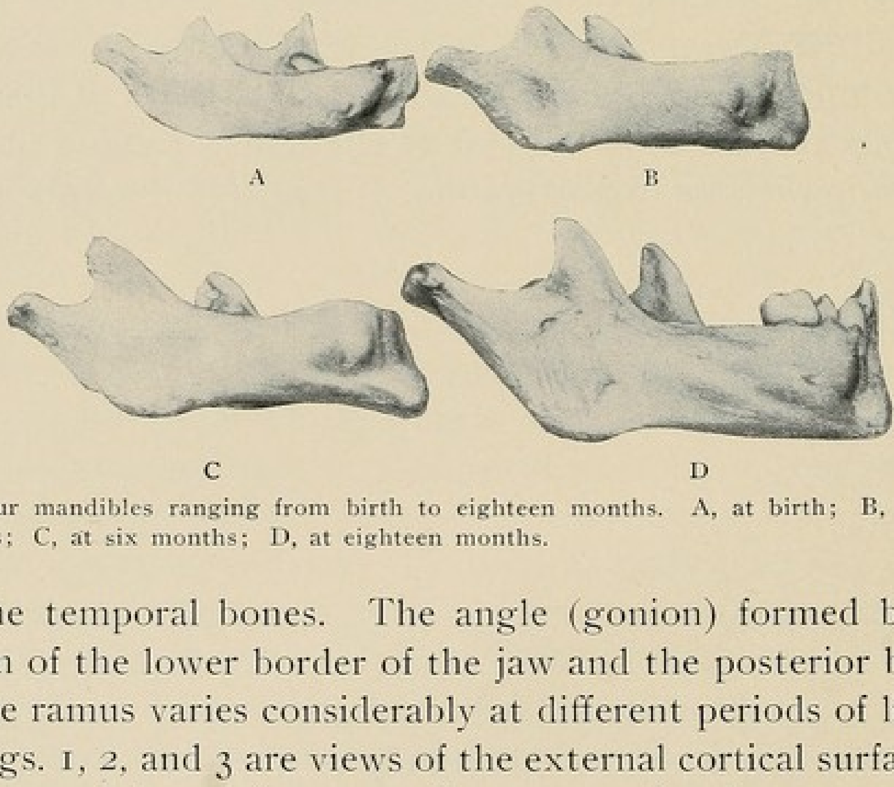
The inner or mucous surfaces, while dense and compact, are thinner and more delicate, and smoother. They are marked by depressions for the lodgment of the mucous glands, by grooves for the passage of the nerves and vessels, and are roughened for the attachment of the muscles.

Cancellated Structure. The cancellated tissue found between the plates of cortical bone varies in thickness and compactness according to the density, the position, and the functions of the bone. The arrangement of the trabeculæ is an interlacing network. The functions of the cancellated tissue are to give bulk to the bone where required and to diffuse shock. Through it pass the nerves and vessels to supply local structures and, by means of bony canals or tubes, the more distant parts. The bones of the head contain many canals and foramina for this last-named purpose, thus differing materially from the other bones of the body. This is a fact of surgical importance, for when these bones have become altered either by breaking down of the tissue or by abnormal growths encroaching upon the foramina or canals, the functions of the nerves and vessels are interfered with, thus affecting not only adjacent tissues, but as well parts of the face and body remote from the seat of the lesion, causing abnormalities in the area of distribution, as atrophy, neuralgia, etc.

THE MANDIBLE OR LOWER JAW.

The Mandible. The mandible or inferior maxillary bone is symmetrical in its general shape, although one side may and usually does differ from the other. It presents for study a body horizontal in direction, with two rami extending upward to the articulation in the anterior portion of the glenoid fossæ

FIG. 1.

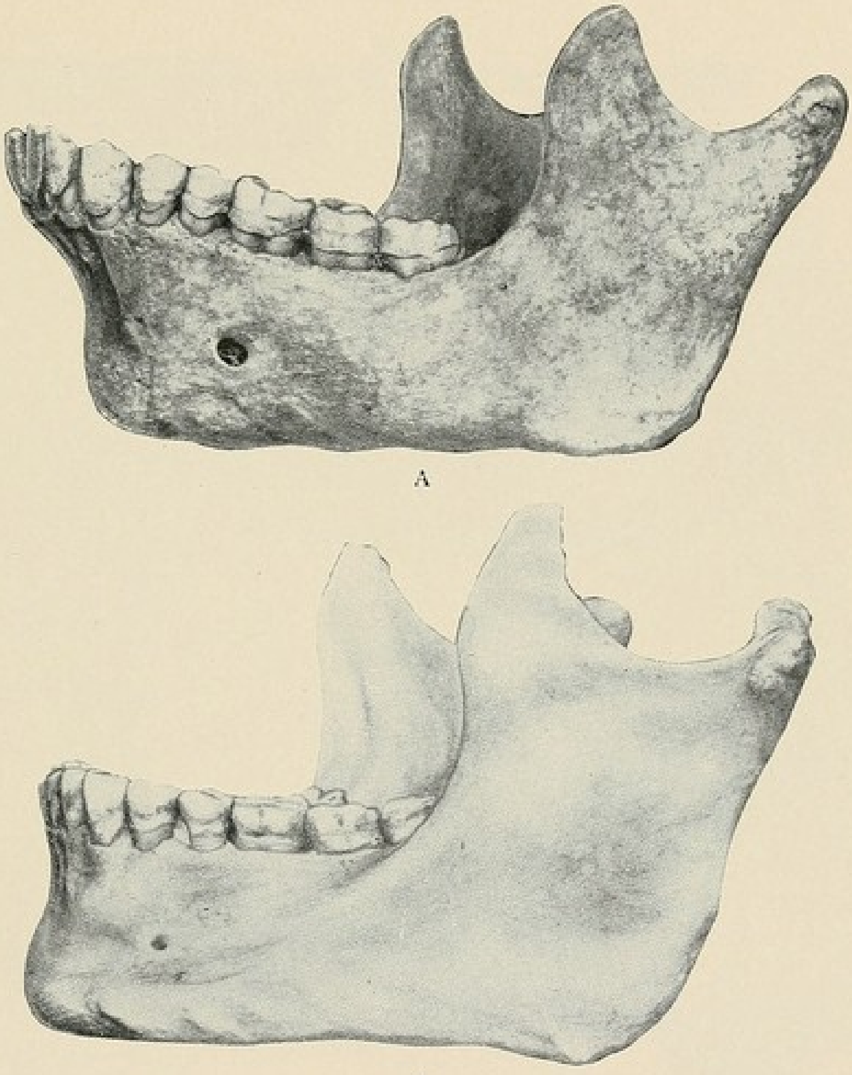


Four mandibles ranging from birth to eighteen months. A, at birth; B, at three months; C, at six months; D, at eighteen months.

of the temporal bones. The angle (gonion) formed by the union of the lower border of the jaw and the posterior border of the ramus varies considerably at different periods of life.

Figs. 1, 2, and 3 are views of the external cortical surfaces of the normal lower jaw at various ages, showing progressive changes in the angle between the rami and the body of the bone, as life passes. At birth (A, Fig. 1) the angle is very obtuse, but as the teeth develop and erupt it becomes less and less obtuse, until about the time the last of the permanent teeth are erupted it is almost a right angle, as shown in Fig. 2. The difference in direction is due to the general separation of the jaws by the growth of the alveolar process and the pro-

Fig. 2.



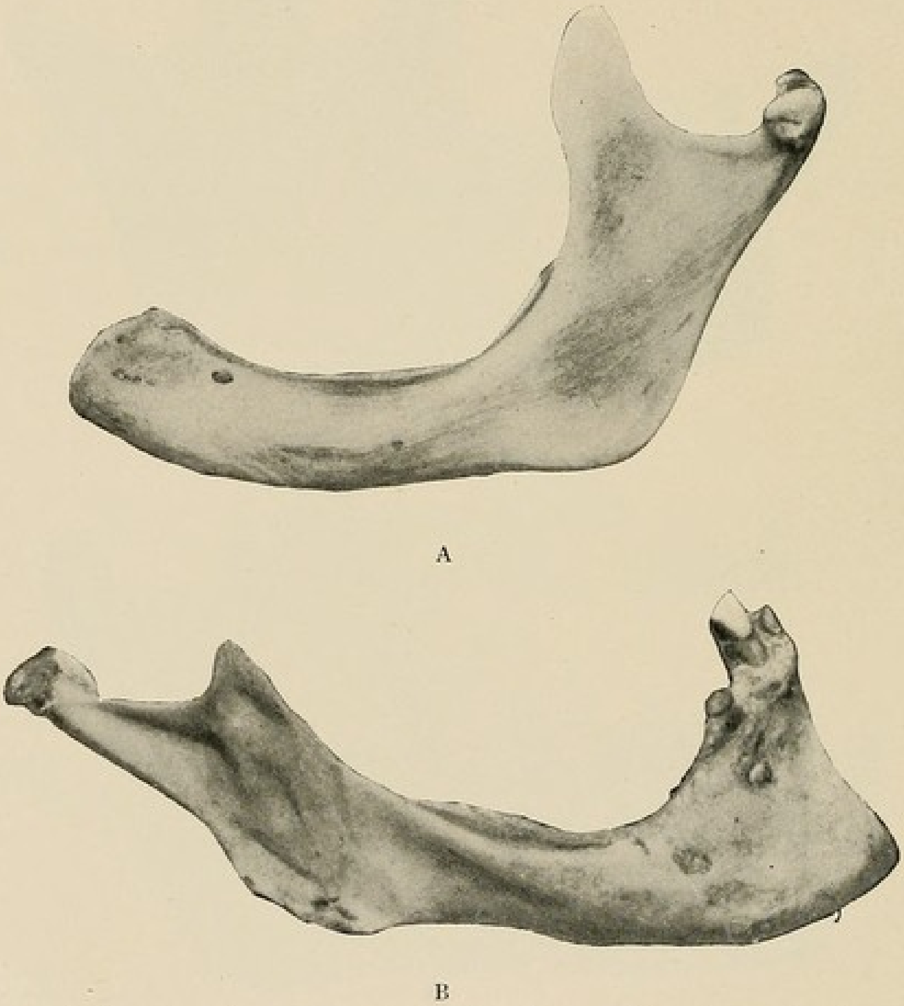
Two mandibles. A, from an adult of the Fan tribe of West Africa. B, from an adult Caucasian.

jection of the teeth into the space between them. As the teeth wear away, or when they are extracted, the process is resorbed, the horizontal planes of the jaws approach each other more closely, and the angle again becomes obtuse.* (See Fig. 3, B.)

*See chapter on "The Relation of the Two Jaws," page 164.

The body of the jaw, in transverse section, shows a U-shaped cortical or dense bony structure, the arms of the U terminating in the plates of the alveolar process,—outer and inner,—which are composed of a modified cortical bone with no definite line of demarkation between them and the body of the bone proper.

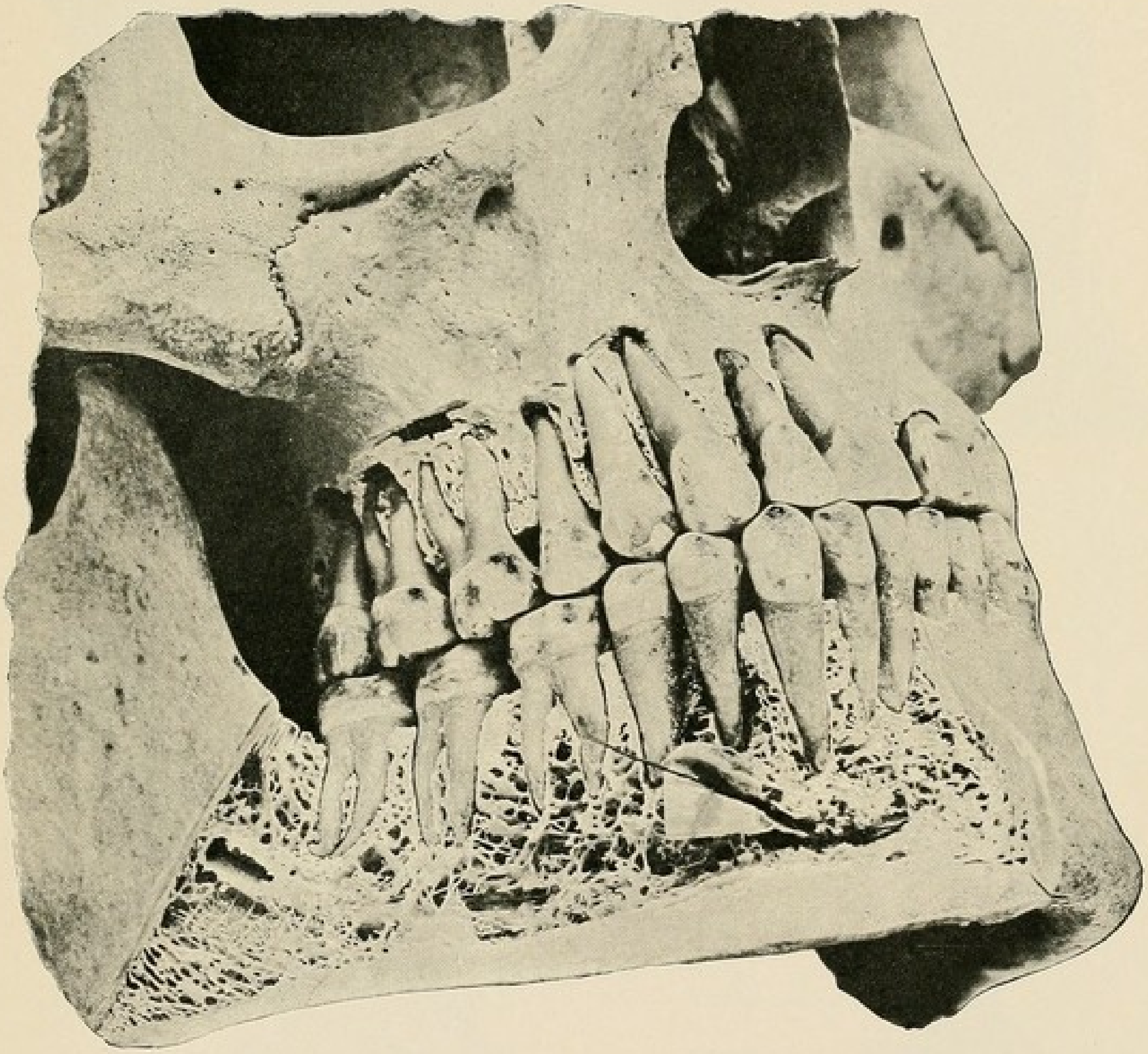
FIG. 3.



Two mandibles of aged persons. A, showing but a slight change in the angle, or gonion, while in B there is great change from that of adult life.

The bone proper is covered with a true periosteum, the alveolar process with muco-periosteum, the latter being thick and dense and containing few mucous glands. It is commonly known as gum tissue. The space between the arms of the U is filled with fine trabeculæ forming the cancellated structure. The roots of the teeth are imbedded within this cancellated structure, each root being surrounded with thin, compact bony tissue, which approaches the cortical bone in density, but is cribriform (sieve-like) in character. (See Figs. 4, 5, and 7.)

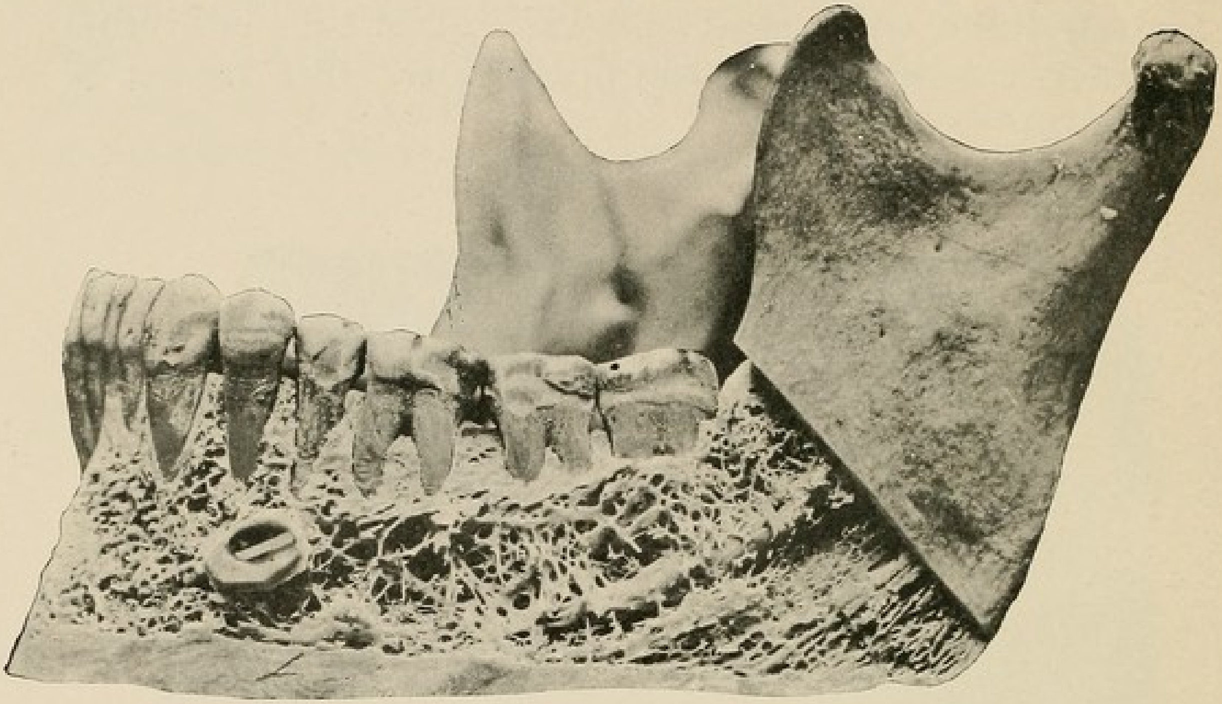
FIG. 4.



Anterior lateral view of upper and lower jaws, with the external cortical portion of bone covering the roots of the teeth removed, exposing the cancellated tissue, the roots, and the cribriform tubes.

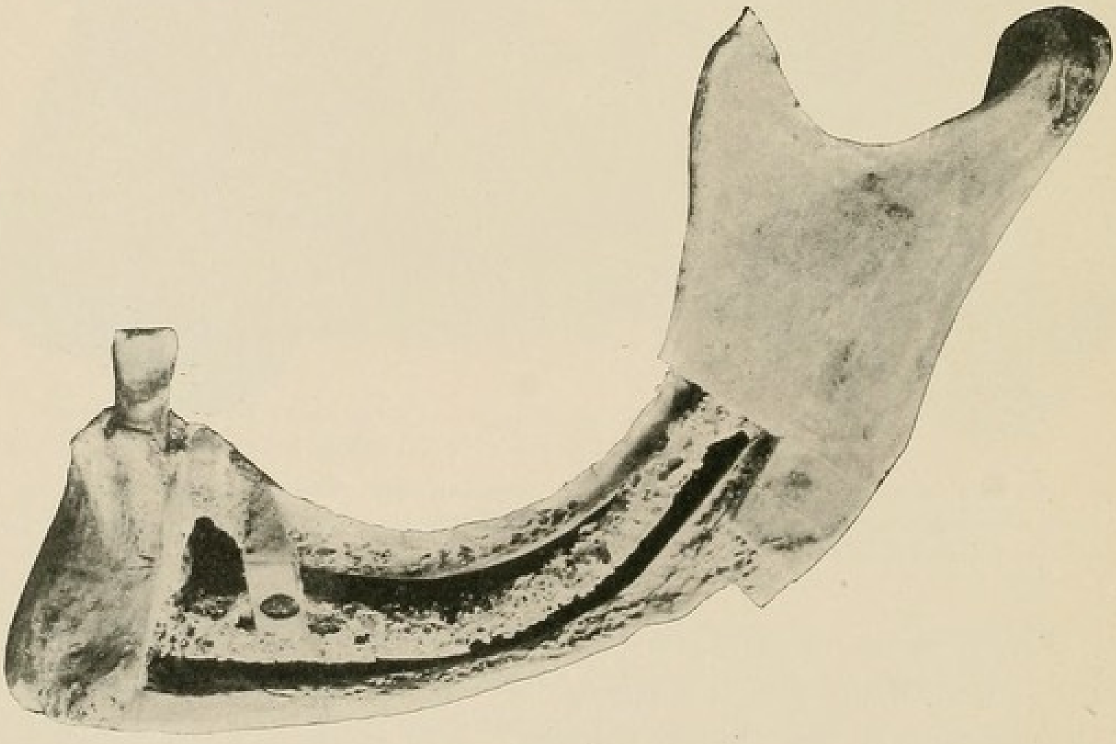
Fig. 7 is an upper view of the mandible with the teeth removed, showing single sockets for the ten anterior teeth and double sockets for the six molars. The shapes of the sockets as shown correspond with the transverse section of the

FIG. 5.



Mandible with the cortical portion of bone removed from the body.

FIG. 6.

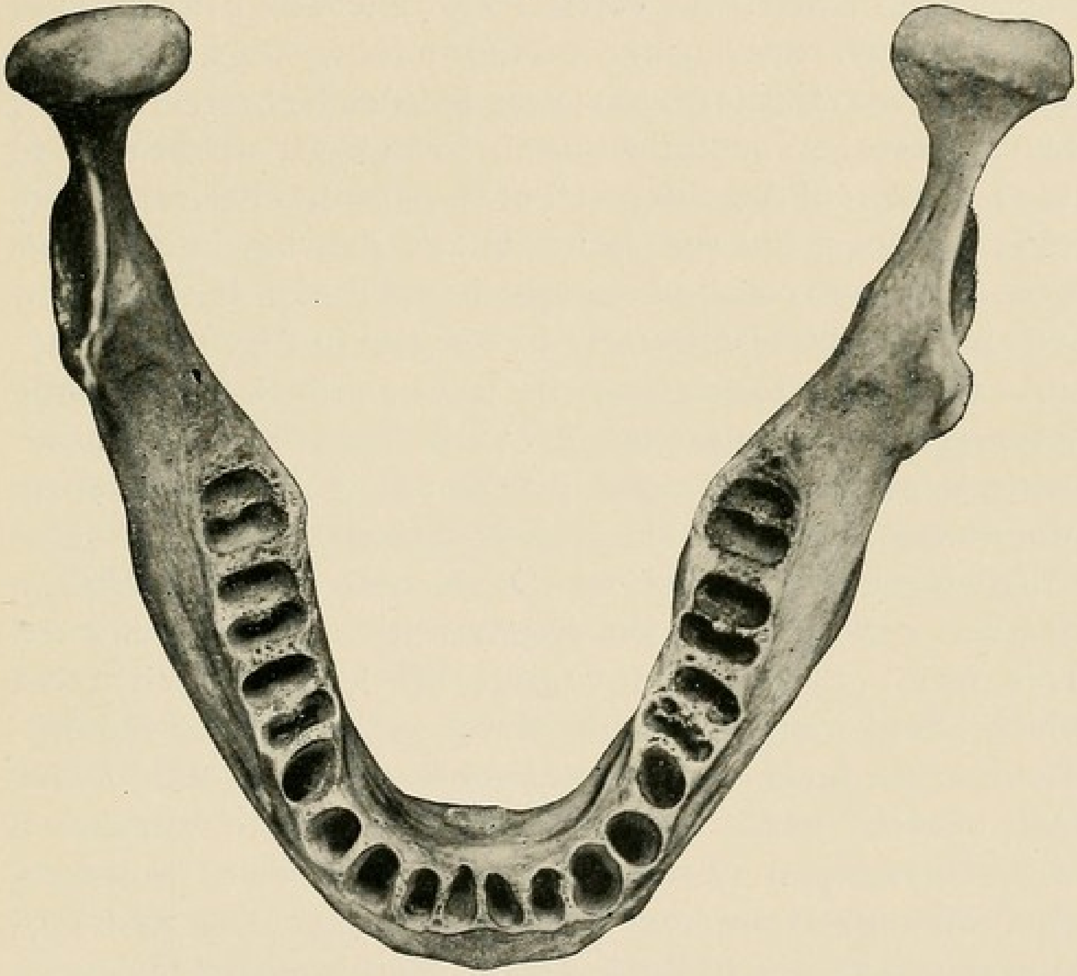


Cribriform tube (inferior dental canal) of the lower jaw isolated.

various teeth at the level of the margins. The septa between the sockets are cribriform in character.

Cribriform Tube. Through the cancellated tissue passes the so-called inferior dental canal, which is, however, more

FIG. 7.



View from above of mandible from which all the teeth have been removed, showing the cribriform character of the septa of the sockets of the teeth.

accurately described by the term, "cribriform tube of the mandible." The function of this tube is to afford a protective passage for the inferior dental nerve and the blood-vessels.

The cribriform tube passes downward and forward from the inferior dental foramen, at first along the inner cortical portion, then, after it leaves the ramus, gradually crossing over through the cancellated tissue toward the outer cortical portion and downward toward the border of the U-shaped space.

As it approaches the mental foramen, its course is near the outer cortical portion and along the lower border of the cancellated tissue, passing beneath the foramen to its termination near the roots of the incisor teeth. This tube can be removed from a normal jaw or isolated as shown in Fig. 6, taken from a specimen in which the cortical and cancellated tissues have been cut away, exposing the cribriform tube. Figs. 4, 5, and 6 show that the cribriform tube is an independent structure, not merely a canal through the bone. In Fig. 4 it will be noticed that a portion of the outer wall of the tube has been removed, while in Fig. 5 the wall is left intact, showing its tube-like form. The outer wall of the tube in the region of the second and third molars is extremely well shown in Fig. 5.

As the tube passes along the jaw its cribriform character becomes more and more marked until, beneath the first molar tooth, it becomes so opened, probably by a sort of stretching process coincident with the growth of the bone, that the tube-like formation is almost lost, as is well shown in Fig. 4. Further forward it again resumes its original character. This main cribriform tube gives off lesser branch tubes which afford passage for the nerves and vessels to the substance of the bone; also, in more or less curved course to the roots of each tooth. The branch tube for the accommodation of the nerves and vessels to the mental foramen is usually given off slightly anterior to the foramen, passing backward from the main tube to the foramen. This is almost invariably the rule,—namely, that the tube to the mental foramen is in the form of a return or recurrent canal, though occasionally it passes from the main tube as it approaches the foramen. The recurrent tube is well shown in Figs. 4 and 5. In the former, the anterior well of the mental foramen has been cut away, and in the latter, a narrow piece of paper has been passed through the foramen into the recurrent tube, showing its direction.

The Dental Branches. The small lateral tubes which serve as nerve and vessel conduits to the roots of the teeth posterior to the mental foramen are given off from the main tube and pass upward and forward in a more or less curved direction, the degree of curvature varying according to the position of the teeth. Those going to the third molar are nearly vertical in direction. In those going to the second molar the forward direction is greater; in those to the first molar this forward direction is increased still more, while those to the second premolar have the longest curve of all. Sometimes the tube passing to the second premolar, instead of beginning at the main tube, is found as an offshoot of that going to the anterior root of the first molar. The small tubes going to the first premolar and the canine are branches of the recurrent tube of the mental foramen, and are curved slightly backward as they pass upward to the roots. In the unusual cases where the branch from the mental foramen is not recurrent, but given off as the main tube approaches the foramen, the latter branches for these two teeth pass directly from the main tube, and with a slight forward curvature. The tubes for the supply of the incisors are also branches of the main tube, and curve slightly forward as they pass upward to the roots.

Method of Growth. The cortical U-shaped portion of the bone is the framework of the jaw, its supporting structure; it increases in length and breadth in a different manner from its contents. It is likely that it grows by an interstitial process, each half having three fixed points between which the growth occurs,—viz., the ramus, the mental foramen, and the symphysis menti (or gnathion). There is no doubt that the distance between these points increases, though the growth between the symphysis and the foramen does not occur at the same time as that between the foramen and the ramus. The periods of growth in these regions seem to correspond with the time of development and eruption of the teeth of the localities concerned. Thus, the increase between the mental foramen and the symphysis menti occurs during the time the incisor, canine, and premolar teeth are developing. After these teeth are erupted, there is little further increase in the length of this portion of the jaw. From the mental foramen to the ramus the increase is inconsiderable until the time draws near for the eruption of the second and third molars, the greatest growth occurring during the development of these teeth, and generally ceasing after the eruption of the last named.

The contents of the U-shaped portion grow forward as the cortical structure increases in length, the teeth immediately posterior to the mental foramen, which are first developed in this region, being pushed forward successively by each developing and erupting tooth. It is this forward movement which gives the curvature to the various small tubes to the roots of the teeth, etc., and accounts for the stretching of the main tube until its distinctive character is nearly lost under the first molar. It also affords a rational explanation of the recurrent feature of the tube to the mental foramen; the end of this tube being attached to the wall of the foramen, when in the process of growth the mass of cancellated tissue is pushed forward, the tube itself is carried along with it, forming a loop.

The reason why the small tubes going to the first premolar and the canine curve backward is, that their points of origin have been carried forward with the return tube from which they spring. The small tubes going to the incisors curve slightly forward, as they arise from the continuation of the main tube near the point where it curves backward to the foramen.

Surgical Significance. This anatomical arrangement has an important surgical significance in certain phases of the operation of resecting the inferior dental nerve, for if the general teaching of anatomy be followed the surgeon is liable to be misled. If the operator cuts down to the mental foramen, then seizes the mental nerve and uses it as a guide while cutting the bone away with the surgical bur from the posterior wall of the foramen, he will find that the nerve cannot be followed as a rule, as the nerve and the canal do not pass backward. But if the anterior wall be cut away, then the nerve can be followed down to the inferior dental nerve, which may then be uncovered to any distance deemed necessary.

Pathological Significance. The pathological significance of this bending backward of the nerve and its bony covering is that if any injury be received in this region, or if any inflammatory condition be produced, either traumatically or by infection from diseased teeth, the nerve is liable to become impinged upon or compressed, thus causing pain or inflammation of the nerve itself. The writer has found neuromata more common in this region than at any other portion of the inferior dental nerve, probably mainly due to the anatomical condition under consideration.

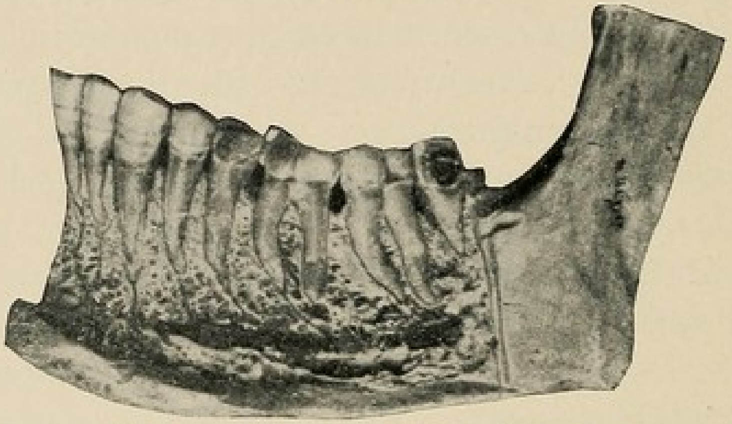
Records of Development. Thus it will be seen that the anatomical structures, the relation of the various teeth considered with regard to the order of their development, and more especially the direction which the lateral branches of the main cribriform tube take to form their connection with the roots of the several teeth, supply us with permanent records of the methods of growth of the mandible during the period between childhood and adult life.

In the boiled and cleaned specimen, naturally all the contents of the tubes—the soft tissues—have disappeared; but the illustrations (Figs. 4 and 5) show clearly that the main tube and the smaller ones passing to the various teeth, and the finer tubes going to the interspaces and general cancellated tissue, have the same general direction and curvature as those going to the roots in their immediate vicinity.

Fig. 8 shows a specimen from which the soft tissues have not been removed. It shows the smaller tubes passing to the roots of the teeth, with their contents, proving that these tubes do act as conduits for the nerves and blood-vessels.

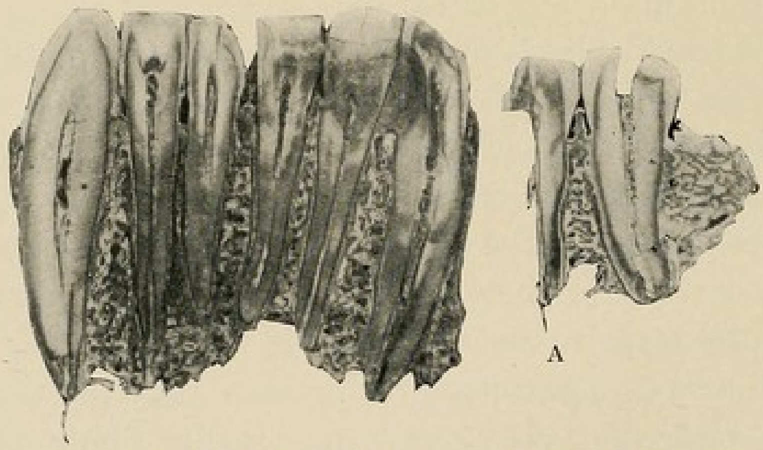
Fig. 9 is from a specimen which was prepared by grinding away the labial and lingual surfaces of the bone and teeth until the pulp chambers and apical foramina were exposed on both sides of the teeth, leaving the tissues extending out of the foramina and through a portion of the bony cribriform tube below. In one tooth, at A, the lateral wall has been broken away, leaving the tissues uncovered by hard structures on the three sides. It will be seen that the nerve has been pushed slightly away from the wall. In this dissection and in many others it will be observed that the tissues passing

FIG. 8.



View of mandible (left side), with the cortical portion of bone removed along with the cancellated tissue, exposing the nerves and vessels within the cribriform tubes as they pass to the roots of the teeth.

FIG. 9.

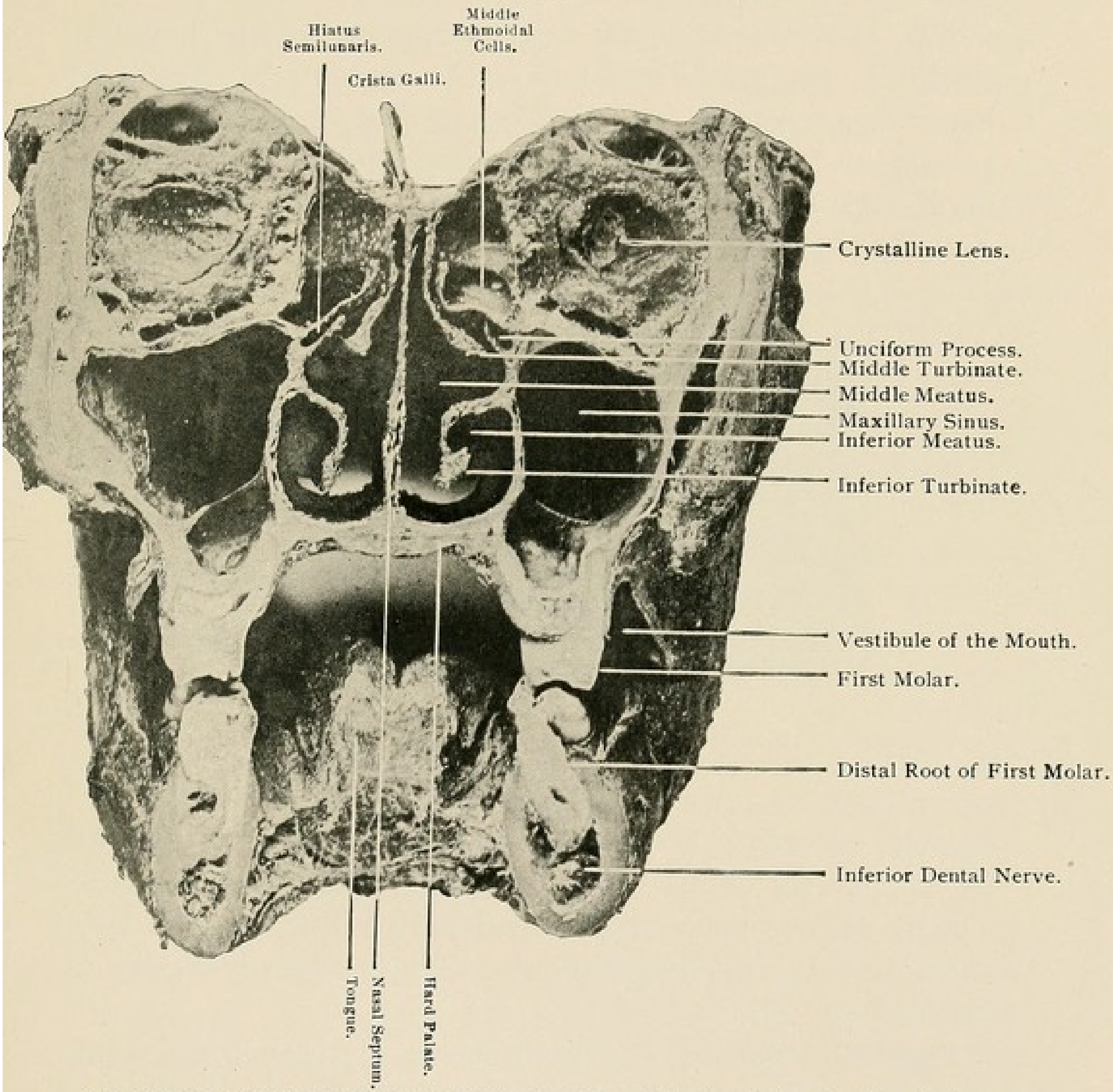


Ground section of the six anterior teeth and two left premolars.

into the teeth give off small branches from the nerves and vessels just below the apical foramen. So clear does this appear that the writer is of the opinion that the lower portion of the pericementum is supplied from the same branches of the nerves and vessels which supply the pulp.

Pathological Significance. The pathological significance of this condition is found in the reciprocal relation of pulp hyperemia and congestion with the same conditions affecting the

FIG. 10.



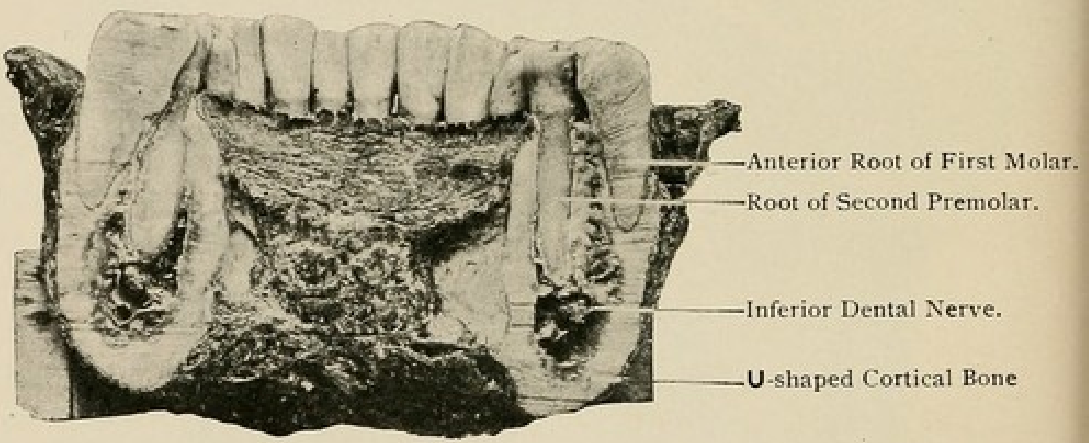
Anterior view of vertical transverse bilateral section of the head, showing the relations of the jaws and the U-shaped cortical bone of the mandible.

apical portion of the peridental membrane so frequently observed in clinical practice.

Fig. 10 is a vertical transverse section through the jaws and tongue at the location of the first molars, affording a good idea of the cortical portion of the bone heretofore referred to, of its relation with the roots of the teeth, and of the position of the cribriform tube with the nerve for which it serves as a conduit. (For further description of this illustration see Fig. 25, page 37.)

Fig. 11 is a view of the anterior portion of the lower jaw shown in Fig. 10. The roots of the second premolar, it will be seen, are nearly in a line transversely with the anterior roots of the first molar, a condition which is not at all uncommon. As the premolar roots are long and comparatively

FIG. 11.



A posterior view of an anterior transverse section of the mandible made through the anterior first molar, showing the U-shaped cortical bone.

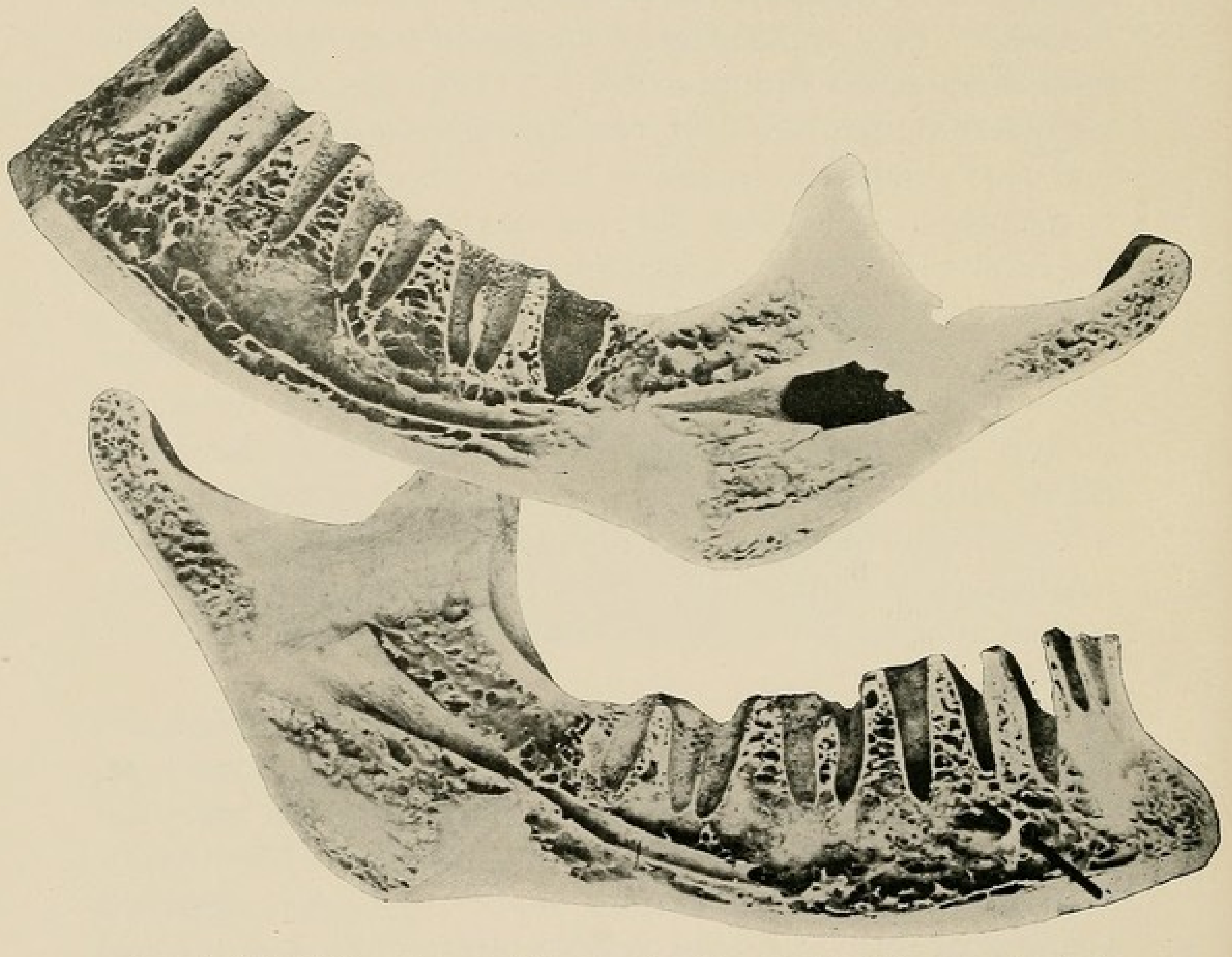
slender, extending below the roots of the molar, often nearly to the inferior dental nerve, while the bone at this point is usually very compact, the difficulty occasionally met with in extracting these teeth without breaking them is readily accounted for.

Surgical Pathology. The relation of these roots to the cancellated tissue of the jaw has a pathological significance. If their pulps become diseased and infected, the infectious matter may pass out through the comparatively open tissue and burrow in various directions, setting up an osteomyelitis and affecting the other teeth, eventually causing an abscess, the discharge of which may pass either through the mental foramen or through the alveolar wall into the mouth, or even through the main portion of the U-shaped cortical bone into the neck. The necrotic process thus extended may include in its destructive area the apical regions of several adjacent teeth, causing devitalization of their pulps. Some practitioners inject hydrogen dioxid through the teeth into abscesses of this character, even before a fistulous opening has formed. The decomposing of the dioxid in contact with the pus generates gas with great force. If this gas has not a perfectly free outlet, it will burrow through the soft tissues and may pass along the cancellated bone from one end of the jaw to the other. The writer has seen cases where such treatment has resulted in the formation of a large pathological canal extending from the symphysis menti to the angle of the jaw.

Fig. 12 represents the left side of a lower jaw cut lengthwise nearly through its center, exposing the cancellated tissue, the sockets of the teeth, and the cribriform tube or inferior dental canal, with its branches to the alveoli. As the tissue is very frail, a considerable quantity of the trabeculæ was lost in the cutting. The outer section shows the direction of the recurrent tube for the accommodation of the mental nerve and vessels.

Fig. 13 represents two sides of a metal cast showing the cancellated structure within the U-shaped portion of the bone. It was made in the following manner, from a perfect and thoroughly cleaned jaw with all the teeth extracted. After covering the openings of the sockets of the teeth with paper, the end of a slender tube about eighteen inches long was inserted in the inferior dental foramen. The bone and tube were then invested in plaster of Paris mixed with a little asbestos. After the investment was thoroughly set and dried, it was heated to about 212° F., and a metal of low fusibility was poured into the tube. This metal passed into the cribriform tube and along its course, finding its way out through the many openings into the cancellated tissue and into the sockets of the removed teeth. After the plaster investment was removed, the body of the bone and the lower portion of the ramus were placed in a 10 per cent. solution of potassium hydroxid, which dissolved the bone away, except where particles of the cancellated tissue are seen as white spots appearing through the

FIG. 12.

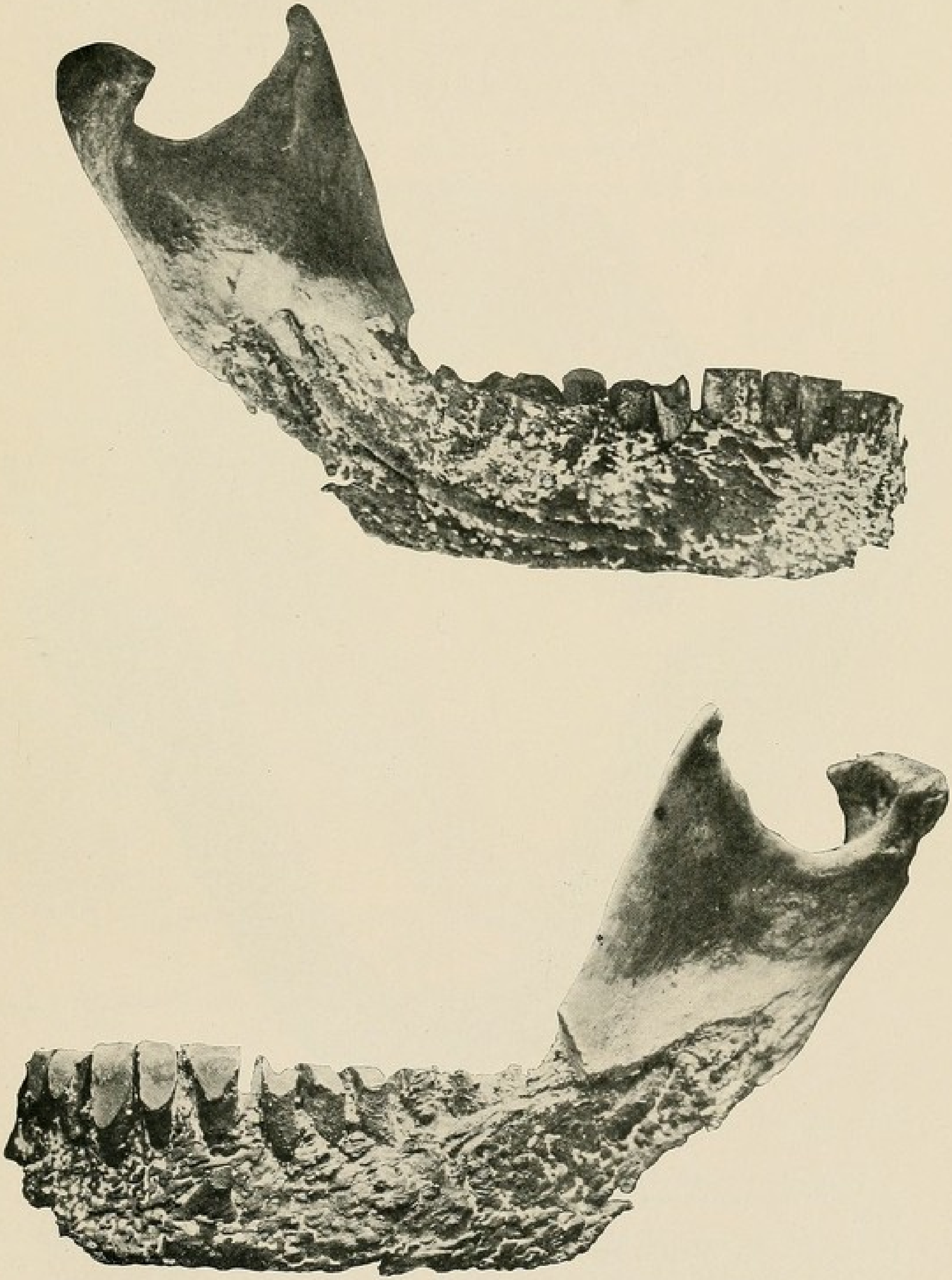


Longitudinal division of a mandible, exposing the cancellated tissues in the body of the jaw and between the sockets of the teeth.

metal. A transverse section of this preparation would show fine threads of bony tissue through the body of metal.

A, of Fig. 13, shows the inner surface, in which the cast of the canal or tube may be said to represent the space occupied by the nerves, blood-vessels, and their membranes. In B, which pictures the outer surface, the dense spot near the

FIG. 13.

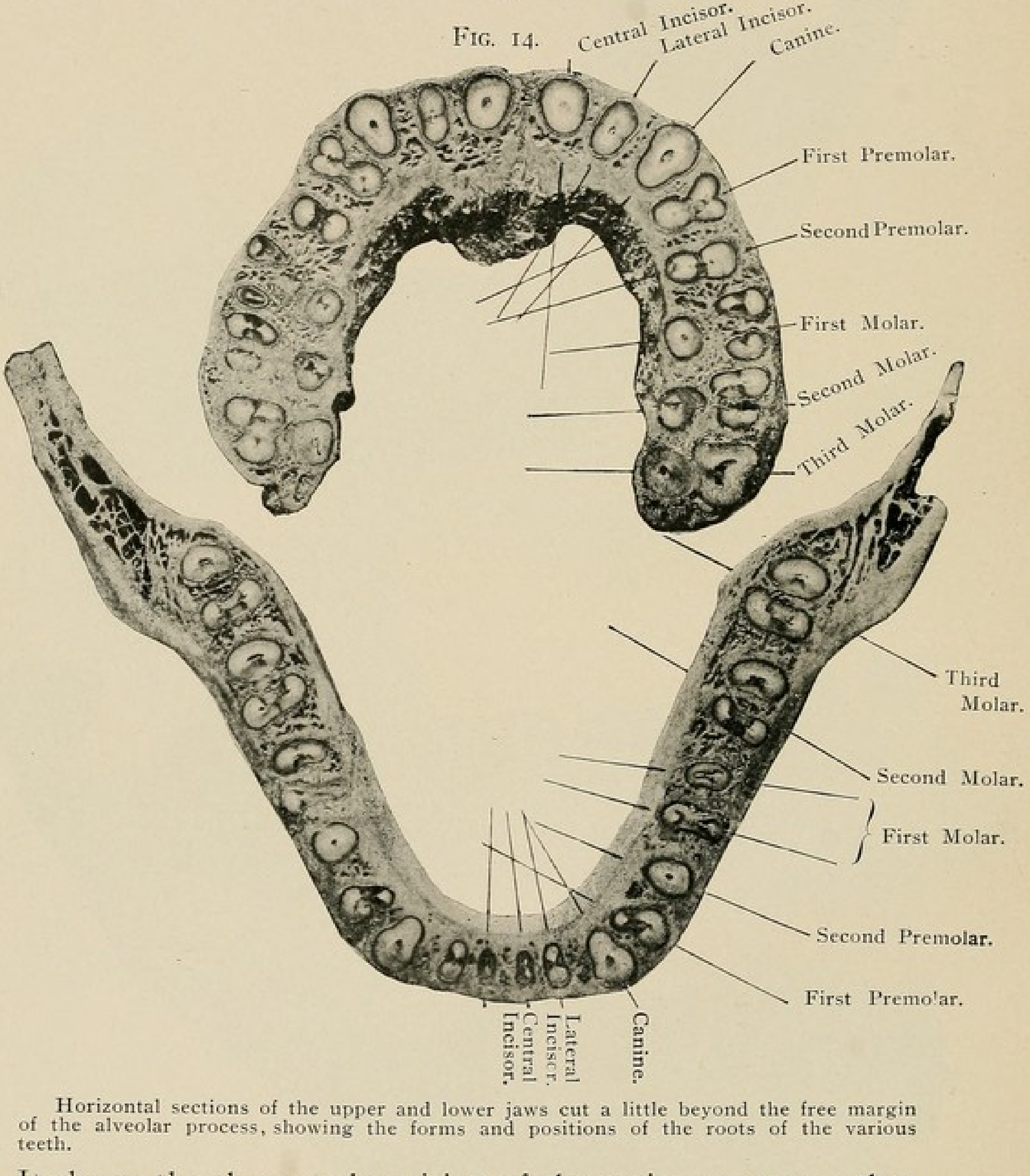


Two views of the sides of a metal cast of the open spaces in the body of the mandible.

border beneath the second premolar indicates where the nerves and vessels passed out of the mental foramen.

Fig. 14 is from a horizontal section of the upper and lower jaws, a little beyond the free margins of the alveolar processes.

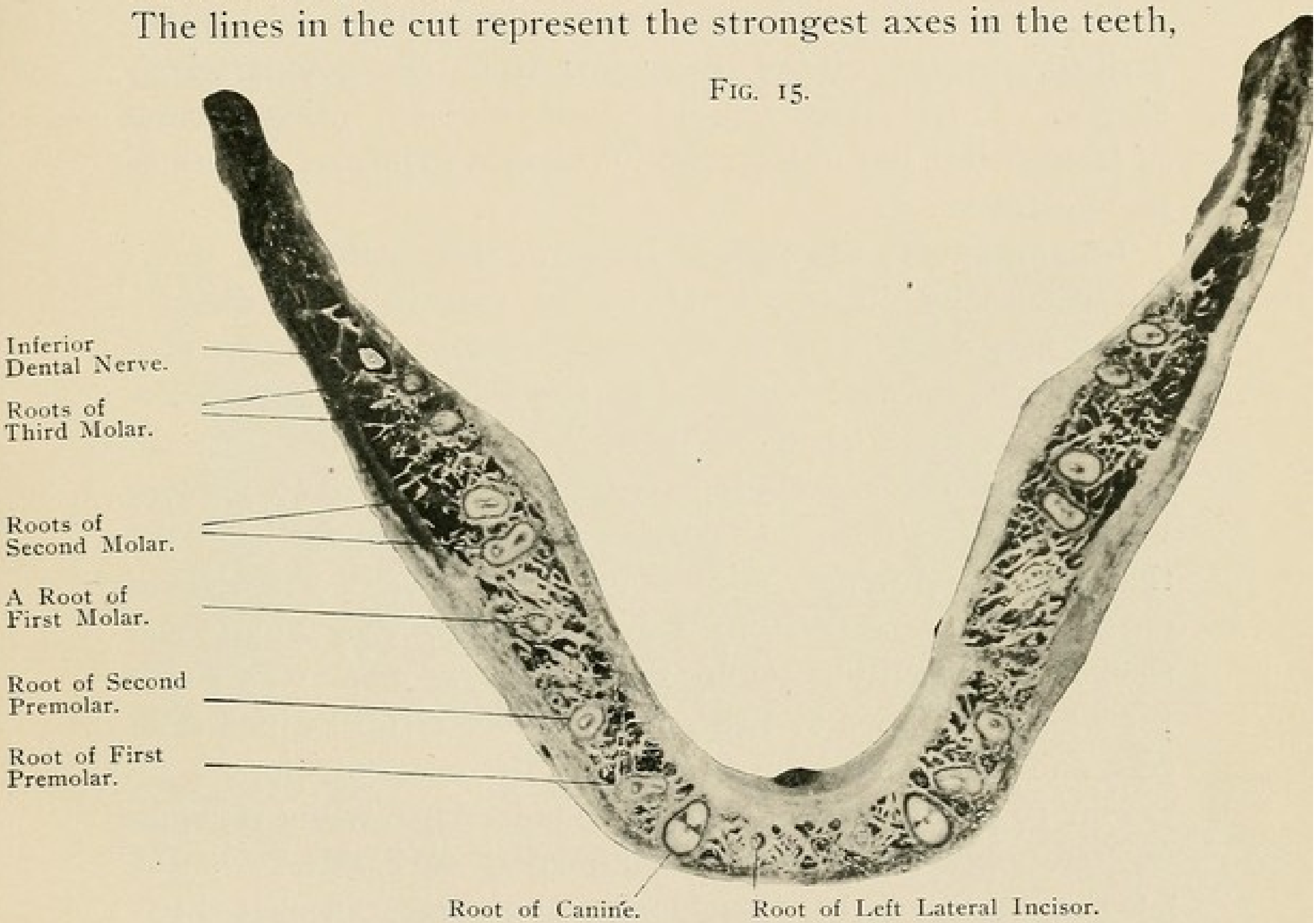
FIG. 14.



Horizontal sections of the upper and lower jaws cut a little beyond the free margin of the alveolar process, showing the forms and positions of the roots of the various teeth.

It shows the shape and position of the various roots on that plane, and their relation to the process and to one another. The conditions here shown are so common as to warrant their classification as the normal type. Particular attention is drawn to the slight distance between the roots and the plates of the alveolar process. It would be manifestly impossible to force the beaks of forceps between the roots and the alveolar process in such cases without breaking the latter on one or both sides. The not infrequent splitting off of a section of the alveolar process in extraction is thus readily accounted for. The lines in the cut represent the strongest axes in the teeth,

FIG. 15.



Horizontal section of the lower jaw cut in the region of the points of the roots of the teeth.

those along which the greatest force is exerted in extracting operations, and which are usually at the same time the lines of least resistance of the surrounding tissues.

The roots of the teeth extend to various depths in the lower jaw, as is seen in Fig. 15, which represents a section cut horizontally, from the same subject as Fig. 14, though nearer to the ends of the roots. The ends of the roots of the second and third molars are plainly seen, also the tip of one of the roots of the first molar, and the roots of the first and second premolars. A little of the lateral incisors will be noticed, but the centrals do not go down so far. The cancellated portion, with the soft tissue filling the spaces, is well shown in the posterior portion of this picture. The nerve is seen passing into its tube.

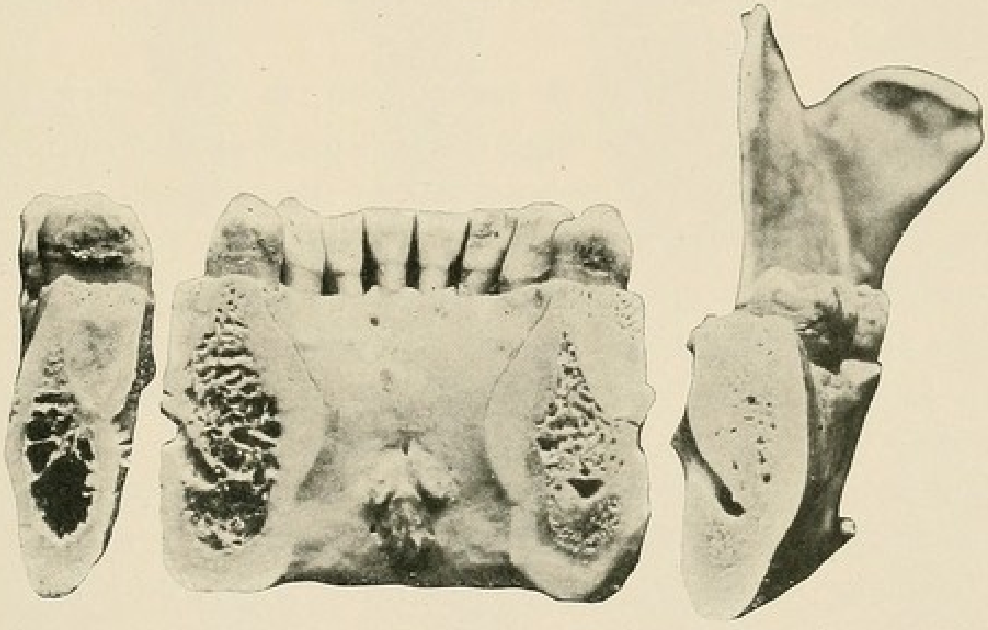
If all mandibles with their teeth were like those just described, surgery of the lower jaw would be comparatively simple. In fact, there would be little to do excepting in cases of traumatism, but unfortunately this is not the case, as will be demonstrated.

Inflammatory Changes. Inflammation within the lower jaw caused by diseased teeth, or by constitutional disturbances, may completely change the character of both the cancellated and cortical portions, by stimulating the bone-building cells of these tissues to undue activity. Under such circumstances, the cancellated tissue may be filled up or converted into a substance so nearly resembling the cortical bone that the line of demarkation is obliterated; while the cortical portion may be solidified—made more dense, ivory-like—and thickened, presenting conditions which very much complicate the situation and make the performance of operations difficult, and sometimes impracticable by the usual methods.

Fig. 16 is taken from a section made transversely through the lower jaw at the mental foramen of each side. On the left side the cortical U-shaped portion and the cancellated tissues are about normal and in condition similar to those in Figs. 4 and 5, while on the right side the cortical portion has thickened and become dense, and the cancellated tissue has become filled with secondary bone deposit. The only apparent reason for this difference is that all the teeth on the left side were in good condition, while on the right side the first molar had been much diseased, causing the inflammation of that side of the jaw; vascular excitement induced activity of the osteoblasts, which caused the deposit of secondary bone.

Inflamed conditions in the jaws of children, occasioned either by abscessing teeth or by constitutional disturbances, will cause the deposit of secondary bone within the cancellated tissue, binding it to the U-shaped cortical portion. In such cases, when the time for the eruption of the molars arrives, especially of the second and third, it is impossible for the cancellated tissue and the erupting teeth to glide forward as shown in Fig. 5. Many cases of the impaction of the third molar are doubtless due to the existence of such conditions.

FIG. 16.



Transverse division of a mandible at the mental foramina. The left side is in an almost normal condition, while on the right side the cortical bone has thickened and become dense, and the cancellated tissue has become filled with secondary bone deposit.

Surgical Pathology. The normal and pathological anatomy of the two sides of the jaw shown in Fig. 16 would require different modes of surgical procedure. The teeth on the right side, being placed in an unyielding bone, would fracture in an attempted extraction, and the roots would remain in the jaw. The cutting of the bone down to the inferior dental canal and nerve on the left side in a case of this character would also be quite a different operation from a similar operation on the right side. The first would be done with ease, the other with difficulty, and when the cutting was done it would be difficult to find and remove the nerve. Correction of irregularities of the teeth in the consolidated area would be almost impossible.

Necrosis and Regeneration. If certain portions of bone be lost, either by necrosis or even by surgical operation, under favorable conditions some new bone will be formed.

In the lower jaw the regeneration of bone is more likely to occur than in the upper. After removal of a section of the jaw regeneration of bone commonly takes place, and if the stumps are held in position and the space is not too great, a natural bridge is formed between them, especially if portions of the periosteum are left.

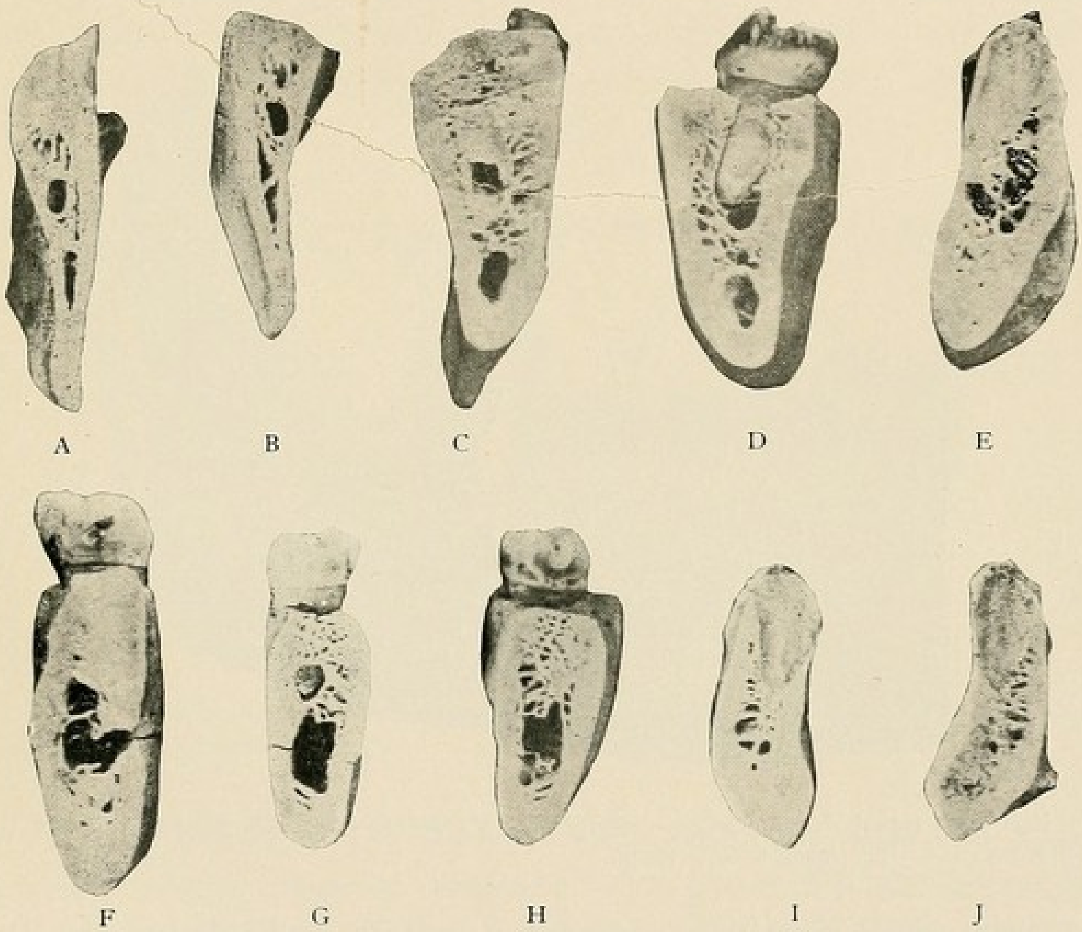
Neuralgia. Secondary bone deposit in the cortical and cancellated tissue of the face is an important factor in producing facial neuralgia, as branches of the trifacial nerve pass through not only to the bone itself, but also to the region beyond in various directions. In the left side of Fig. 16 the spaces are comparatively open, while the right side of the same jaw is nearly solid; nerves passing through this half would be impinged upon, and neuralgia, the cause of which would be difficult to determine, would result. In neuralgia from this cause, the obvious treatment would be the burring away of the greater part of the abnormally solidified bone, using the surgical engine, a much better agent for its removal than the ordinary mallet and chisel.

Secondary Deposits. The cancellated portion of the mandible usually increases in compactness as persons advance in years. Along with the progressive increase in density of the tissues due to advancing years, other factors, pathological in character, by which the teeth become diseased, set up an inflammatory condition, which causes secondary deposits.

Fig. 17 shows several sections from a lower jaw, which was not quite normal, there being evidence of past inflammation having changed the structure of the bone. Several teeth had been extracted before death. In some of the sections only one canal is seen, while in others several appear, necessitating close observation to decide into which the main nerves and vessels have passed.

In the resection or removal of the entire nerve from the bone, a surgeon not anticipating this condition might easily clear out a portion of a canal without touching the main nerve. This mistake might not occur in the dry bone, but

FIG. 17.

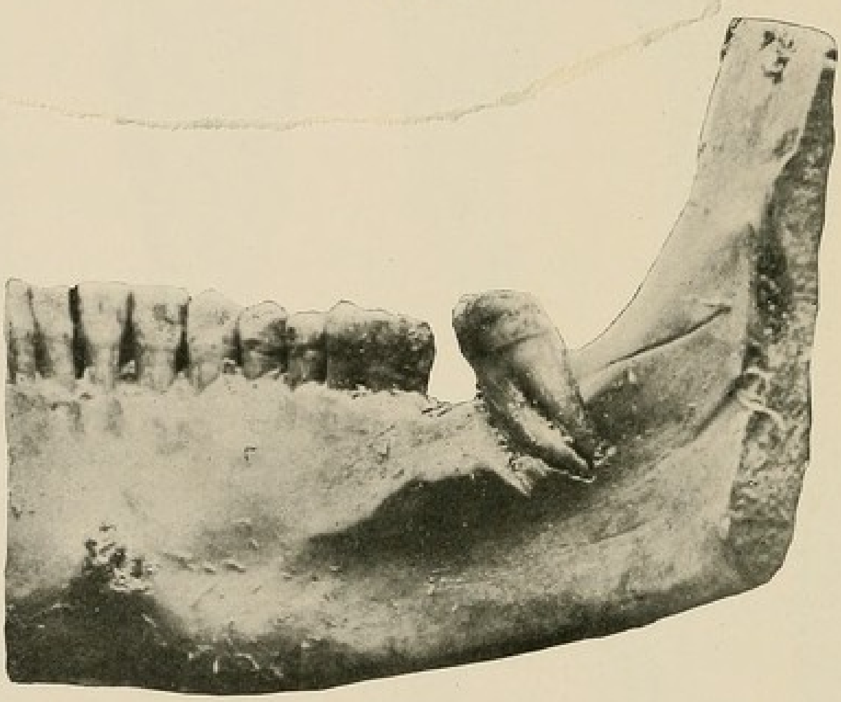


Sections made at different points from a mandible which was not quite normal in its density.

in the living, where the parts are vascular, the error could easily be made. In section D it will be seen that the anterior root of the second molar penetrates the true nerve canal. In case of abscess of this root, the discharge would flow into the nerve canal, thence backward or forward along the nerve, causing great pain by compression.

Fig. 18 represents a specimen in which the roots of the third molar passed out through the inner wall of the lower jaw, at a considerable distance below the mylo-hyoid ridge. A putrescent pulp in this tooth would have discharged its infective matter at once into the submaxillary triangle. The writer believes that there are many serious unrecognized cases where devitalized teeth of this character cause infection of the tissues of the neck, and even of the thoracic cavity. Therefore, if diseased teeth in this region do not respond to treatment

FIG. 18.



Part of a mandible showing the roots of the third molar tooth passing through the inner wall into the submaxillary fossa.

at once, they should be extracted, as not only ill health, but death itself may and does occur from their presence. The writer has seen large triangular swellings just under the jaw, which indicated that there was trouble within the submaxillary triangle, a symptom of an enlarged submaxillary gland. Upon examination of the teeth a diseased molar was found, and after this tooth was removed the swelling subsided.

Mandibular Triangle. A marked variation of the lower jaw is found in the relative distances between the centers of the two condyles and between these and the central incisors.

These measurements have been commonly accepted as describing an equilateral triangle. The measurements of the jaws which have passed through the writer's hands do not bear out this hypothesis. In fact, the variations are as great as in any other feature of the face. In only one case was an exact equilateral triangle found. Some approached that figure, but in the great majority the sides of the triangle, taking the distance between the centers of the two condyles as the base, considerably exceeded the length of the base. In rare instances the base exceeded the length of the sides. The varia-

Fig. 19.

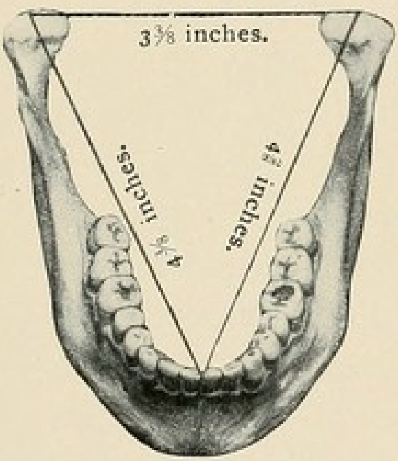
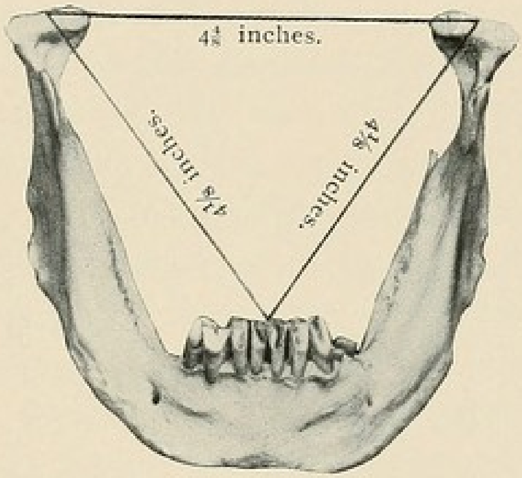


Fig. 20.



Two mandibles showing variations in distance between the two condyles and from the condyles to the incisor teeth.

tions here noted would seem to indicate that while the equilateral triangle may be assumed as a general basic principle in the architecture of the lower jaw, the variations are the anatomical facts with which we are practically concerned so long as the hypothetical form remains unproved.

Figs. 19 and 20 are made from photographs of two jaws in which rather extreme conditions were found. In Fig. 19 the base of the triangle is nearly one-third shorter than either of the sides. In Fig. 20 the base exceeds either side. Between these extremes (and probably to some extent beyond them on either side) every variation in the relation of the sides to the base of the triangle may be found in normal jaws.

In this description of the lower jaw or mandible, the intention has been to emphasize the necessity for the surgeon to promptly recognize departures from the accepted diagrammatic form of the normal jaw, and the results of pathological changes in its structures. The attempt has been to illustrate this necessity by typical cases which should serve to enforce principles rather than enter into details.

THE MAXILLA OR UPPER JAW.

THE upper jaw, from a surgical point of view, includes the right and left maxillæ, and in addition all the other facial bones except the mandible and part of the ethmoid and sphenoid bones of the cranium. The surgical operation of removing the right or left maxilla does not usually involve the removal of the entire bone, for the nasal process, the floor of the orbit, and the zygomatic surface may be left. In its removal, however, the inferior turbinate, portions of the lachrymal, the palatal, the malar, and the ethmoid bones will probably be removed with it. Especially is this true in the general method of operating, but if the resections are made with the assistance of the surgical engine, the greater portion of the associated bones may be left undisturbed.

Architectural Features. The maxillæ are situated beneath the walls of the anterior fossæ of the brain-case and rather loosely attached by what may be termed buttresses and flying buttresses. In the center, near the nasion, the nasal processes rest firmly against a buttress in the median line, the internal angular processes of the frontal bone. Below is a flying buttress, the nasal septum, especially that portion formed by the vomer, which passes upward and backward from the inter-articulating ridge of the maxillæ and palate bones to the buttress-like body of the sphenoid bone, where it is firmly held or braced in place by the vaginal processes. Laterally the upper jaw is supported through the malar bones by the external angular processes of the frontal bone and the flying buttresses of the zygomatic arches to the temporal bones at the sides of the skull; posteriorly by the pterygoid process of the sphenoid, with a portion of the palate bone interposed.

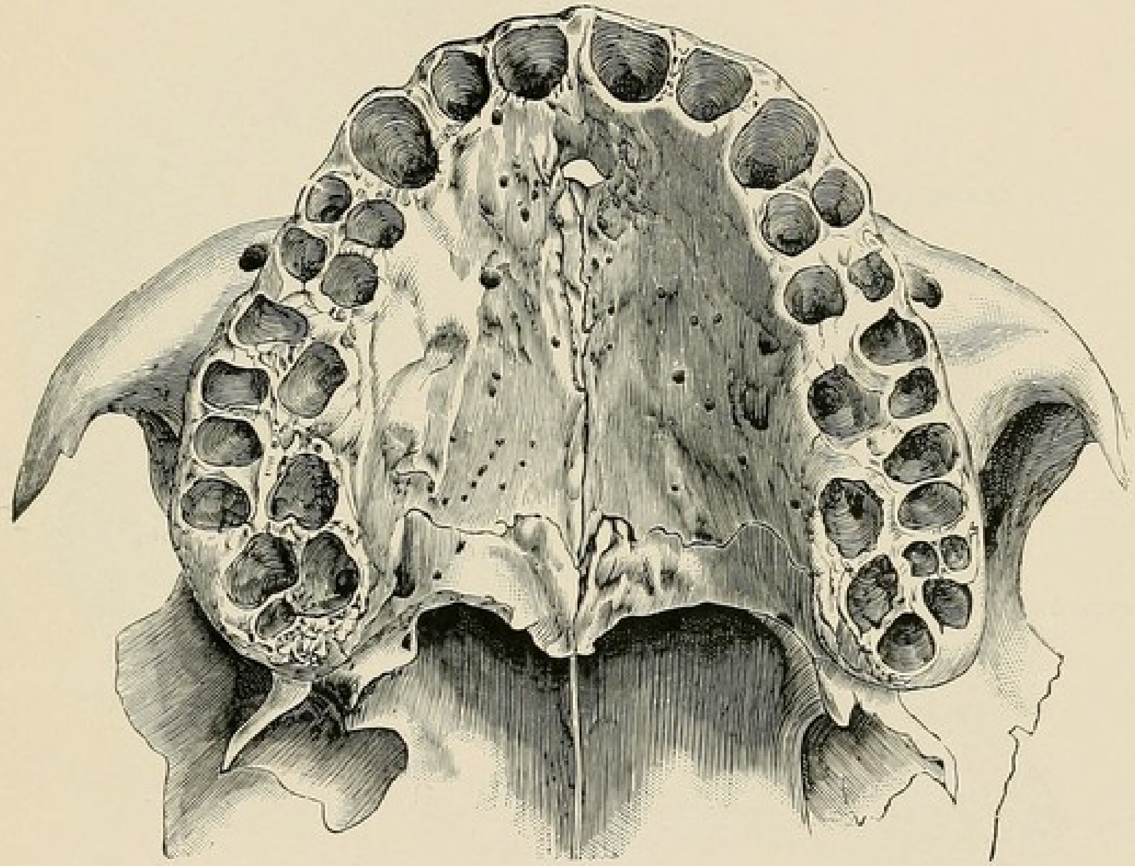
The buttresses, situated and distributed as they are, not only afford support against forces acting externally, but also dissipate and diffuse shocks which would otherwise be transmitted to the cranium. As a consequence of its construction, but little force in a forward direction is necessary to detach the upper jaw from the cranium, though it will withstand a blow of great force received from below through the lower jaw or from in front, or even from the side.

Pathological Relations. The upper jaw gives support to one-half of the teeth and like the lower jaw is subject to defects of development and to various pathological changes, chief among which may be mentioned cleft palate, congenital or acquired; necrosis, caries, sarcoma, odontoma, odontocele, impacted and supernumerary teeth. It may also be affected by alveolar and dento-alveolar abscesses, diseases of the mucous-lined sinuses and air spaces, which last may also give rise to such symptoms as impaired respiration and the discharge of offensive matter. Tumors or abscesses of the maxillary sinus often grow to such a size as to elevate the floor of the orbit, depress the roof of the mouth, and force outward the walls of the cavity, distorting the contour of the face in the region of the canine fossæ. Neuralgia in the teeth may be symptomatic of disease of the bones of the jaw, and neuralgia in many regions of the head is traceable to the teeth.

The under surface of the upper jaw is bounded by the alveolar process and the roof of the mouth or the palatal processes, both of which are covered by periosteum and mucous membrane (muco-periosteum). That portion of the mucous membrane over the alveolar process is thick and dense, and is known as gum-tissue; it contains but few mucous glands, while the portion covering the roof of the mouth is not so dense and is well supplied with racemose mucous glands.

The Alveolar Process. The alveolar process is made up of two plates, an external and an internal, consisting of dense, compact, cortical bone. The outer plate extends upward and merges, without a line of demarkation, into the outer surface of the true maxilla. The inner plate extends upward and inward and is continuous with the palatal process of the palate bone and maxilla proper. The space between the plates is occupied by the sockets of the teeth, the alveoli, which are surrounded by a very thin cribriform plate of bone, by cancel-

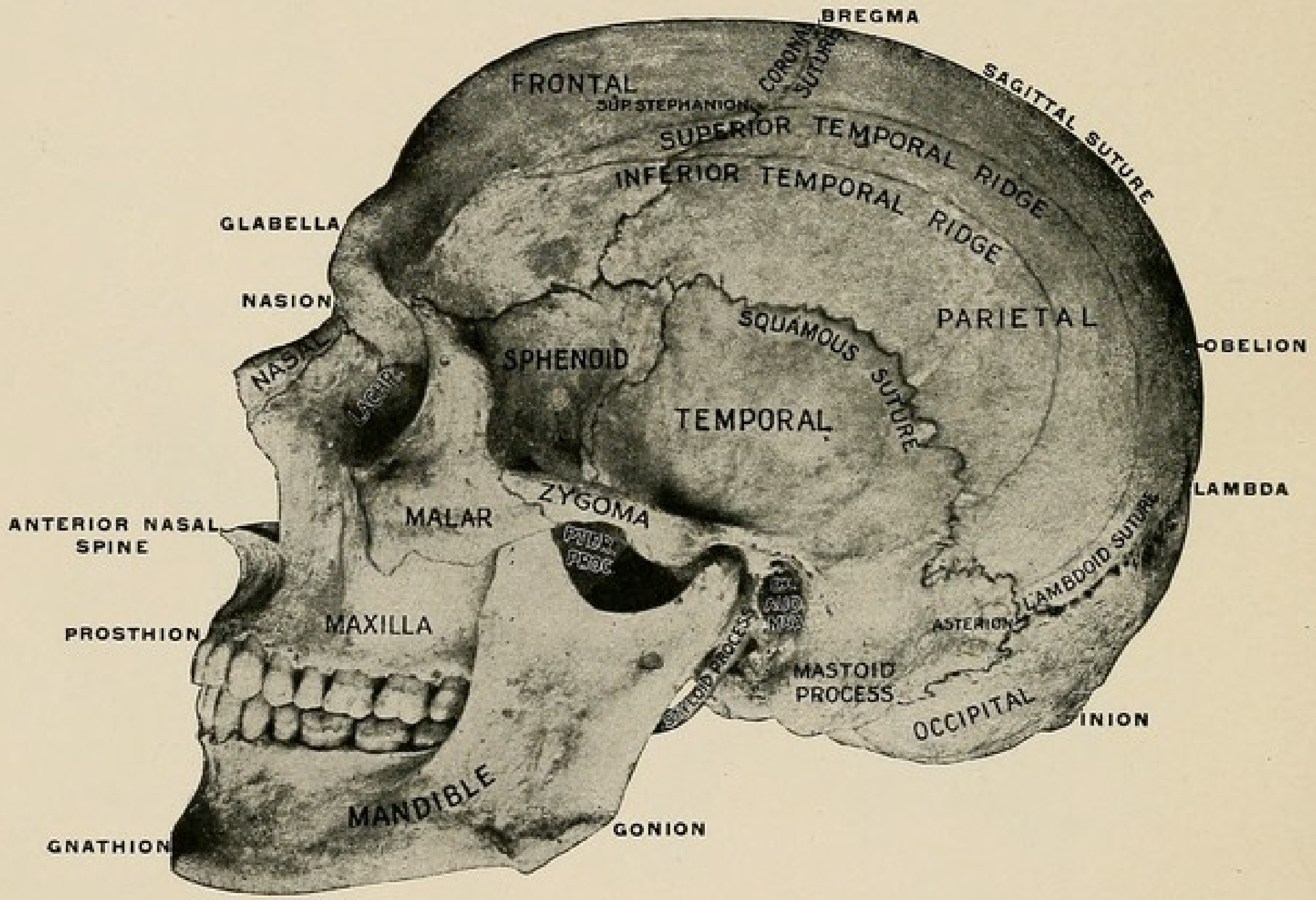
FIG. 21.



View of the under surface of the upper jaw showing the alveoli of the various teeth.

lated tissue, nerves, vessels, etc. The alveolar process belongs to the teeth and is developed with them for the purpose of holding them in position. It disappears in various degrees after the teeth are lost, sometimes before, more especially when there is pyorrhea alveolaris, and also as an indication of advancing old age. Should the alveolar process be the primary seat of disease, sound teeth will loosen and may fall out. The outer alveolar plate is resorbed after the loss of the teeth to a greater extent than the inner one, which is of advantage to the dentist in fitting artificial teeth to the gums; consequently, in extracting teeth this fact should be remembered, so that injury to the internal plate may be avoided. At the same time, no particular harm results from the removal of a small portion of the outer plate, though the loss of any of the gum-tissue should be avoided if possible.

FIG. 22.



Side view of a typical skull.

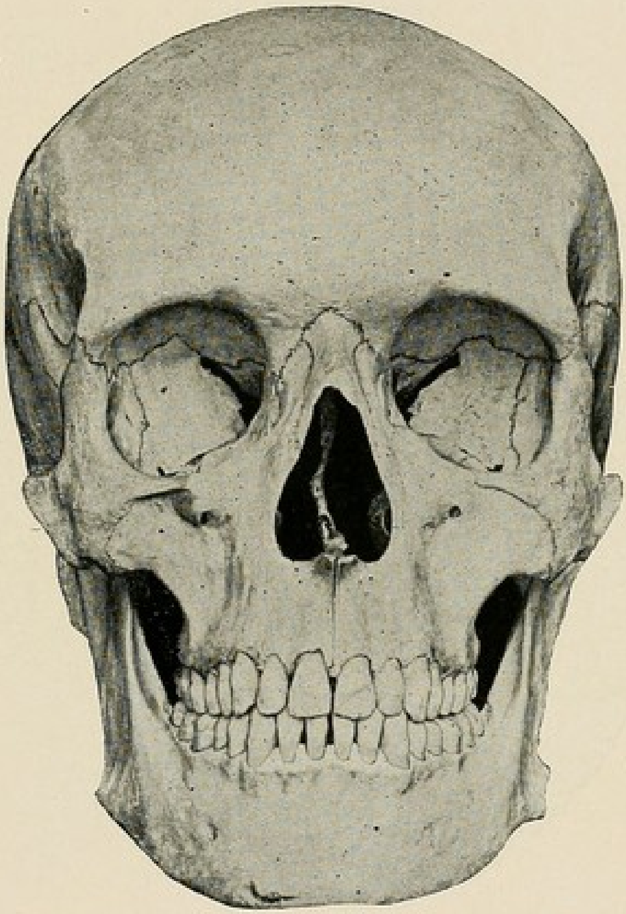
Fig. 21 gives a fair idea of the alveoli of the upper jaw. It will be observed that there are two sockets for the roots of the second premolar teeth. This is not usual, though it occurs occasionally. On the right side there are spaces for five roots for the third molar, which also is not common.

In order to thoroughly appreciate the differences in the bony anatomy of the face, it is necessary to study skulls and bones considered typical at various periods of life.

Fig. 22 gives a side view of an almost ideal skull, with its perfect occlusion of the teeth, and with the various bony parts indicated according to the received modern nomenclature.

Fig. 23 represents a front view of the same skull. It is nearly symmetrical, presenting the typical anatomy of the external bony structures of the face. There is but the

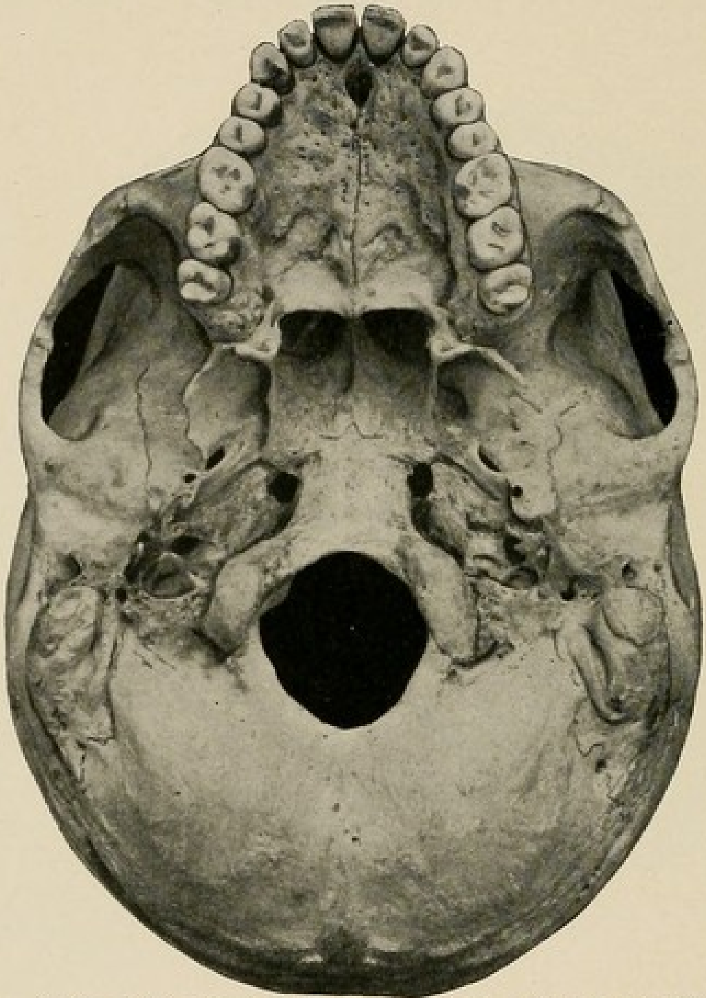
FIG. 23.



Anterior view of the typical skull shown in Fig. 22.

slightest variation in the two sides. It will be noticed that the upper right first molar stands out slightly more than the left. The septum of the nose is seen to be deflected in the same direction, and upon examination of the internal structures of the nose it is found that the bulla ethmoidalis is enlarged on the left side, projecting toward the concavity in the septum. This is an example of what might be taken as quite a constant anatomical law, that when the mouth, palate, and dental arches are bilaterally symmetrical, the outer cranial structures exhibit a like condition. What is more, this bilateral symmetry will be found to extend throughout the body. However, this law, as well as all others relating to anatomical science, has its exceptions.

FIG. 24.



Under view of the skull shown in Figs. 22 and 23, with the mandible removed.

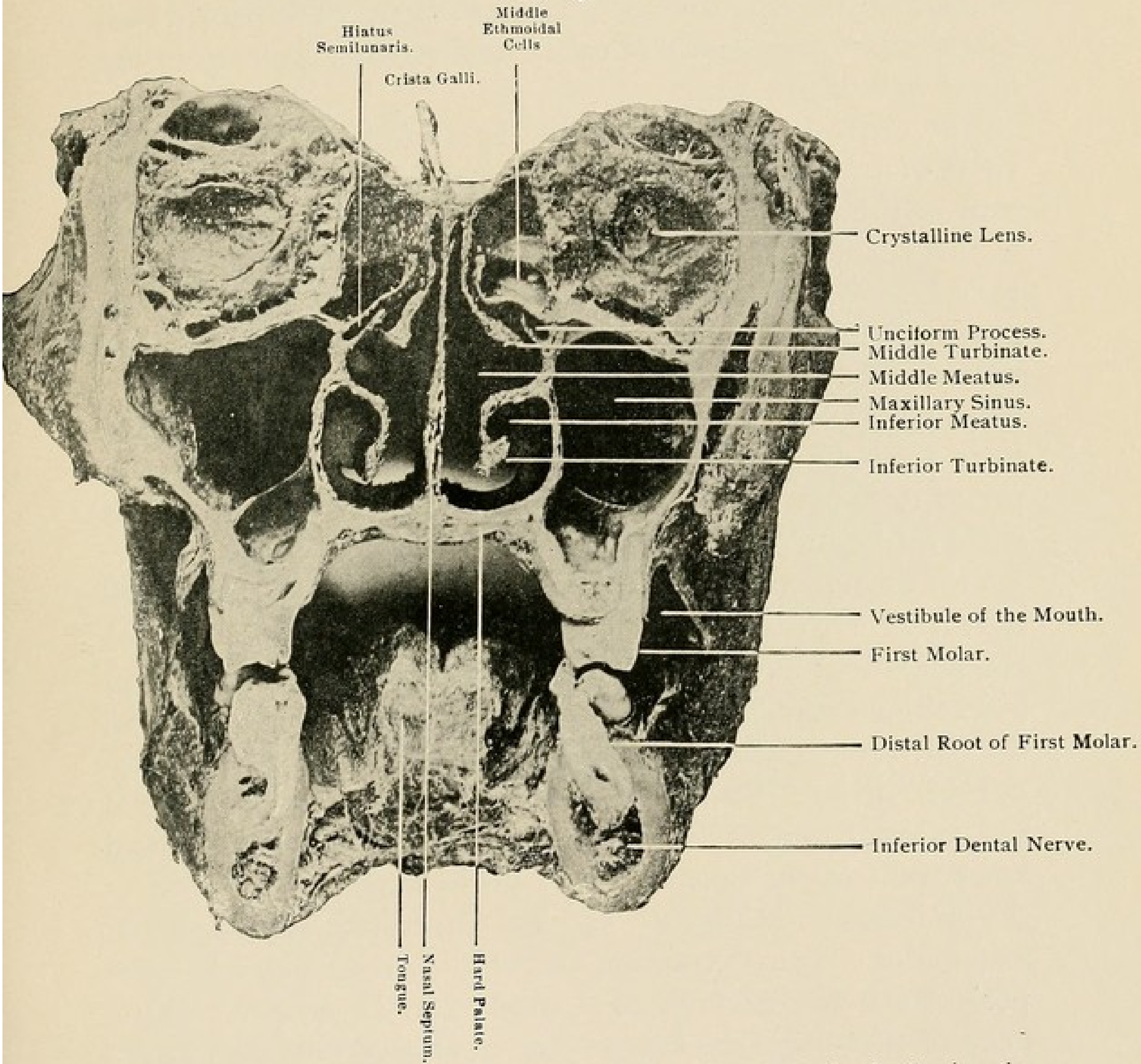
Fig. 24 shows a view of the same skull from below, where it still appears almost perfect anatomically. The slight projection of the upper right first molar is again observable, and it will also be seen that the external plates of the pterygoid processes are not quite alike on both sides; there is also a slight difference in the zygomatic arches.

Fig. 25* shows a transverse bilateral section, passing verti-

*Fig. 25 is a repetition of Fig. 10.

cally through the anterior portion of the orbit, the maxillary sinus, and the first molar of each jaw, dividing the eye just in front of the crystalline lens. In the upper portions of

Fig. 25.



Anterior view of a vertical transverse bilateral section of the head, showing the relations of the jaws, and indicating the positions of the turbinates, antra, etc.

the nasal cavities are seen the middle ethmoidal cells. At about the center of the floor of the orbit and the roof of the sinus, which is very thin in this case, will be found the infra-orbital canal as commonly described, and below, the nearly pyramidal cavity of the maxillary sinus, with a partial septum crossing transversely from the inner to the outer wall.

In the lower angle of the left sinus can be seen the anterior buccal root of the second molar, while on the inner wall is a portion of the palatal root of the first molar. The palatal root of the right first molar is easily seen passing well up in the inner wall of the sinus.

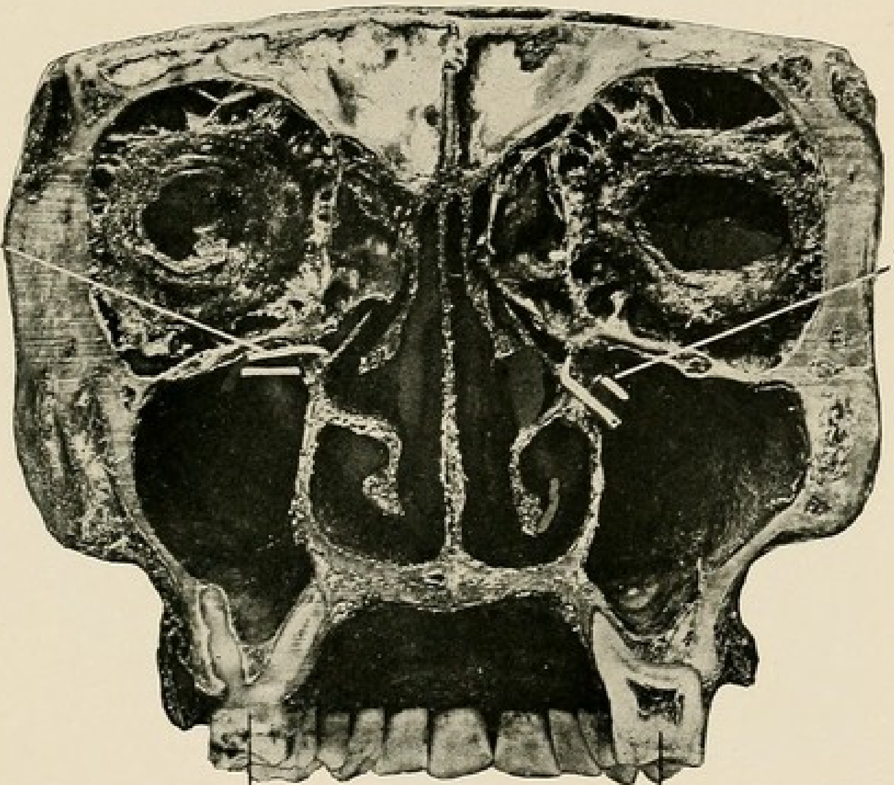
The central portions of Figs. 25 and 26 afford excellent views of transverse sections of the nasal chamber. The septum in the center is unusually straight. Above the septum is the crista galli, to which the falx cerebri is attached anteriorly. On each side of the septum, at the upper attachment, is the roof of the nasal chamber. Running down on either side at a little distance from this are the middle turbinate bones, the scroll-shaped bones below, and, hanging from the outer wall, the inferior turbinate bones. The superior turbinate bones cannot be seen in a section cut in this region, as they are situated further back in the skull.

Fig. 26 represents the anterior portion of the same skull shown in Fig. 25. At the anterior superior angle of the antrum is seen a cord marking the passage (ostium maxillare) from the antrum into the hiatus semilunaris. In the floor of the antrum will be seen the septum referred to in the description of Fig. 25. On the left side will be observed the palatal and anterior buccal roots of the first molar in the outer and inner walls of the antrum. The positions of these roots, as shown here and in Fig. 25, are very interesting from a dental standpoint. The extraction of teeth having roots in such positions, if not carefully done, might carry away parts of the floor of the sinus (see Fig. 58), or in case of breakage in extracting, the roots could easily be forced into the sinus by injudicious use of the forceps. Also, by using too much force in placing artificial crowns, the floor might be fractured.

In the majority of the skulls belonging to the white race so far examined, roots of the molar teeth pass up into the walls of the antrum, being covered at the point where they approach the surface by only a thin conical portion of bone.

Fig. 27 shows a section similar in character to Figs. 25 and 26, but from a negro skull. Note the great thickness of the floor of the antrum, and the position of the roots of the teeth. In the negro race the walls and the floor are much thicker than in the white; therefore, as a rule, the roots of the teeth do not pass up into the wall, or even near the floor of the sinus.

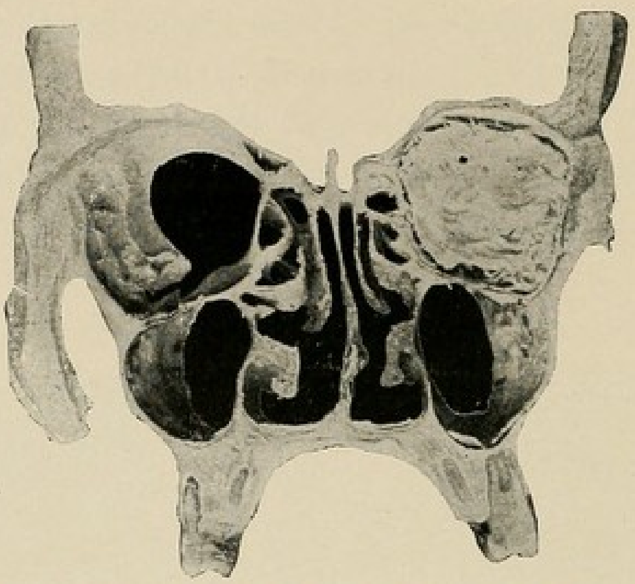
Fig. 26.



Posterior view of vertical transverse bilateral section of the head from the same skull as Fig. 25, showing the ostium maxillare, which is indicated on each side by a cord passed through it.

Fig. 28 is an illustration of a tooth which has been perforated by a drill while in the mouth, the operator supposing his drill was passing up the palatal root, instead of which it passed through the pulp chamber, the base of the crown, the alveolar process, and into the maxillary sinus. It will be observed that in extracting it a portion of the floor of the antrum has been brought away with the tooth. At the time of extraction the patient was suffering from empyema of the antrum.

FIG. 27.



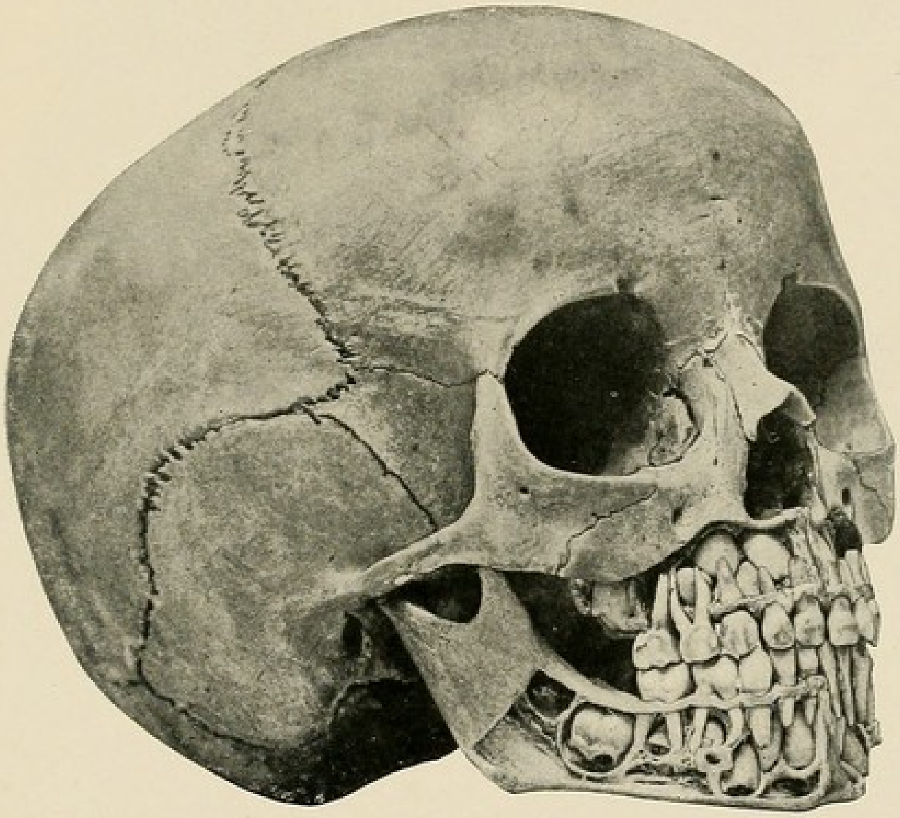
Anterior view of a vertical transverse bilateral section of a negro skull, showing a deep alveolar process.

FIG. 28.

Tooth which has been drilled through while in the mouth.

Fig. 29 is taken from the skull of a child of about six years, showing all the deciduous teeth in position and the developing permanent teeth, except the third molar of the lower jaw and the second and third upper molars, which at this period of life are in a very immature state. The outer plate of the alveolar process and the cancellated tissue have been removed, in order that the positions and relations of the dental organs at this period of life may be more clearly seen.

FIG. 29.



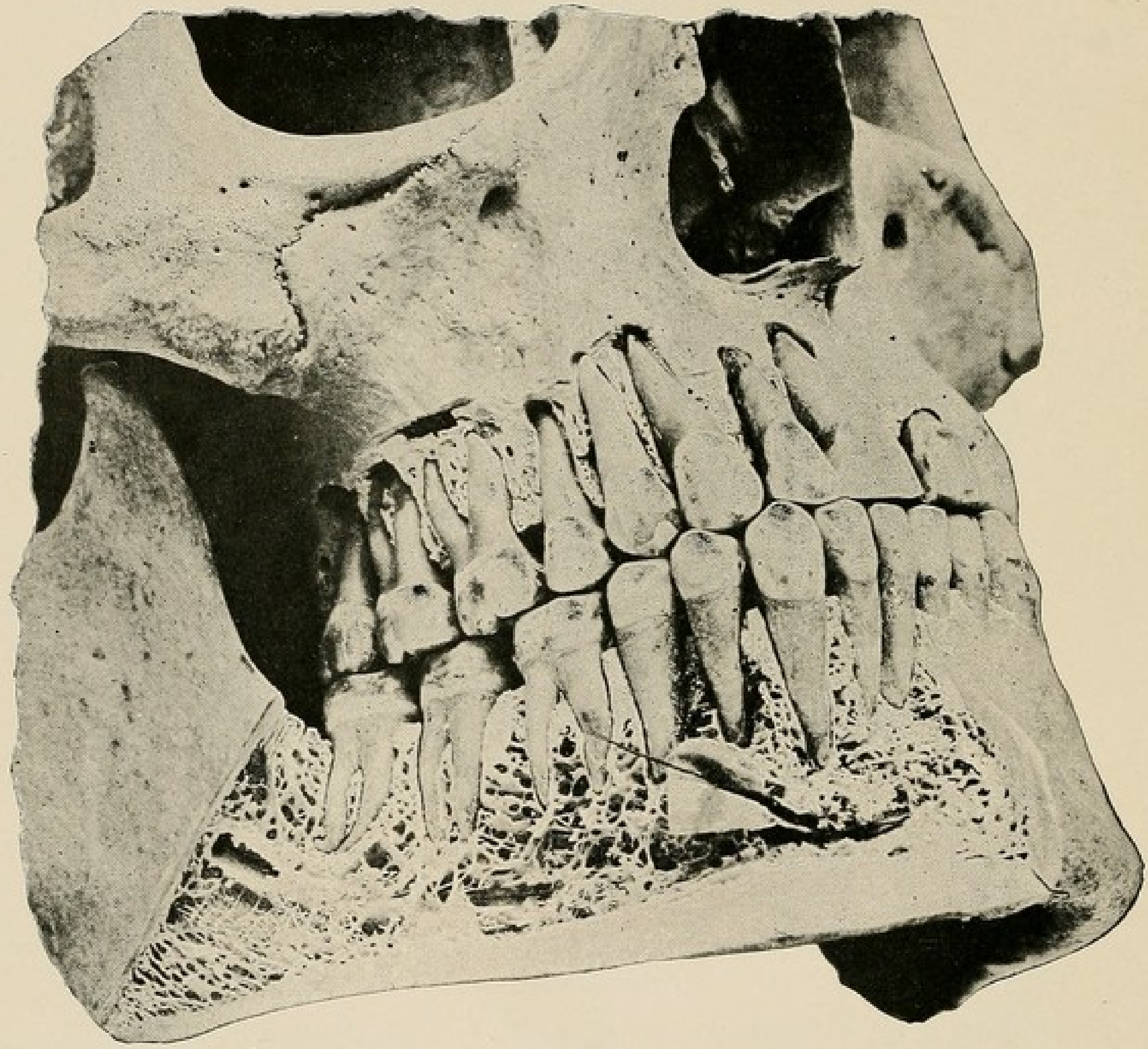
Skull of a child about six years old, showing all the deciduous teeth in position and the developing permanent ones.

Fig. 30* gives an antero-lateral view of an almost ideal articulation of the permanent teeth. The illustration shows the relation of the bones forming the external structures of the jaws. The outer surfaces of the lateral and anterior walls of the antrum are shown, the teeth having been denuded of the external plate of the alveolar process. It will be seen that in removing the external plate the maxillary sinus has been opened into immediately over the roots of the molars, showing

*Fig. 30 is a repetition of Fig. 4.

how thin, in this case, the bone is between the roots of the teeth and the external wall of the sinus. It is also very thin over the roots of the canine and first and second premolars.

FIG. 30.



Antero-lateral view of upper and lower jaws with the external plates of the alveolar process and some of the cancellated tissue removed, exposing the roots of the teeth and the cribriform tubes.

The infraorbital foramen is the termination of the infraorbital canal, which is generally described as passing through the solid bone of the infraorbital ridge to the groove in the floor of the orbit. As a matter of fact, this canal often passes diagonally through the maxillary sinus, somewhat in the form of a tube.*

At the inner anterior angle of the floor of the orbit will be observed the opening of the nasal duct, which will be again referred to when viewing the internal structures of the maxillary sinus and the nasal fossæ. The lower jaw of this figure has been described. (See Fig. 4.)

Figs. 5, 14, and 30 demonstrate the arrangement of the cancellated tissue between the teeth, also between the teeth and the cortical bone, where it acts as an elastic cushion to lessen shock from blows upon the lower jaw or from concussion in mastication. It is this arrangement which permits the movement of the teeth in various directions during eruption or in correcting irregularities of the teeth.

Nutritional Supply to the Teeth. The vessels of nourishment of the posterior teeth of the upper jaw do not pass through and along the cancellated tissue as they do in the lower jaw, but in a groove on the outer wall of the maxillary sinus (as shown in B, Fig. 31), from which are given off branches to the apices of the roots of the teeth, many of the latter being covered with only a thin plate of bone. Occasionally this thin covering is lacking. The upper anterior teeth are supplied by branches or continuations of the posterior dental nerve and vessels, passing through canals or tubes in the cancellated portion of the bone.

The principal nerves and vessels supplying these teeth are smaller than those for the lower teeth, because they are not required to give off large external branches, as the mental branches to the lower lip and adjacent tissue. They pass to the upper teeth along shallow grooves in the walls of the maxillary sinus (see B, Fig. 31). The length of these grooves varies considerably, depending somewhat on the distance from the main branch to the portion over the roots of the teeth.

In some teeth where the roots are imbedded in the inner

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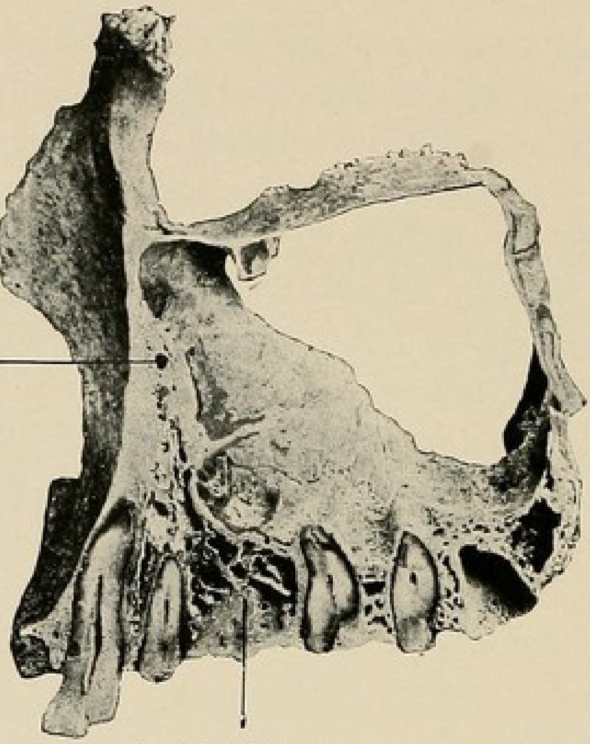
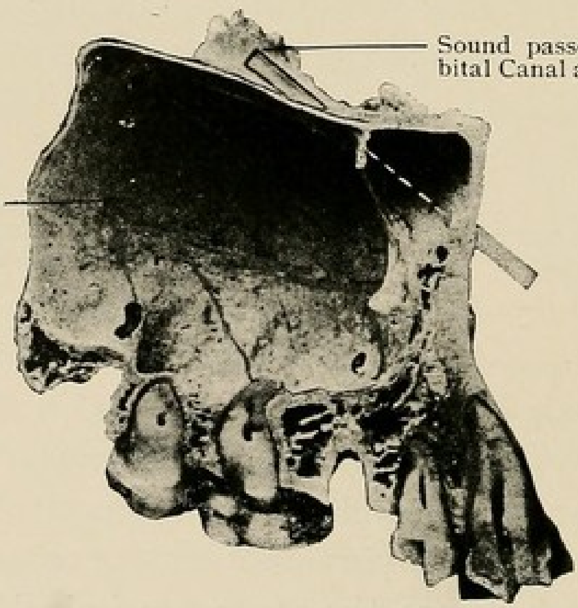
*For further description of this variation, see page 63.

FIG. 31.



A



B

Antero-posterior division through the maxillary sinus and the teeth, showing an infraorbital sinus above the canal.

plate of the bone forming the antrum, the nerve and vessel pass at once into the apical foramen. If they pass through the cortical bone, they will only be found in a short canal; but where their course is through cancellated tissue to the apical foramen, as in the case of the anterior teeth, or through other surrounding tissue, they are conveyed in tubes more or less cribriform in character, somewhat similar to those found in the lower jaw.

THE NASAL FOSSÆ.

Descriptive Anatomy. The nasal fossæ—the internal nose—are two chambers situated on each side of the median line of the face, extending downward from the under surface of the anterior portion of the brain-case superiorly, to the upper surface of the bones forming the hard palate inferiorly, and from the facial border to the external aperture of the nose anteriorly to the free border of the external pterygoid plate posteriorly. They are lined with muco-periosteum covered with ciliated epithelium; and the membrane is continuous with the lining of the several sinuses, cells, and passageways of this region. On the upper, lateral, and posterior borders of the nasal fossæ there are various mucosa-lined sinuses, cells, and canals, all communicating with the fossæ, the excess of fluids secreted by them passing into the nose. The lachrymal ducts conveying the excess of fluids from the anterior surface of the eyes, the Eustachian tubes communicating with the middle ear, and the maxillary sinus, the frontal sinus, the sphenoidal sinus, the ethmoidal cells, and the cells belonging to the orbital process of the palate bone, have their outlets in the nasal fossæ. The fossæ are separated from each other by a thin partition of bone and cartilage, the nasal septum; they open on the anterior surface by the anterior nares. The two principal functions of the nose of man are concerned with the beginning of the respiratory act and with the special sense of olfaction.

The lower part of the chamber forms a direct passageway for the air into the respiratory tract, also for the expired air leaving the lungs. The upper portion of that part of the fossæ formed by the ethmoid bone contains the beginning of the olfactory organs. As it is necessary to their function that these parts be kept moist, there are numerous pockets in and about them the lining membrane of which secretes fluids. These fluids pass over the shed-like projections of the turbinate bones into the nose, supplying the necessary moisture.

In Figs. 25 and 26 are good examples of nasal fossæ of bilateral symmetry. For convenience in describing the nasal fossa, it may be divided into roof, floor, and outer and inner walls, the last named being formed by the nasal septum.

The roof of the nasal fossa is long, narrow, and irregular in form. It is divided into anterior, middle, and posterior sections.

The anterior portion is formed by the under surface of the nasal bones and the nasal spine of the frontal bone. It is concave from side to side, and extends inward and upward to the ethmoid bone, at an angle of about forty-five degrees.

The middle portion is narrow, nearly horizontal in direction, and is composed of the under surface of the cribriform plate of the ethmoid bone, through the openings of which the filaments of the olfactory nerves pass between the nasal fossæ and the brain. Besides the numerous openings there are slit-like foramina, which give passage to the nasal nerves and vessels. The cribriform plate, on account of its thinness and its sieve-like construction, and the presence of the slit-like openings, affords but a slight partition between the nasal chamber and the anterior portion of the brain-case.

The posterior portion of the roof of the nose is the longest of the three parts, and extends from the posterior extremity of the cribriform plate obliquely downward and backward to the free margin of the internal pterygoid plate. It is composed of the body of the sphenoid bone and the alæ of the vomer.

The floor of the nasal chamber extends from the external opening anteriorly to the pharyngeal space posteriorly. It is smooth, and concave from side to side. The bony structure is composed, anteriorly of the intermaxilla, medially of the palate processes of the maxillæ, and posteriorly of the horizontal plate of the palate bone. The nostril, the anterior opening, is made up of cartilage and is lined with mucous membrane. The cartilaginous portion forms the vestibule of the nose. In the normal nose, the floor joins this on the same plane and gradually slopes downward and backward. (See Fig. 32.) Occasionally there is quite a depression immediately back of the union of the bone and cartilage. The floor often varies in its relative position to the other structures. It is seldom on the same level as the floor of the antrum; it may be on either a higher or a lower plane. Examples of these variations are seen in the sections shown in Figs. 66, 67, 68, and 69.

The nasal septum forms the inner walls of the nasal fossæ. It consists of six bony structures, named in the order of their importance,—viz., the vertical plate of the ethmoid, the vomer, the crests of the maxillæ and palate bones, the rostrum of the sphenoid, and the nasal spine of the frontal bone. These bones do not form the septum completely, but leave a triangular notch in the anterior portion, which is filled up with cartilage.

Septal Spurs. In Figs. 25 and 26 it will be seen that the nasal septum is nearly vertical, without a bend or a nodular process or "spur" upon it. It is commonly thought by rhinologists that a straight septum is unusual. This would seem to be an error, probably due to the fact that the great majority of the noses which they examine are abnormal. It is quite true that in many cases the septum is more or less deflected or curved to one side or the other, assuming a central position only as it passes downward and nears its connection with the floor of the chamber. On the convex side of the curve in these cases, a ridge or process is often found which is called a "spur," and which may extend quite over and come in contact with the external wall or the inferior turbinate. (See Figs. 67, 82, and 90.)

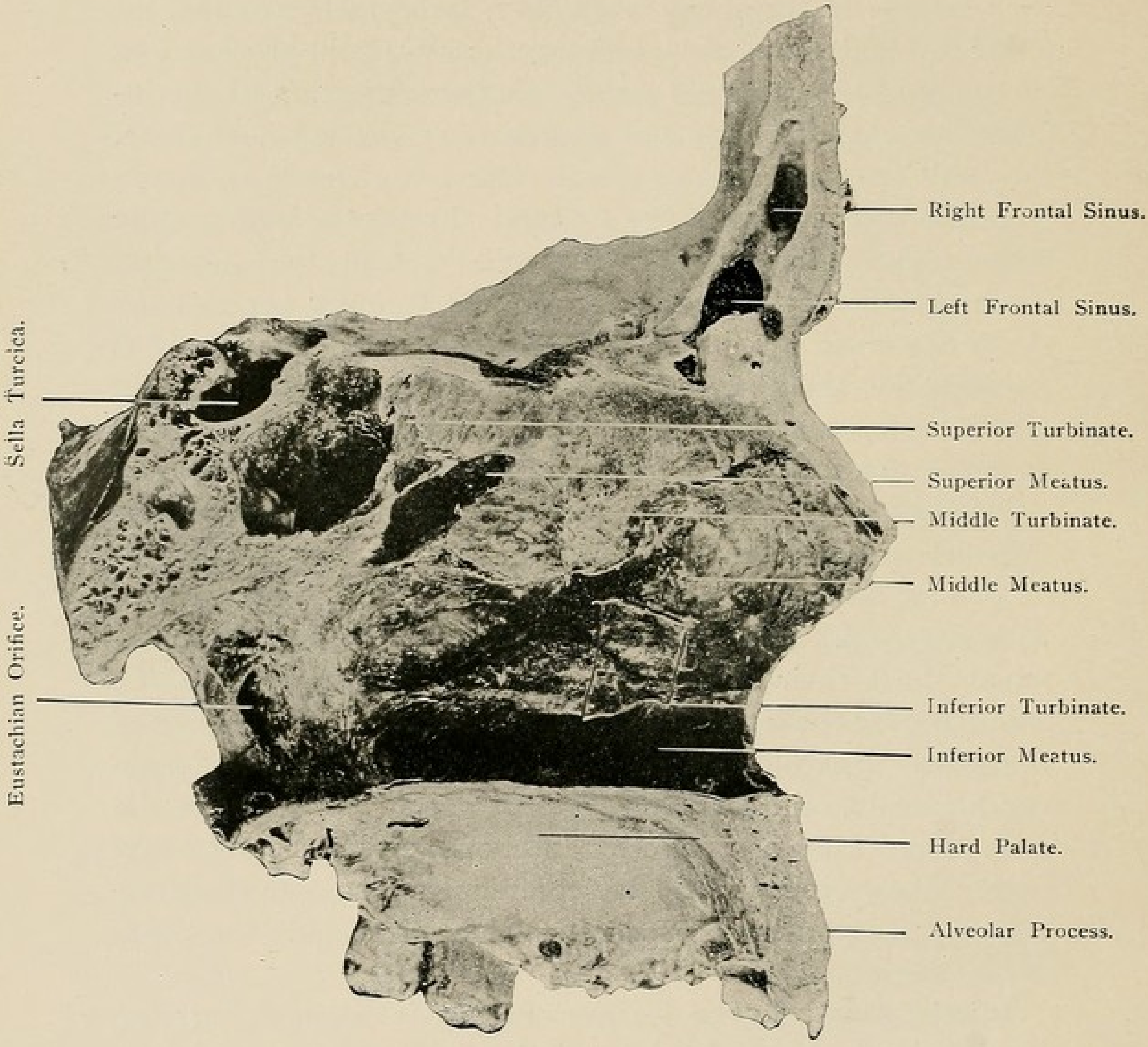
Nasal Meati. The external lateral wall is the most extended, irregular, and complicated portion of the nasal fossa. It varies, perhaps, more in its general formation than any other portion of the body of like size, and is correspondingly difficult to treat surgically. Several bones enter into its formation on each side,—viz., the nasal, maxillary, lachrymal, ethmoid, inferior turbinated and palate bones, the pterygoid process, and the body of the sphenoid bone. By the projection of the inferior turbinated bones and processes of the ethmoid bone, this wall is divided into several almost horizontal compartments known as meati. The anatomical works generally name three meati,—the inferior, the middle, and the superior. Zuckerkandl, however, says that about $6\frac{7}{10}$ per cent. of the skulls examined by him have had four meati. The writer has found about sixty per cent. with four meati in the skulls of which he has made sections. (See A, Fig. 33, and Fig. 84.) In many cases there are five, and in one skull were found six.

Figs. 32 and 33 give a general idea of the arrangement of the outer walls of the nasal chambers. The upper portion, or all of that which belongs to the ethmoid bone, is associated with olfaction. The ends of the nerves, usually called the terminals, have their origin over this region; they also are distributed over the upper portion of the septum and the roof of the nose. The fibers converge as they pass upward to form the filaments, and then through the various foramina in the cribriform plate of the ethmoid bone enter the olfactory bulb. The various meati have communications with the maxillary sinus and other air spaces which are formed in the bones of this region.

Inferior Meatus. The inferior meatus is situated between the inferior turbinated bone and the floor of the nose. It is much longer than the others and is the principal passageway of respiration.

Nasal Canals. The nasal canals, which are for the accommodation of the lachrymal ducts, have their origin in the inner anterior lower angle of the orbits. The superior orifices commence between the nasal processes of the maxillæ and the lachrymal bone. From this point the canals extend down and terminate in the upper portion of the inferior

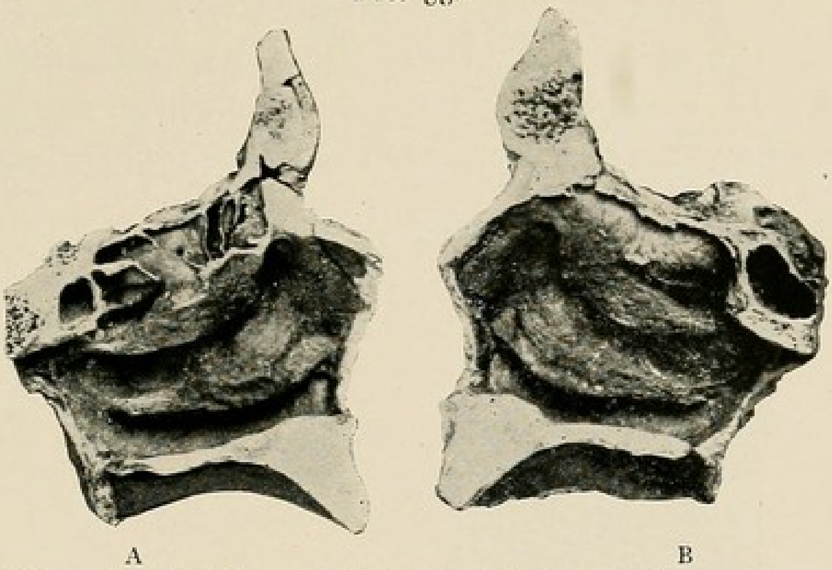
FIG. 32.



External wall of a left nasal fossa.

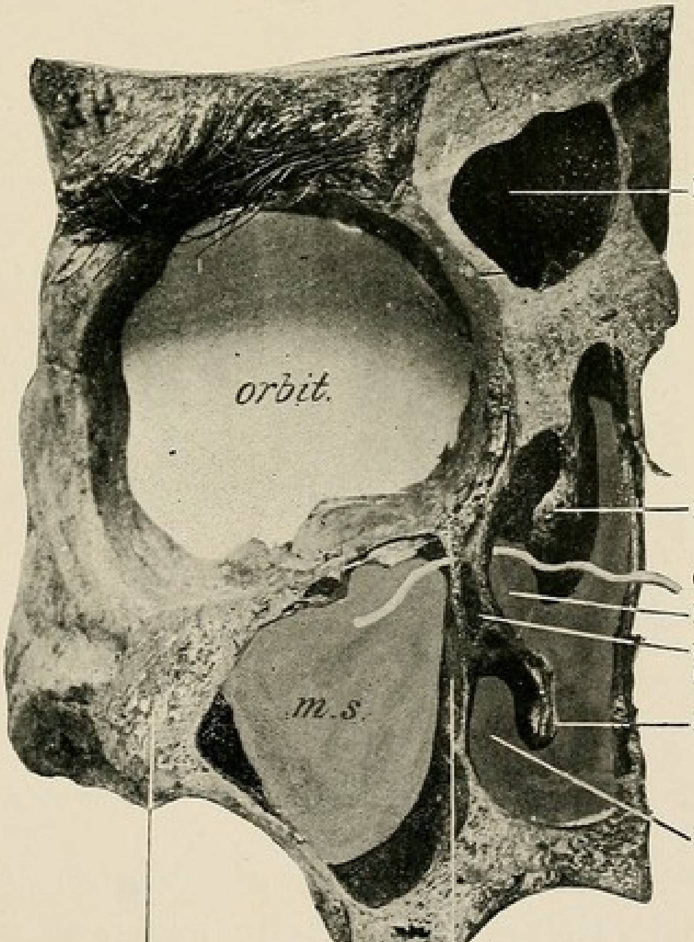
meatus of the nose. (See Figs. 34, 35, 37, 38, and 39.) The direction of their descent varies considerably in different subjects, and even in the same subject. They usually pass backward, and when the antrum is large and the nasal chamber

FIG. 33.



External walls of the nasal chamber, each showing four meati.

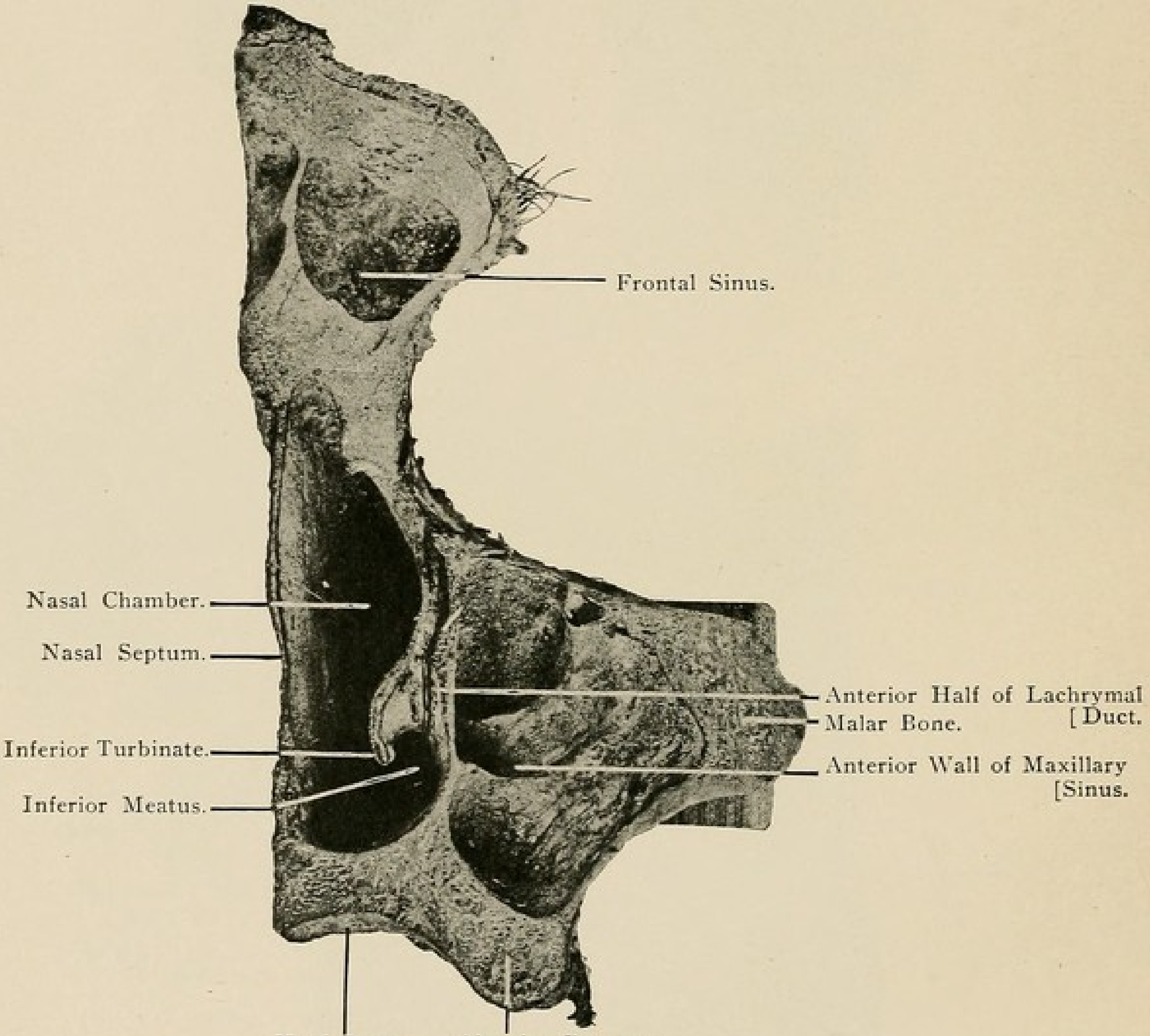
FIG. 34.



Anterior view of a vertical transverse section of the right side of face.

narrow, the direction may be inward; where the antrum is small and the nasal fossa wide, the direction is likely to be outward. In exceptional cases it is slightly curved. The duct may have a valve composed of mucous membrane at its lower extremity.

FIG. 35.



Posterior view of a vertical section cut from the front of Fig. 34.

Fig. 34 affords an anterior view of a section cut vertically or longitudinally through the lachrymal duct, showing its posterior portion as it passes from the orbit downward within the wall separating the nasal chamber from the maxillary sinus, the duct terminating in the upper portion of the inferior meatus. On the upper right corner is the frontal sinus. To the left of this is the orbit. In the center of the wall between the orbit and the maxillary sinus will be seen the infraorbital canal, and below it the maxillary sinus, which in this case is very large. In the upper portion of the nasal chamber is seen the middle turbinated bone, below which is seen a cord which has been passed from the middle meatus through the ostium maxillare into the maxillary sinus.

Fig. 35 is from a vertical section, cut transversely just within the infraorbital ridge. In the upper portion is the anterior wall of the frontal sinus, on the left side is the nasal septum, and to the right of this is the nasal cavity. The anterior half of the nasal duct, shown in the previous illustration, will be seen to commence at the inner angle of the orbit and terminate at the inferior meatus.

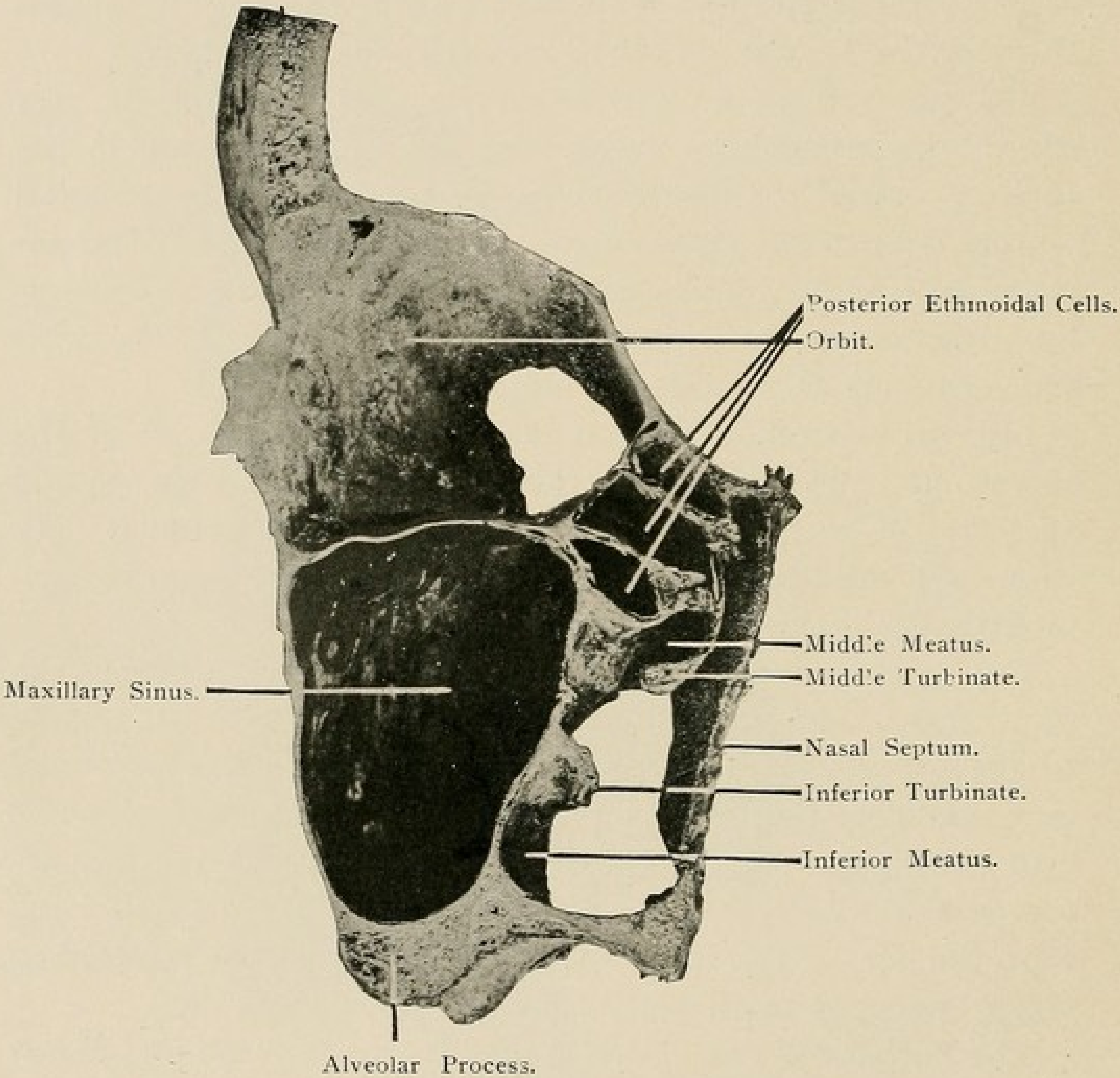
Fig. 36 is from a section near the posterior wall of the antrum and the orbits, from the same subject as Figs. 34 and 35. It will be noticed that the wall of the antrum is very thin. At the upper right corner are seen the posterior ethmoidal cells, below which is the nasal chamber.

Fig. 37 is from a section showing the greater portion of the upper jaw. The upper boundary is on a level with the middle of the orbits. Two sounds passed down into the lachrymal ducts indicate that the ducts pass outwardly as they descend into the upper part of the inferior meatus. It will be observed that the right duct has a greater outward deflection than the left. (The impacted canine tooth will be referred to when impacted teeth are considered,—see page 127.)

The horizontal line above the roots of the teeth and below the malar bone makes a division of the section just above the floor of the nasal chamber. The under surface of the upper portion is shown in Fig. 38, which affords a view of the surface of the inferior turbinate from below, with the lower orifices of the lachrymal duct. It also shows the lower edges of the middle and superior turbinates, and the roofs of the antra. Attached to the roof of the right maxillary sinus are two abnormal bony growths generally known as osteophytes.

The middle meatus is situated between the lower portion of the turbinate masses of the ethmoid bone and the inferior turbinate, and forms two-thirds of the posterior portion of the outer wall of the nasal fossa. This is the most important

FIG. 36.

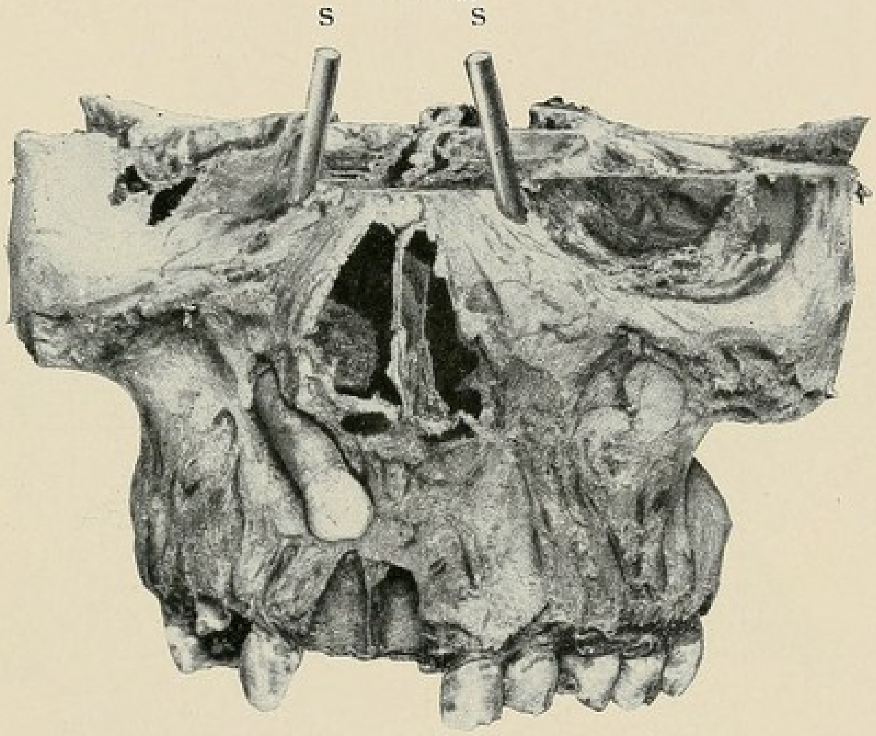


Anterior view of vertical section cut posterior to that shown in Fig. 34.

meatus and is subject to more variations in its anatomy, physiology, and pathology than are all the others. It has anatomical communications with the frontal and maxillary sinuses, and with the anterior and middle ethmoidal cells. In order to study this meatus and its relations, it is necessary to make a number of sections of the parts with all the tissues in place. By removing the middle turbinate, the internal structure of the parts is brought into view.

Fig. 39 shows the outer wall of the nasal chamber with the internal wall of the turbinate mass of the ethmoid bone cut loose and turned up, affording a good idea of the normal anatomy of this region. The frontal sinuses are exposed. In the illustration the right frontal sinus extends over the

Fig. 37.

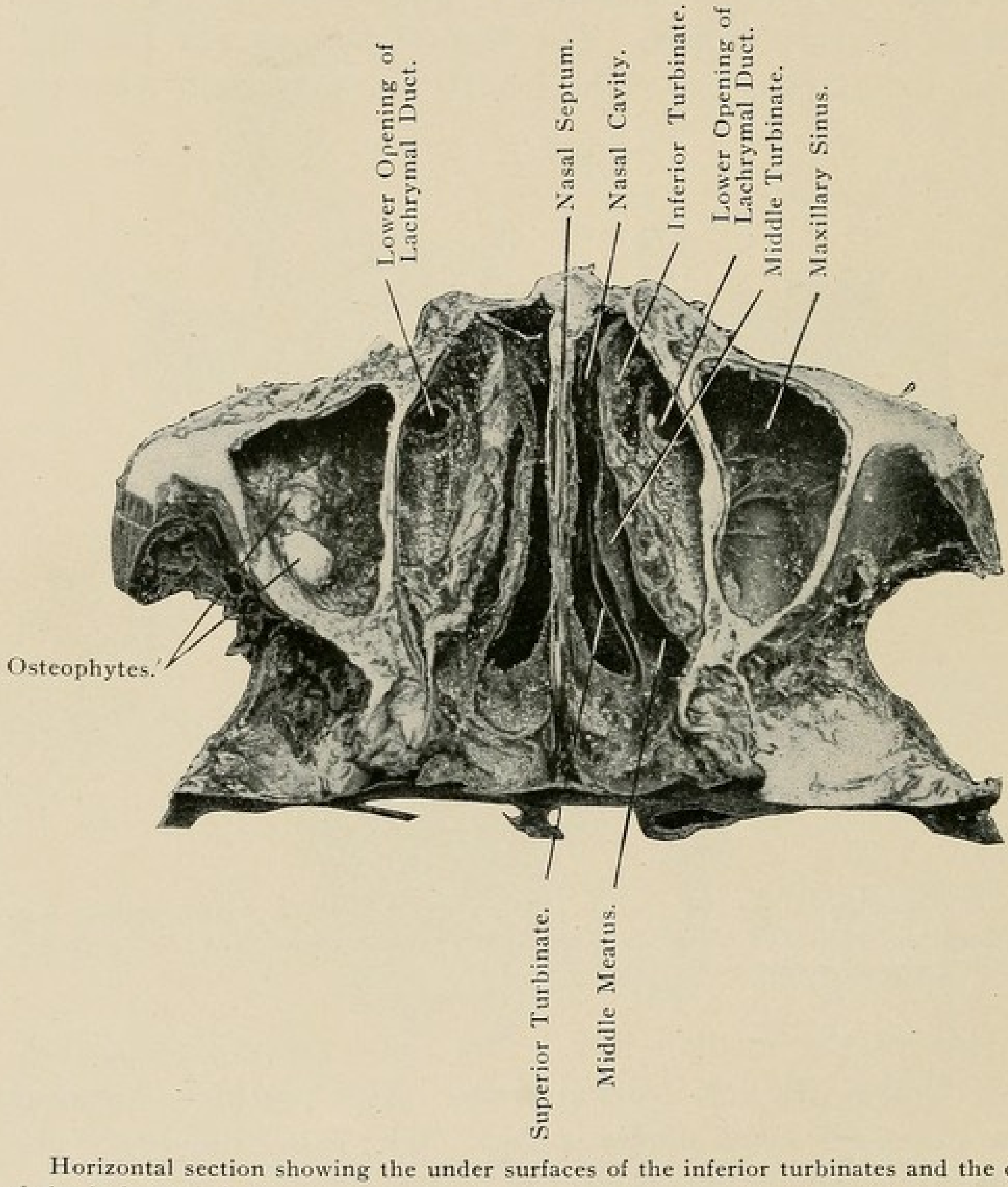


Section showing the greater portion of the upper jaw. S S, sounds passed down lachrymal duct, showing that they do not pass at the same angle. The illustration also shows an impacted canine tooth.

left side of the median line. The open space immediately below this is the left frontal sinus. The partition between these sinuses in some places is thin. The lower portion of the left frontal sinus is funnel-shaped. This opens into a passage leading into the middle meatus, the funnel-shaped portion and the passage being commonly called the infundibulum.

Hiatus Semilunaris. The infundibulum is often included in the part which has been named by Zuckerkandl the hiatus semilunaris, and which extends from the frontal sinus to and through the middle meatus in the form of a semicircular groove or cleft along the outer wall of the meatus. It extends downward and backward in a curved direction, being horizontal in its posterior portion, and terminates a little be-

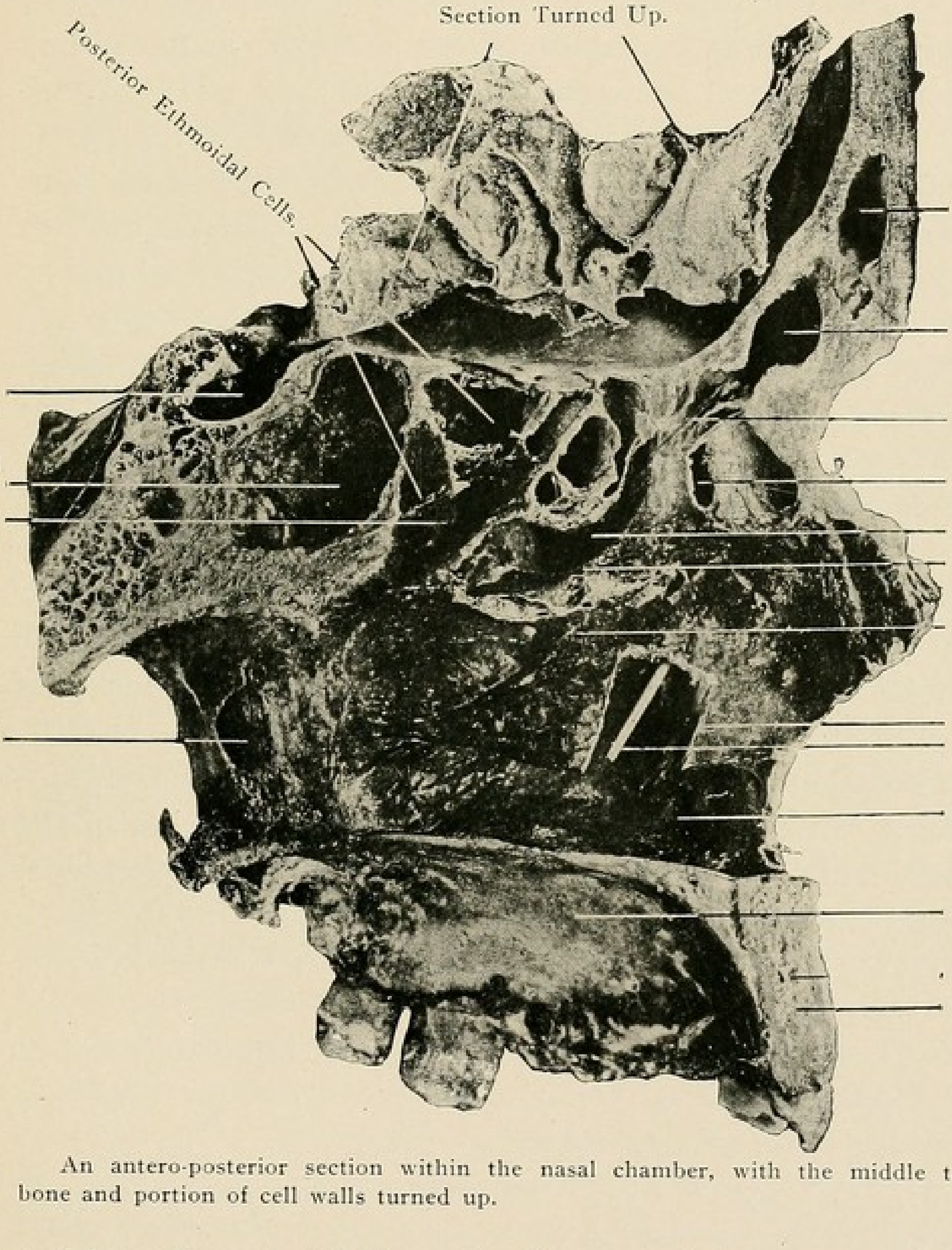
FIG. 38.



Horizontal section showing the under surfaces of the inferior turbinates and the outlet of the lachrymal duct.

hind the center of the nasal cavity. At its commencement it is narrow, but it widens as it passes downward and backward, its widest part being at the bottom and near the opening between the maxillary sinus and the nasal chamber (ostium maxillare). Besides the opening of the frontal sinus into the hiatus semilunaris, there are openings from the anterior and middle ethmoidal cells, and from the maxillary sinus. Its in-

FIG. 39.



An antero-posterior section within the nasal chamber, with the middle turbinate bone and portion of cell walls turned up.

ner boundary is falciform in shape, and is composed of the uncinate process of the ethmoid bone with membranous tissue, forming a shield or guard to the opening of the maxillary sinus, to prevent foreign substances from passing into it. A "sound" cannot be passed from the nasal chamber through the ostium maxillare into the maxillary sinus in a normal living person.

The superior meatus is shallow, and is shorter than the inferior or middle meatus. It is situated between the superior and inferior turbinate masses of the ethmoid bone, and in the articulated skull between the superior and middle turbinates. The cell situated in the orbital process of the palate bone, the posterior ethmoidal cells, and the sphenoidal sinus all have their openings into this meatus when there are but three meati, but when there are four the posterior ethmoidal cells and the sphenoidal sinus have their openings into the fourth or supreme meatus. If there are five meati the sphenoidal sinus usually opens into the fifth. In other words, this sinus has a tendency to open into the highest meatus.

The fourth or supreme meatus of Zuckerkandl is formed by an infolding of a portion of the turbinate mass similar to that of the third or superior meatus, though smaller in extent. When the fourth meatus exists, the fluids of the posterior ethmoidal cells and those from the sphenoidal sinus pass through it to reach the nasal chamber.

The occasional fifth meatus is formed similarly to the third and fourth meati by an infolding of the upper portion of the turbinate mass. In such cases the fluids from the sphenoidal sinus pass through it instead of into the fourth.

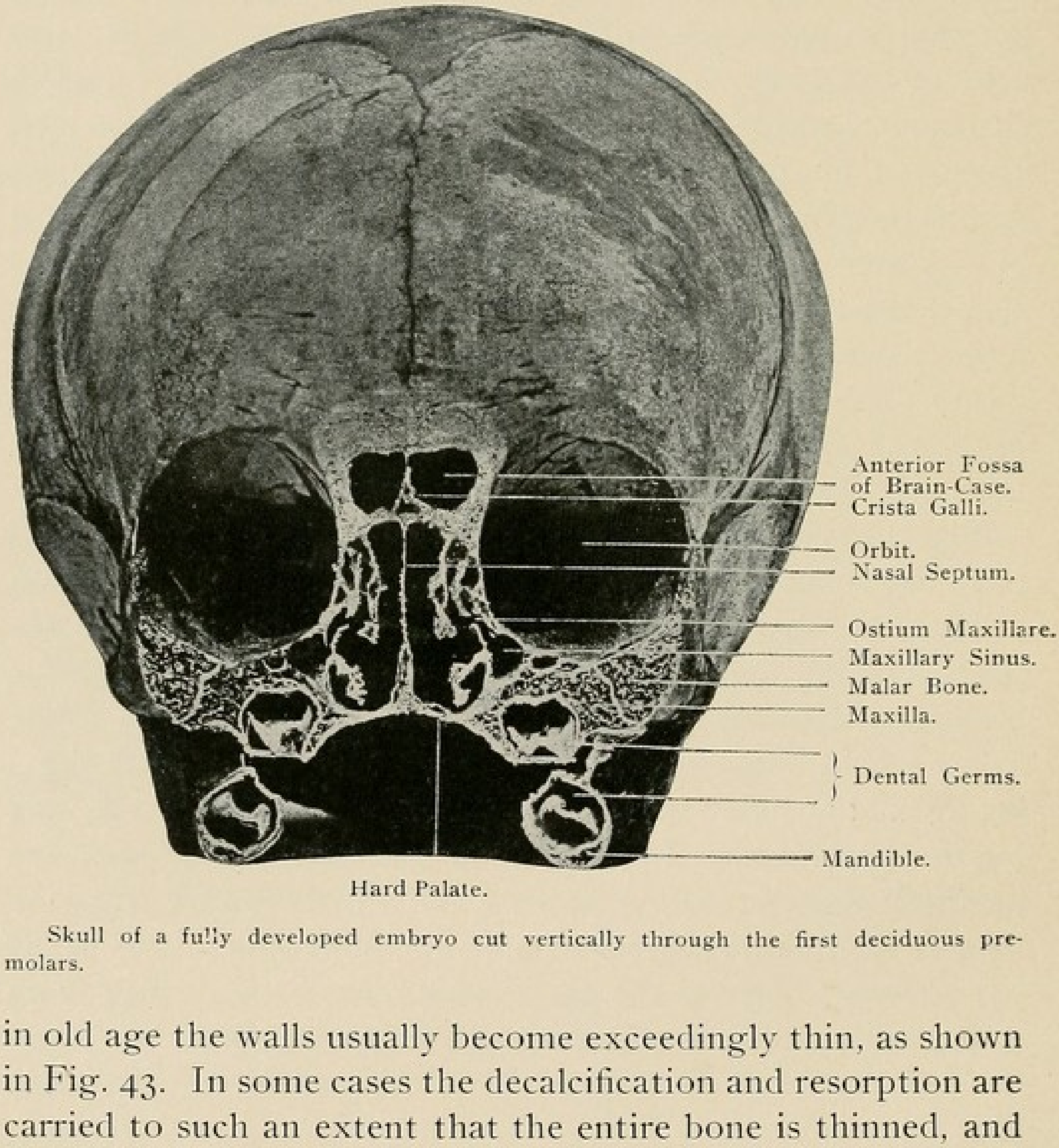
THE MAXILLARY SINUS.

The maxillary sinus (antrum of Highmore) is the largest air cavity associated with the nasal chamber. It is situated in the body of the maxilla on each side. It varies in shape, size, and in the thickness of its walls, according to age, race, and the presence or absence of teeth and tooth-germs within the jaw. It is lined with muco-periosteum surmounted by ciliated epithelium. The typical sinus is pyramidal in shape, the apex being toward the malar bone,—into which it may extend (see Fig. 76),—and the base toward the nasal cavity. Its size and form vary in different subjects, and even in the two sides of the same subject. (See Figs. 65, 68, 69, 70, and 71.) In rare cases, it is lacking on one or both sides.

Fig. 40 is a view of the skull of a fully developed embryo from the collection of Professor Thomas C. Stellwagen. It is a transverse section cut vertically just within the floor of the orbit. In the upper portion are seen two openings into the brain-case with the crista galli and falx cerebri between them, below which is the nasal chamber with its septum. Projecting from the outer wall of the chamber are the middle and inferior turbinates. In the middle meatus may be seen the unciform process passing upward and a little inward from the base of the inferior turbinate. At the outer side of this is the passageway known as the hiatus semilunaris, from which there is a small opening (ostium maxillare) passing into the maxillary sinus, which is very small at this period of embryonic life.

The development of the sinus begins about the fourth month of gestation by an invagination of the lining membrane of the nose from the hiatus semilunaris into the body of the maxilla. From the time of the invagination until the eruption of the permanent teeth, the greater portion of the maxilla is occupied by the dental organs. (See Fig. 29.) As the invagination progresses, the cancellated portion of the bone undergoes resorption. This resorption of the internal portion of the maxilla is continued in a variable degree throughout life, until

Fig. 40.



Skull of a fully developed embryo cut vertically through the first deciduous premolars.

in old age the walls usually become exceedingly thin, as shown in Fig. 43. In some cases the decalcification and resorption are carried to such an extent that the entire bone is thinned, and an ordinary lancet blade can be easily passed through the wall into the sinus, or the entire substance of the bone may be resorbed in places, leaving nothing but the muco-periosteum at these points. As this process goes on, the roots of the premolars and molars within the walls are approached, until in many places the points of the roots are covered only by a thin lamina of bone. (See Fig. 41.) Even this, in rare cases, may be lost, leaving only the muco-periosteum as a root-covering.

At first the sinus has a sphenoidal shape, but it eventually approaches the pyramidal form. Its walls are five in number, the inferior or floor, the anterior or facial, the posterior or zygomatic, the superior or roof, and the proximal or nasal.

The floor of the maxillary sinus is somewhat triangular in its general outline, and is usually uneven, owing to the presence of partial septa and conical elevations over the roots of the various teeth. These elevations are found over the roots of the molars, sometimes over those of the premolars, and less frequently over those of the canine teeth. As age advances and the teeth underlying the sinus are lost, the floor becomes comparatively smooth. Septa may extend to various heights transversely from side to side, forming deep pockets between them. The floor of the antrum may descend between the roots of the molar teeth, as shown in Figs. 25 and 26, a condition much more common among the white race than among negroes. In the negro skull these elevations over the roots of the teeth are seldom found because of the greater thickness of the bone, so that the floor of the sinus in the negro is usually smooth. The floor is concave from side to side and slightly so in the antero-posterior direction, as shown in Figs. 27, 34, and 60, having thus a basin-like form, and is usually below the level of the nasal chamber. (See Figs. 27 and 34.)

The anterior wall is almost a square with rounded corners. It is smooth, with a slight depression, which varies according to the position of the passage of the infraorbital canal or tube, as shown in Fig. 31. Occasionally the roots of the canine and premolar teeth are found in this wall. In infancy it contains the follicles of the anterior teeth. (See Fig. 29.) The anterior dental canal for the accommodation of the anterior dental nerves and vessels passes from the sinus into the wall to reach the anterior teeth. (See Fig. 31.) The reason why this canal is so high up in the bone is that the apices of the roots of the teeth, more especially of the canines, before eruption or during development and growth, are situated high up in the bone. As the teeth descend to their position in the arch, the nerves and vessels are extended and the bony tissue closes around them, leaving for their accommodation a canal along the track traveled by the teeth.

The outer wall of the sinus is more or less triangular and concave on its inner surface; the concavity may extend into the malar bone. (See Fig. 76.) The wall also extends upward and outward in a slightly curved manner, though it varies somewhat according to the position of the section. The surface may be broken up over the buccal roots of the teeth, as shown in B, Fig. 41. The plate of bone forming the outer wall varies in thickness and density and undergoes changes in this particular at different periods of life. In childhood the dental organs of the upper jaw, before eruption, are located, in whole or in part, in the outer or anterior wall or in the floor of the sinus. Fig. 29 shows the relation of the first or deciduous teeth to the floor of the antrum at the location of the molars. A little later, as the development of the permanent teeth proceeds and they are pushed forward preparatory to taking their place in the arch, the outer and lower portion of the maxillary bone appears to be crowded with teeth, as shown in Fig. 29.

The posterior or zygomatic wall extends from a line vertical to the center of the malar process backward and inward to the proximal or nasal wall. It is concave in a transverse direction and nearly straight in its vertical direction. In the young it is thick, but, like the outer wall of the antrum, it becomes thinner and thinner as age advances, until it may be no thicker than a sheet of note-paper.

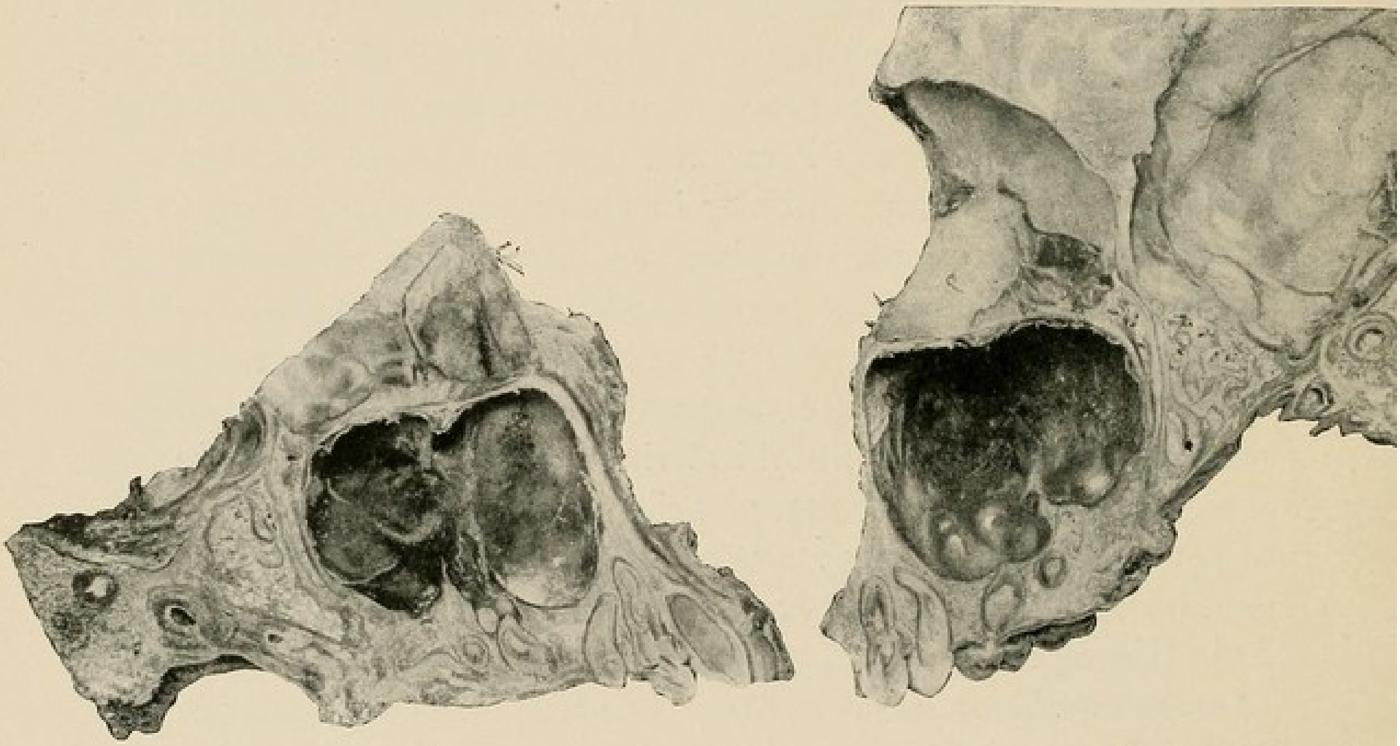
The superior wall or roof of the sinus is usually triangular in shape, the base of the triangle beginning at the inner or nasal wall. It is convex in a transverse direction, with the inner edges varying in height. Its junction with the inner wall varies in position in different subjects. Sometimes it is found on the level of the center of the floor of the orbit. (See B, Fig. 79.) At other times it is higher and near the center of the inner orbital wall. (See Figs 73 and 94.) Its surface is usually marked by a ridge of bone which contains the canal for the passage of the infraorbital vessels and nerves. This canal commences at the posterior border of the floor of the orbit; continuing forward, it is lost about the middle of the floor, where it passes into the infraorbital foramen. The ridge extends downward and forward to meet the anterior wall of the sinus, as shown in Figs. 31, 54, 79, and 141. The dipping down of the ridge varies greatly in extent, being scarcely noticeable in some specimens, while in others it extends downward so far that the canal becomes distinctly tubular in character, passing diagonally through the sinus, carrying the infraorbital nerves and vessels across the anterior portion, with an open space above the tube. (See Figs. 31, 54, 79, and 141.) The open space above the antrum extends outward into the lower rim of the orbit, forming an infraorbital sinus or pocket, as seen in Figs. 31, 54, 79, 92, and 141, a variation which the writer has not seen mentioned in any work on anatomy. The tube-like canal has a thin lamina of bone extending from it to the side of the true sinus.

The proximal or nasal wall of the sinus is quadrangular in shape, with the inferior angles slightly rounded. (See Figs. 42 and 85.) In a typical skull this wall is vertical and slightly convex. The lower edge almost always turns slightly outward to join the floor of the sinus, but occasionally it is found dipping in under the floor of the nasal chamber toward the median line, and meeting the floor of the sinus over the palatine process. (See Figs. 66, B of 83, and 94.)

The ostium maxillare, an oval-shaped foramen, which affords communication between the sinus and the nasal fossa through the hiatus semilunaris, is usually found on the upper edge of the proximal wall near the anterior portion. It occasionally commences in the roof of the sinus, then passes in a slightly curved direction, terminating in the hiatus semilunaris, as shown in Fig. B, 79, and Figs. 81 and 85. In pathological conditions or in extreme old age, there may be two or even more openings between the maxillary sinus and the nasal chamber. (See Figs. 95, 96, and 97.)

Septa of the Maxillary Sinus. The shape and size of the maxillary sinus and the character of its septa vary so much

FIG. 41.



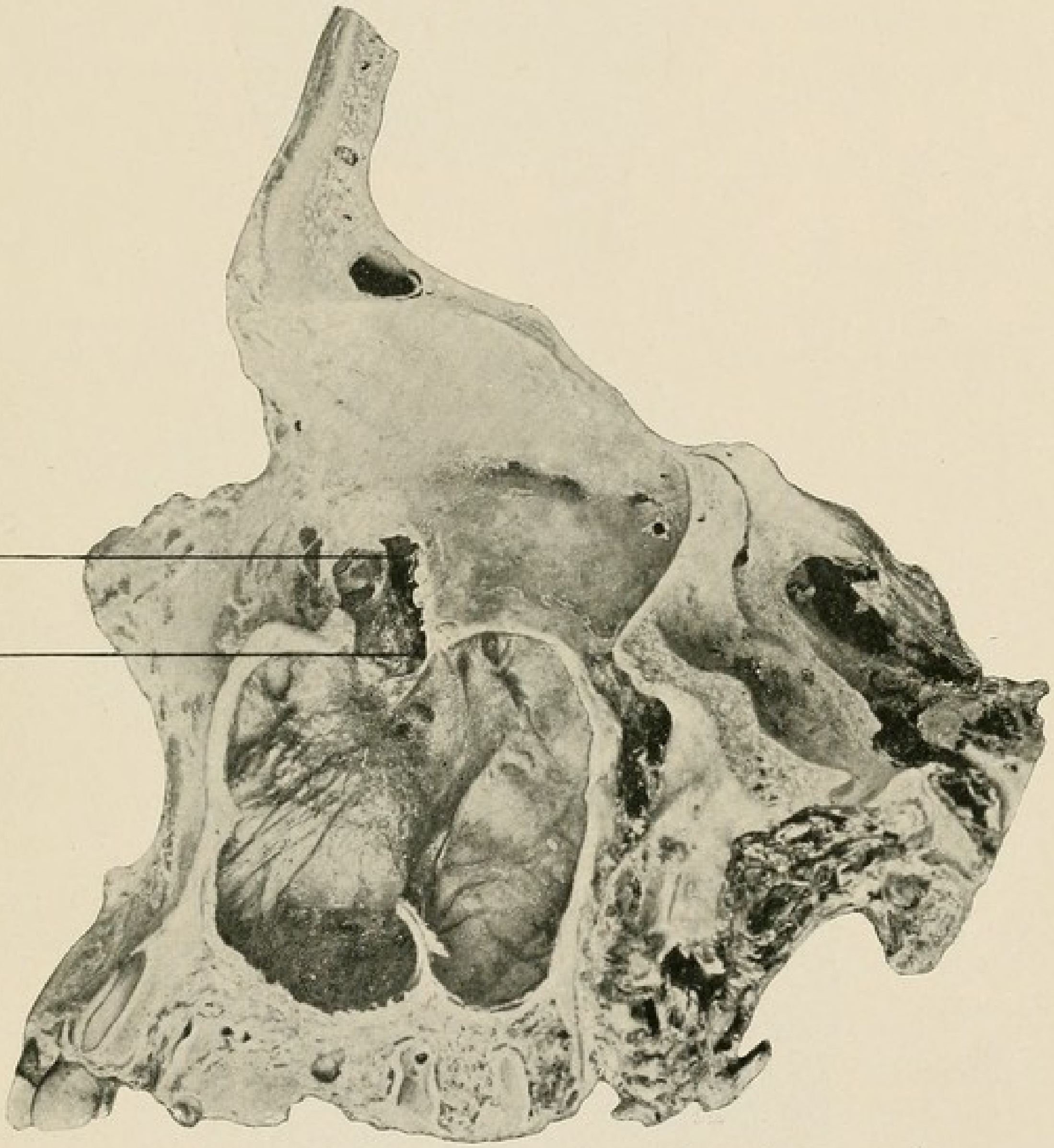
A B

Two antero-posterior sections made by dividing the orbit and maxillary sinus vertically, showing conical elevations over the roots of the various teeth. The root of the second premolar curves forward. It more commonly curves backward.

that it is almost impossible to say what is typical shape and what are typical septa. From whatever direction sections are made, variations in shape and size will be found. *Partial bony or membranous septa* are found passing partly across in various directions, but the writer has been unable to find complete septa of the maxillary sinus, though it is said by some investigators that they exist.

Fig. 42 represents an antero-posterior section near the inner wall of the orbit, showing a maxillary sinus of about the average size for the age of the subject. A portion of the os planum is cut away to show the continuation of the outlet of

FIG. 42.

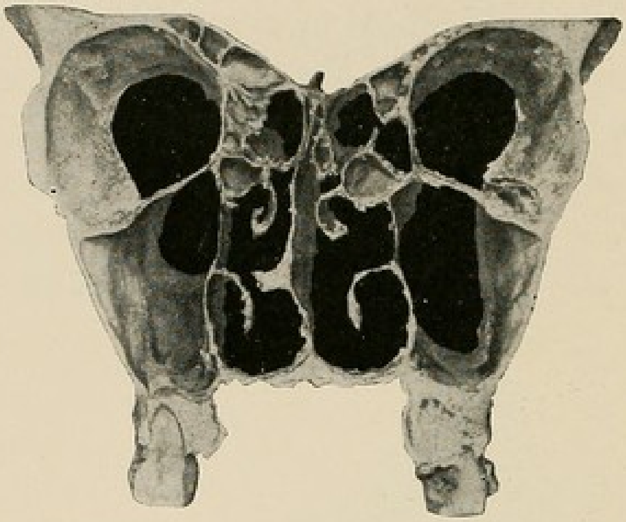


Antero-posterior division through the maxillary sinus.

the sinus. A partial bony septum arising from the floor and passing transversely across forms two deep pockets.

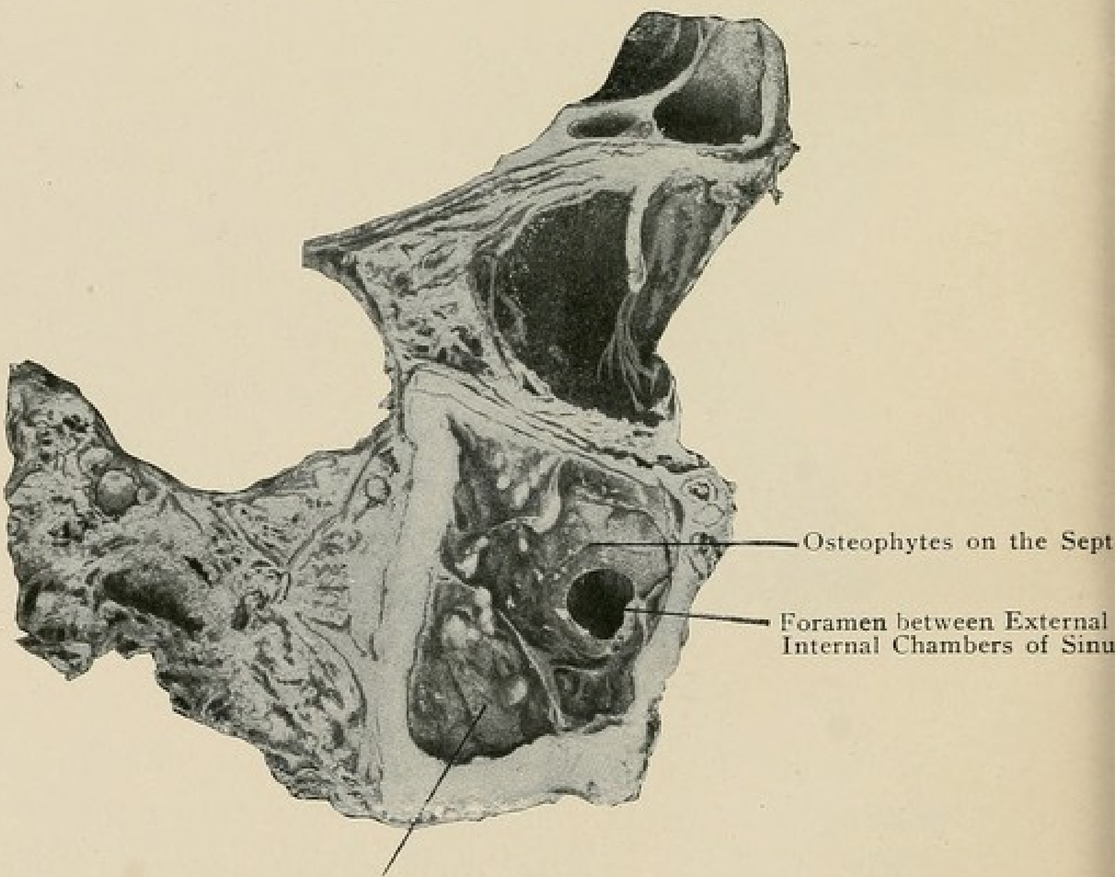
Fig. 43 shows vertical membranous septa of differing sizes on the two sides, dividing the lower portion of the cavity into semi-chambers. The septum on the left side is small; that on

FIG. 43.



Anterior view of a vertical transverse section from a skull of an old person, showing the thinness of the walls of the maxillary sinus, also membranous septa of the sinus.

FIG. 44.

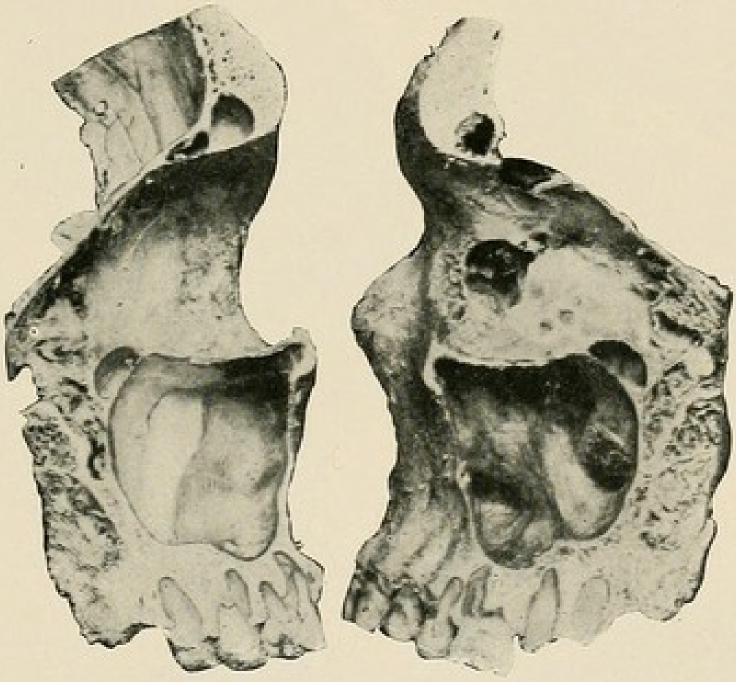


A vertical antero-posterior division through the frontal sinus, orbit, and maxillary sinus, showing a membranous septum of the sinus.

the right extends nearly to the roof. Resorption has reduced the thickness of the walls of the antrum to thin bony layers.

Fig. 44 is from an antero-posterior section through the frontal sinus, the middle of the orbit, and the maxillary sinus, showing an incomplete vertical antero-posterior membranous septum with a foramen connecting the external and internal compartments of the sinus. Situated on the membrane are a number of small osteophytes.

Fig. 45.



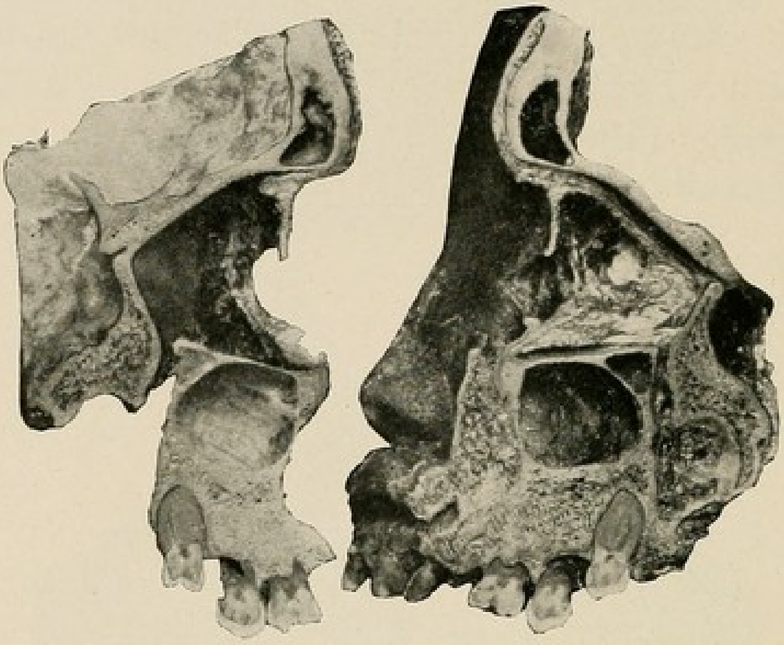
A B

Antero-posterior division through the center of the orbit, maxillary sinus, and molar teeth, showing a crescent-shaped cell at the upper posterior corner of the maxillary sinus.

Fig. 45 shows what might be thought to be a bony division of the maxillary sinus; but close investigation reveals that the crescent-shaped cavities situated on the upper posterior corner of the sinus are the cell of the orbital process of the palate bone cut in two. A probe passed through the opening in B would enter the superior meatus of the nose.

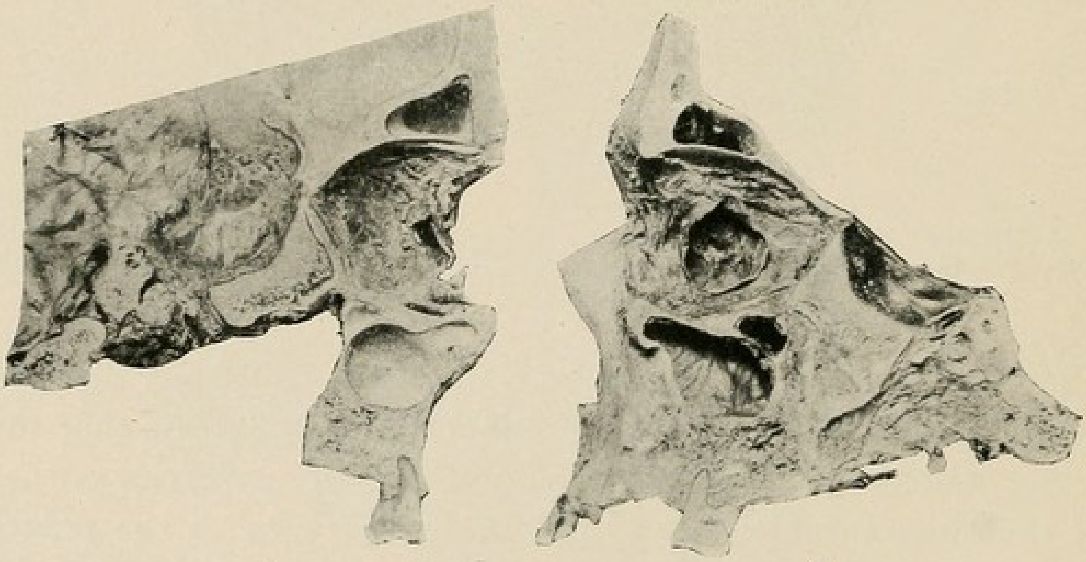
Fig. 46 shows a section of a negro skull through the molar teeth and the middle of the orbit. It shows a sinus at the upper posterior corner of the maxillary sinus. This opens into the superior meatus of the nose and belongs to the palate bone. The antrum is very small.

FIG. 46.



Antero-posterior division through the center of the orbit, maxillary sinus, and molar teeth, showing a triangular cell at the upper posterior corner of the maxillary sinus.

FIG. 47.



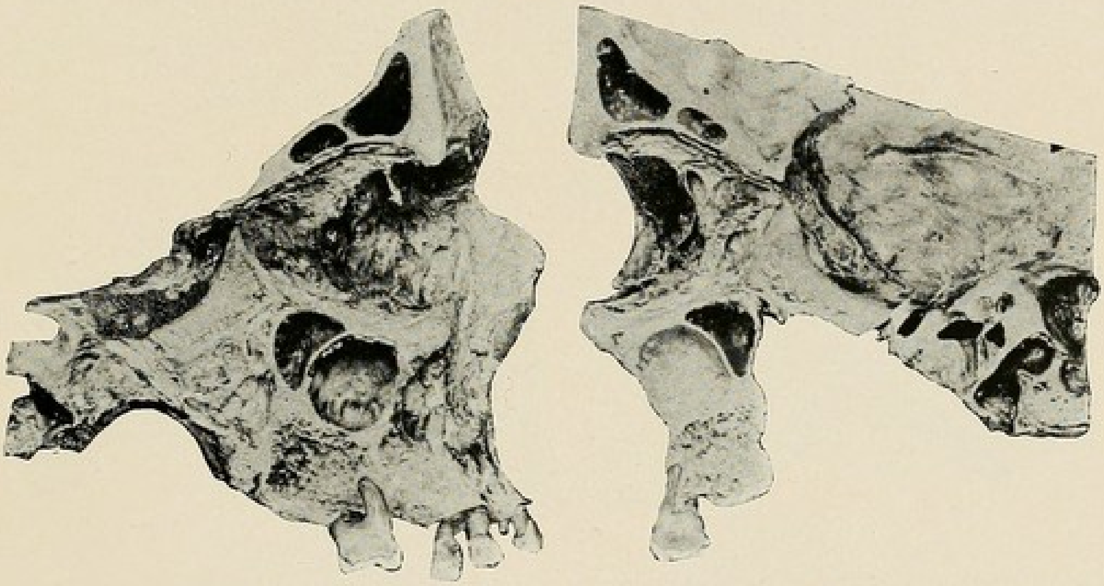
A B

Antero-posterior division through the center of the orbit, maxillary sinus, and molar teeth, showing a peculiarly shaped sinus.

Fig. 47 is taken from the left side of another negro skull. The section is made in the same region as the last, showing a very small, peculiarly shaped antrum, and a crescent-shaped cell which opens into the superior meatus.

Fig. 48 is from the right side of the same skull as Fig. 47, showing apparently two sinuses. The posterior one passes around the posterior border of the external surface of the anterior or true sinus. The apparent second sinus is undoubtedly an enlarged cell of the orbital process of the palate bone. The true maxillary sinus is extremely small. It may be that on account of this the cell was abnormally enlarged to increase

Fig. 48.



A B

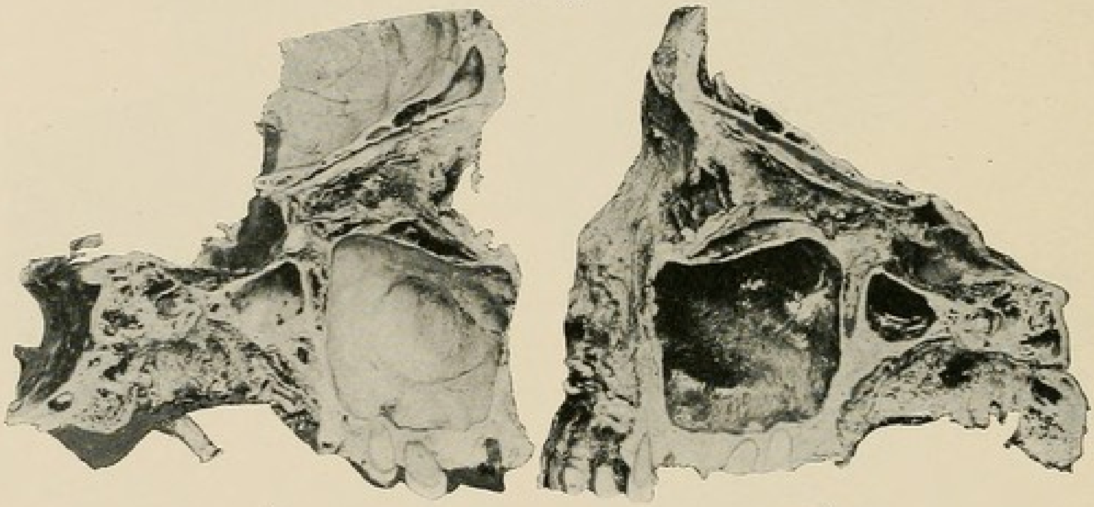
Antero-posterior division through the center of the orbit, maxillary sinus, and teeth, showing an enlarged cell of the orbital process of the palate bone, and a correspondingly small maxillary sinus.

the air space of this region, or that the palatal process has encroached upon the space usually occupied by the maxillary bone. The bony septum of this specimen might very easily be mistaken for a division parting the antrum into two; but the writer would not thus classify it, as this posterior sinus opens into the superior meatus, the same as the other palatal cells just described.

It is a well-established fact that the maxillary sinus is developed by an invagination of the mucous membrane of the middle meatus into the body of the maxilla. If there should be two of these invaginations, it could then be easily accepted that these cells are a divided maxillary sinus; but as the outlet of the posterior one is into the superior meatus, into which the cells of the orbital process of the palate bone open, it seems evident that this is an enlarged palatal sinus or cell, and not a divided maxillary sinus.

Fig. 49 is from another section made through the molar teeth and the center of the orbit. Posterior to the maxillary sinus, we find another sinus of a different character, which from superficial observation might be thought to be related to it or

FIG. 49.



A B

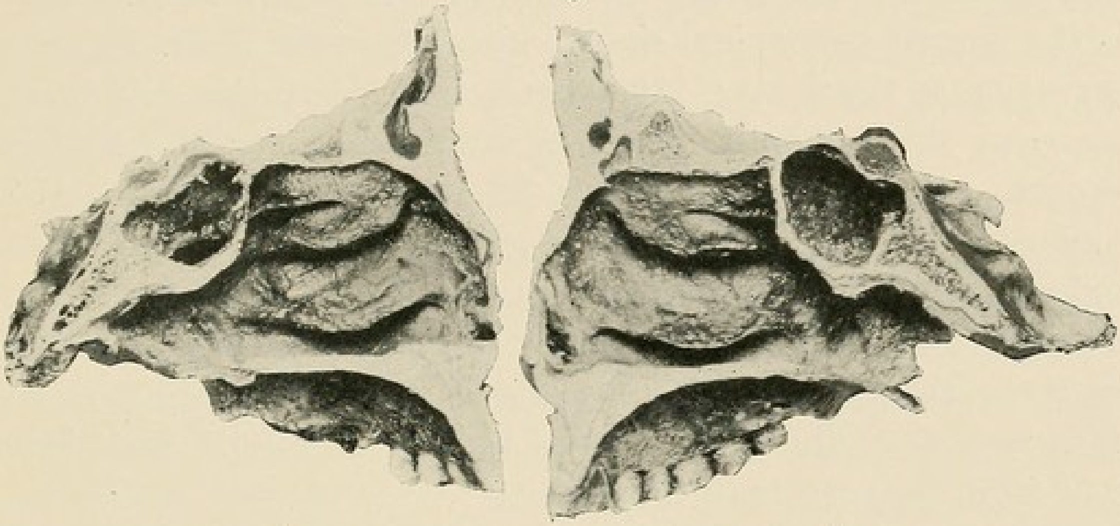
Antero-posterior division through the center of the orbit, maxillary sinus, and molar teeth, showing a large maxillary sinus and a large sphenoidal sinus.

to be an enlarged cell belonging to the palate bone. A probe passed into it leads into the supreme or fourth meatus of the nose, indicating that it may be related to or connected with the sphenoidal sinus. In fact, it is a very large sphenoidal sinus extending out laterally in a line almost to the outer part of the maxillary bone.

Fig. 50 gives a view of the external walls of the nasal fossæ of the same skull as Fig. 49. The sphenoidal sinus shown in B extends laterally until it forms the cavity posterior to the maxillary sinus seen in Fig. 49. It will be observed that this large sphenoidal sinus extends well forward toward the frontal bone and backward toward the basilar process of the occipital bone.

Fig. 51 is an outer and inner view of a section showing an extremely large sphenoidal sinus. In A the cut is made through the premolar teeth, and a little to the inner side of

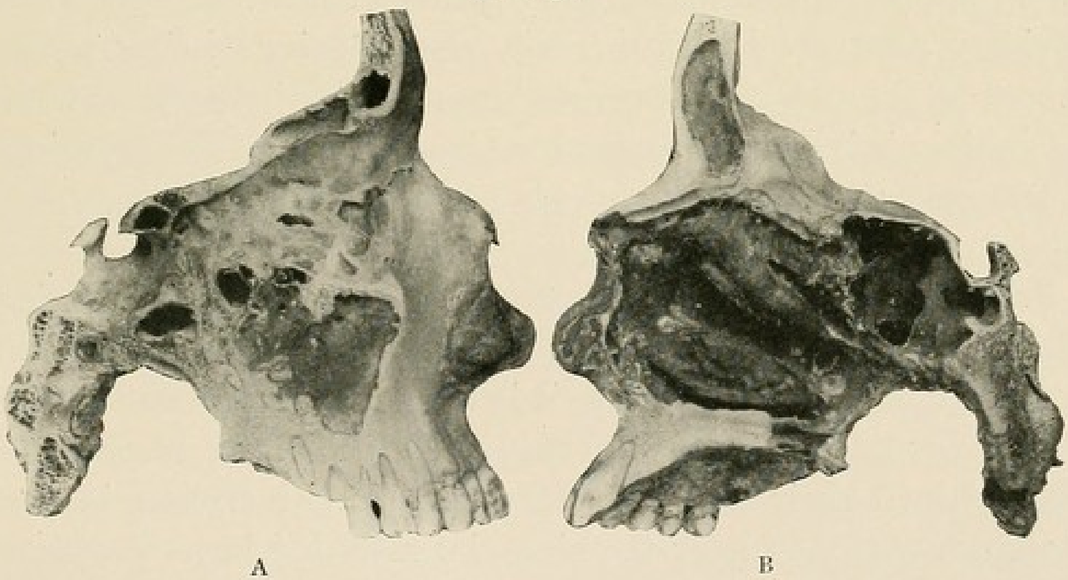
FIG. 50.



A B

External walls of right and left nasal chambers, with large sphenoidal sinuses, B having four meati.

FIG. 51.



A B

Two views of an antero-posterior section. A shows the inner wall of the orbit, maxillary sinus, and openings leading into the sphenoidal sinus. B shows the external wall of the nose and a large sphenoidal sinus.

the middle of the orbit, exposing the inner wall of the maxillary sinus, the cell of the palate bone, and the sphenoidal sinus, over which is seen the sella turcica. The irregular opening in the anterior clinoid process in A leads to and is a part of the sphenoidal sinus. In B the external wall of the nose will be observed. In the region of the body of the sphenoid bone is a very large sinus, at the bottom of which will be noticed a space under the sella turcica shown in A. This is the largest sphenoidal sinus which has come under the observation of the writer. It extends forward to the cribriform plate of the ethmoid bone; backward to near the basilar process of the occipital bone; laterally on a line with the molar teeth; superiorly into the anterior clinoid process, with only a very thin plate of bone between it and the floor of the anterior fossa of the brain-case. In such cases the partition between the sphenoidal sinus and the maxillary sinus is so thin and sieve-like that infected fluids will readily find their way from the former to the latter.

In the usual physiological description of the sinus, the fluids are spoken of as passing out of it. It is a question if this be the case under normal conditions. It is more than likely that the law of supply and demand is so balanced that *the parts of the maxillary sinus are kept moist only*, the openings being so arranged at the top as to prevent undue loss of the fluids while the subject is lying on the back or is standing. The openings in the other air cells or sinuses are so arranged as to make almost complete drainage.

Dental Relationships. Because of the close anatomical relation of the maxillary sinus with the tooth-germs and the roots of the permanent teeth, it is evident that the sinus must be more or less influenced by them. As the teeth develop and descend into their normal places, the sinus increases in size. If a tooth situated near the sinus be retarded in its eruption, the development of the antrum is interfered with at that particular point. If the root of a tooth be left in the jaw in old age, resorption immediately over that root will not progress as in the parts from which the roots have been removed. (See Fig. 85.)

It has been shown how closely the apical portions of the roots of the teeth are often associated with the sinus. (See Figs. 25, 26, and 41.) This close proximity gives the impression that the maxillary sinus is oftener infected from diseased teeth than from any other source, some authorities claiming that three-fifths of the diseases of the antrum are brought about in that way. The writer thinks this a mistake. Though recognizing that diseases of the antrum do arise from the teeth, he believes that, aside from constitutional diseases and malformations, it is more often through the common communication between the nasal chamber, the frontal sinuses, the ethmoidal cells, and the maxillary sinus, that infection is conveyed to the antrum from diseased cells and sinuses above it. He recognizes, at the same time, that the posterior ethmoidal and sphenoidal cells and the cells of the orbital process of the palate bone can also infect the antrum by resorption of the partition between these cavities. It is the writer's observation that there are more cases in which teeth are lost through diseases of the antrum than cases in which the teeth are primarily diseased, causing infection of the antrum and associated cells. In Fig. 26 it will be observed that the anterior buccal and palatal roots of the first molar tooth pass up into the walls of the antrum. This is the class of cases where diseased teeth may cause infection of the maxillary sinus. If the pulp of a tooth so related to the antrum should become devitalized and infected, the parts around the apical foramen might also become infected and abscesses occur. From the close proximity of the points of the roots to the sinus, it might be supposed that these abscesses would break into the antrum, as they occasionally do. Other examples of infection of the antrum through diseased teeth in no way militate against the idea that the teeth are not first in importance as factors in causing disease of the antrum.

It is, however, clear that pus or infected matter will pass in the direction of the least resistance. When the investing tissues of a tooth become so infected, the osteogenetic layer of the muco-periosteum stimulates renewed activity, with the result that a new layer of bone is produced by it which covers these parts and protects this cavity so that abscesses, with but few exceptions, point and break into the mouth.

Careless operation by the dentist sometimes causes infection of the sinus, as drilling through the tooth and the floor of the sinus, or forcing the root of a tooth into the sinus, through fracture of the wall in an unskillful effort to extract, or carelessness in driving artificial crowns or bridges upon the teeth or roots.

Fig. 52 gives a view of an undeveloped and unerupted third molar which was causing irritation in the floor of the sinus.

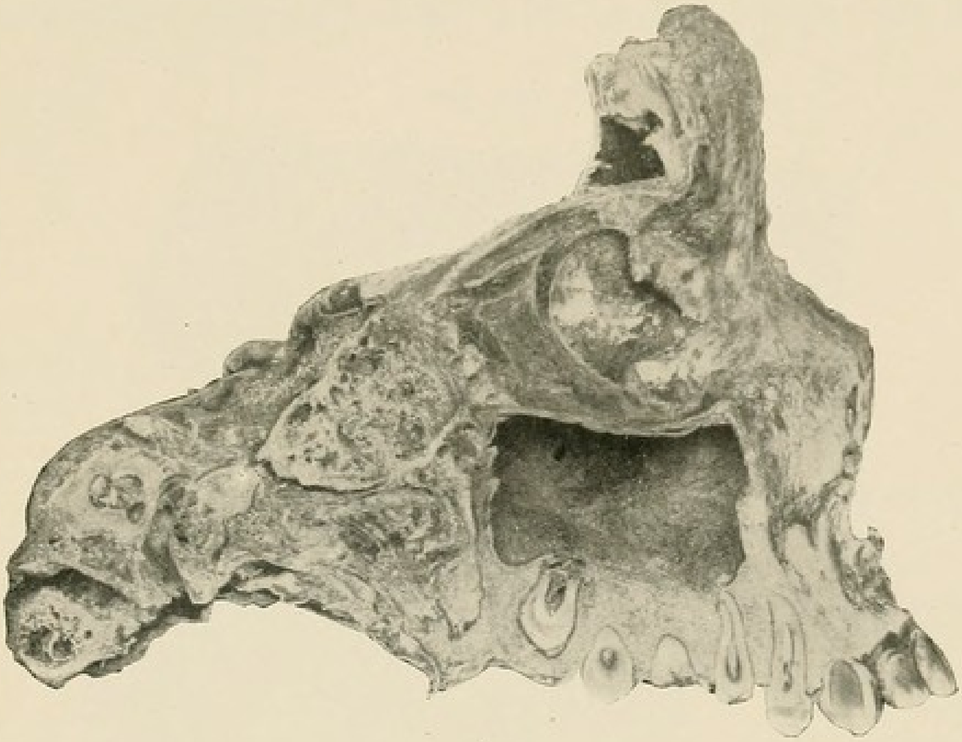
Fig. 58 is from the opposite side of the same skull, showing a similar condition and with an abscess which has burrowed under the mucous membrane near the roots of the first molar tooth.

Fig. 54 is a view of an antero-posterior section of the upper jaw with the first molar decayed and the pulp-chamber of the tooth open. The root-canal has been infected and the infection has been carried into the sinus. In this case there is evidence of a constructive periostitis upon the floor of the antrum, which has caused a thickening of bone over the apex of the root. At a later period suppurative inflammation has occurred and perforated the floor of the antrum.

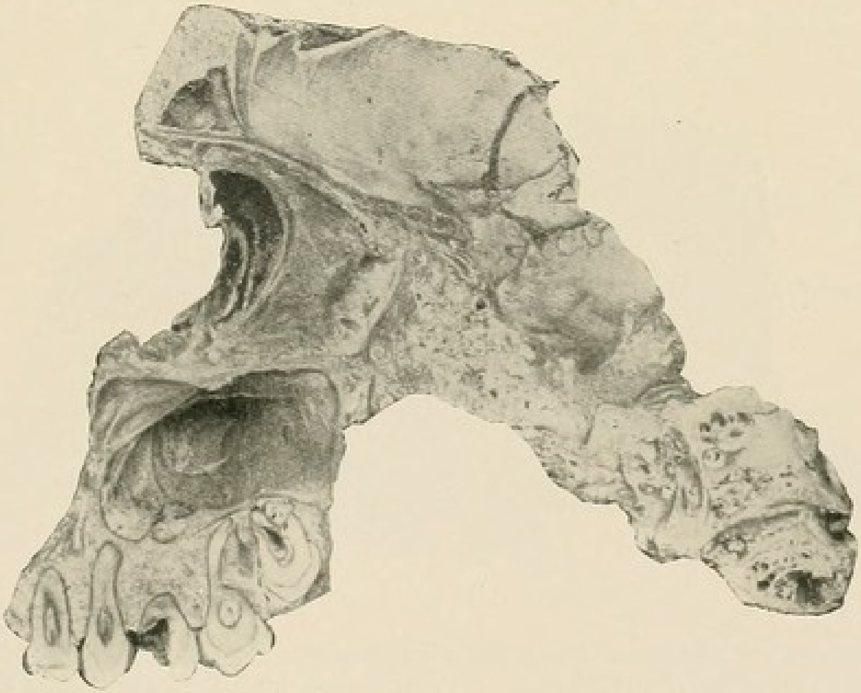
Fig. 55 is a view of the floor of the antrum and the nasal chamber. In the middle of the antrum there is a conical elevation with an opening in the center exposing the apex of a tooth. In this case new bone has been formed over the diseased root, but at some subsequent time the bone has been broken down and the antrum has become infected.

Fig. 56 is a vertical transverse section of the sinuses and nasal chamber. In the floor of the right antrum the conical portion of the bone, covering the infected tooth, has been cut through its center, exposing the end of the root in the infected region, the condition being somewhat similar to those shown in Figs. 54 and 55.

FIG. 52.



A

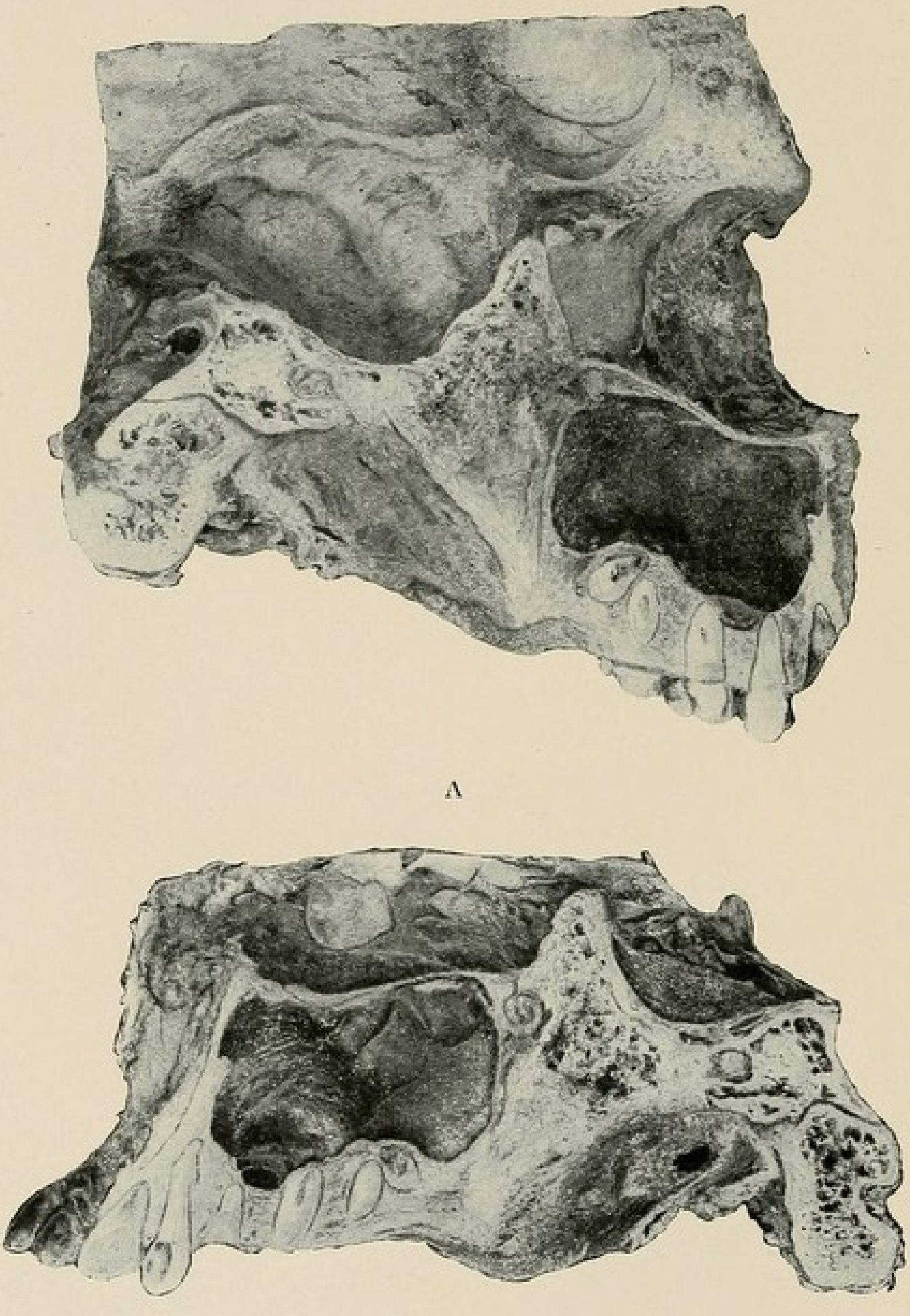


B

Antero-posterior division through the orbit, frontal and maxillary sinuses, and molar teeth, showing an undeveloped molar which was causing irritation in the floor of the sinus.

Fig. 57 is made from the left maxilla of the same skull from which Fig. 54 was taken. The pulp of the first molar was de-

FIG. 53.



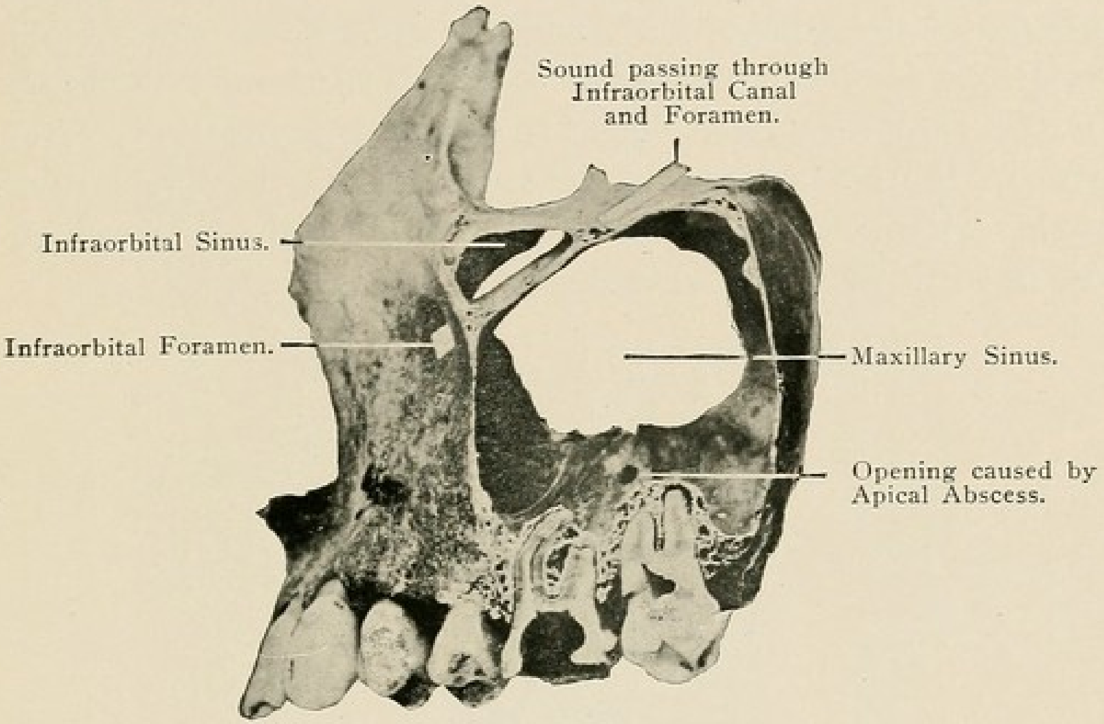
A

B

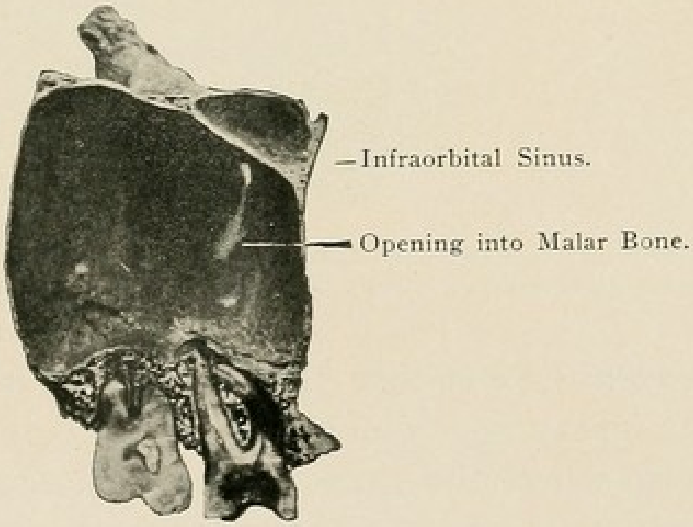
Antero-posterior division through the orbit, frontal sinus, maxillary sinus, and molar teeth, showing a similar condition as in Fig. 52. An abscess has burrowed under the mucous membrane near the roots of the first molar tooth.

vitalized. In B quite an exostosis over the position of the infected root is seen. An examination of the hard palate shows that the discharge of the abscess was made into the mouth, which the writer believes is the usual outlet for apical

FIG. 54.



A



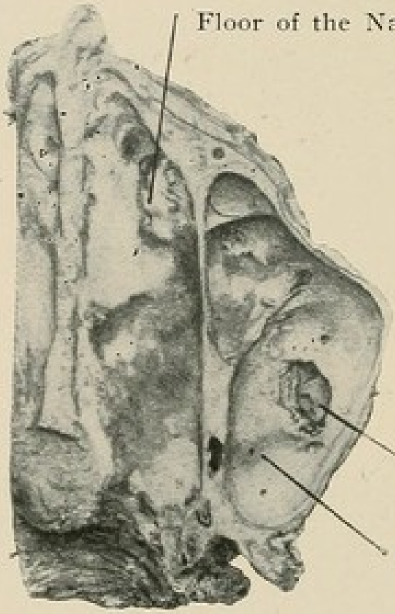
B

Antero-posterior division of the maxilla, showing opening of a dental abscess within the antrum and an infraorbital sinus.

abscesses in the upper jaw,—of course recognizing that they occasionally open into the antrum.

It has been shown by these examples how numerous are the variations of the maxillary sinus in shape, size, and position, and in its relation to the mouth and teeth, the nasal chamber, the frontal sinus, the ethmoidal cells, the cell of the orbital process of the palate bone, and the sphenoidal sinus. The variations are most important to the dentist and rhinologist. In the field of stomatology, so many complications often arise in the extraction and treatment of teeth that a thoroughly scientific knowledge of the results of all recent research in this region is absolutely necessary.

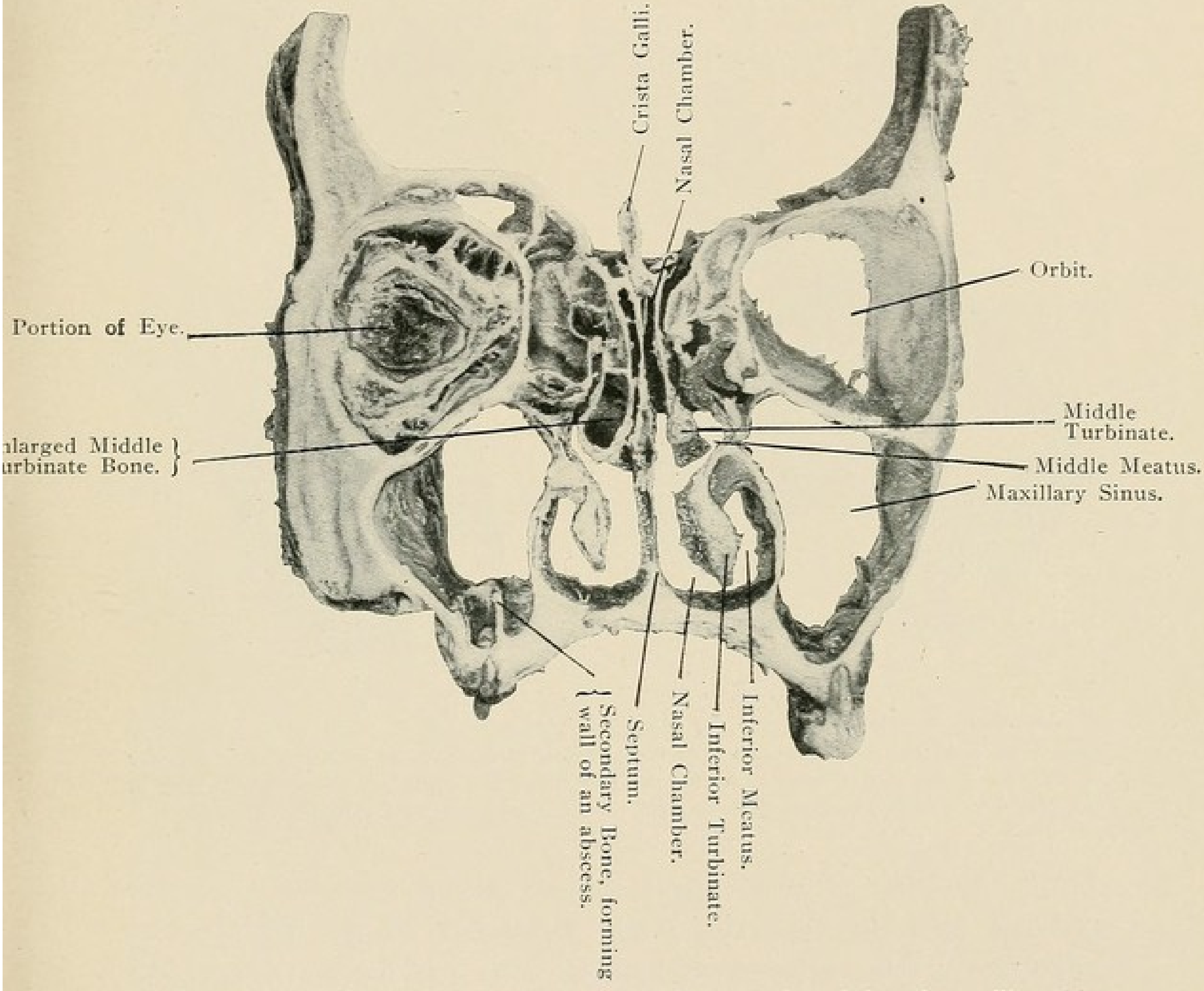
FIG. 55.



Horizontal section above the right floor of the nasal fossa and maxillary sinus, showing the opening of a dental abscess in the floor of the antrum.

Surgical Relations. In the extraction of the upper molar teeth great care should be exercised, because, as has been shown, where the antrum is large, extending downward and inward between the roots of the teeth, as seen in Figs. 25, 26, and 94, if undue force should be exerted, not only the tooth grasped by the forceps, but also a great portion of the floor of the antrum with other teeth attached is liable to be carried away. Examples of the results of such accidents are shown in Fig. 58. A and B are from specimens broken away with the ordinary forceps, and C is from a specimen of the work of the old-fashioned turnkey. When using much force in placing artificial bridges or crowns upon the teeth immediately beneath the antrum, there is danger of breaking the

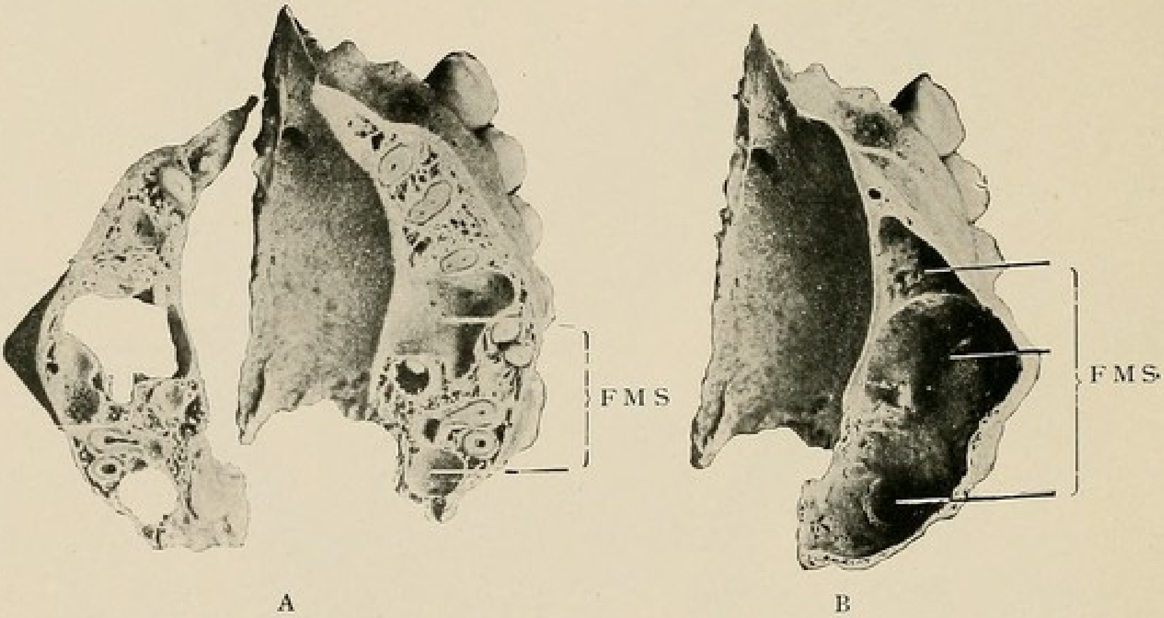
FIG. 56.



Anterior view of a vertical transverse section in the region of the crista galli, middle of orbit, and molar teeth, showing effect of dental abscess in floor of maxillary sinus.

floor in subjects where the walls are thin. When the pulps of the teeth have become diseased and infected, the infection may pass out of the apical foramen into the tissues immediately surrounding the root, and thence into the antrum, as has before been mentioned. In cleansing the root-canal there is some danger of passing the instrument through the apical foramen directly into the sinus. Soreness of the teeth caused by inflammation of the peridental membrane with abscesses threatening to open into the mouth, sometimes disappears suddenly, although no fistulous opening into the mouth has formed. When this occurs the abscess has frequently found an opening into the sinus. Diseases of the maxillary sinus are liable to produce disturbances in the

Fig. 57.

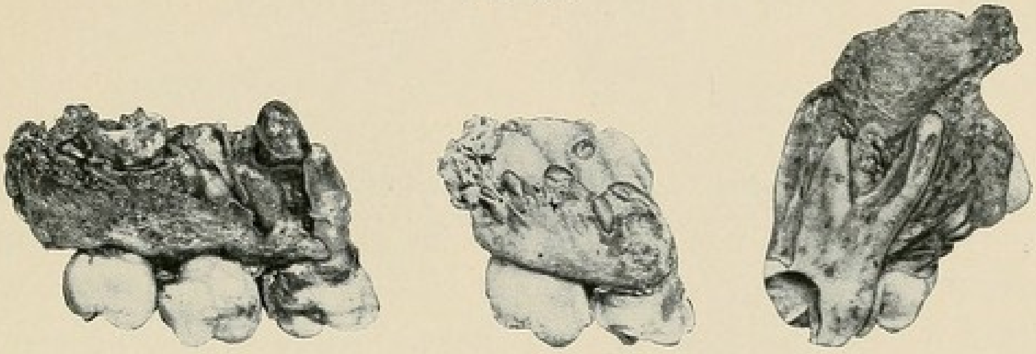


Horizontal sections through the maxillary sinus. F M S, floor of the maxillary sinus. In B there is an exostosis over the position of an infected root of the first molar tooth. In A the cap of bone covering the root has been removed, exposing the end of the root and a fistula extending downward, opening into the roof of the mouth.

teeth, as their blood supply passes along the floor of the antrum and through the wall. Branches of the fifth nerve accompany the vessels, and these also are liable to become deranged in their true function.

The maxillary sinus is on a lower plane than any of the other sinuses and cells associated with the nasal chamber, and has its outlet in the upper anterior portion; when the hiatus semilunaris is blocked below or posterior to the opening of the sinus, it becomes engorged with the fluids which have no other normal exit, thus producing pressure upon its walls and upon the nerves and vessels passing through it. It is in such cases that additional openings are found leading from the maxillary sinus. (See Figs. 95, 96, and 97.)

FIG. 58.



A B C

Three pieces of bone with molar teeth that have been accidentally broken away with part of the floor of the maxillary sinus in extraction; A and B with ordinary forceps, C with an old-fashioned turnkey.

THE FRONTAL SINUS.

The frontal sinuses are two irregular shaped chambers situated in the lower part of the facial portion of the frontal bone and in the process forming the roofs of the orbits, with a thin lamina of bone between them. They vary considerably in size, shape, and position.

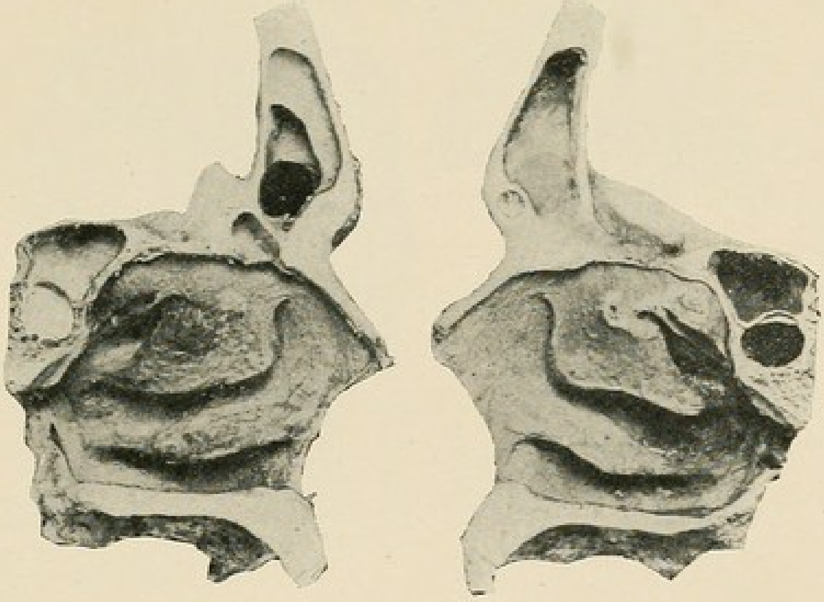
Development. They appear about the second year after birth and are formed by an invagination from the upper anterior portion of the hiatus semilunaris and by a dissolution of the tissue between the outer and inner plates of the frontal bone, the excavations for the formation of these sinuses as well as for the various other cells and sinuses being supposedly carried on through the agency of the osteoclasts. The sinuses continue to increase in size until advanced age. They sometimes extend over the greater part of the orbit and even as high as the frontal eminences. They are lined with mucous membrane and communicate with the nasal chambers through the infundibulum and the hiatus semilunaris.

Fig. 59 shows a large left frontal sinus, which passes over to the right of the median line, leaving but little room for the right sinus in its normal position, as is seen in B. Often, in such cases, the opposite side will extend its air space in some other direction to make up for the loss caused by the invasion.

Fig. 60 is made from B of Fig. 59, cut through the center of the orbit, showing that the frontal sinus has extended back over the orbit to the region of the optic foramen. It has also extended outward under the external angular process of the frontal bone.

Fig. 61 is made from a skull where the frontal sinus has

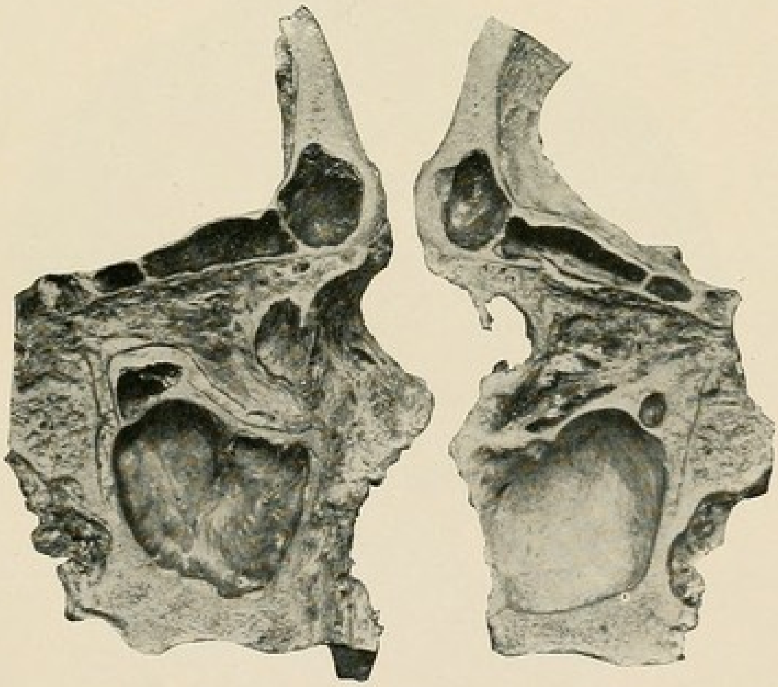
FIG. 59.



A B

External walls of the nasal chamber showing the left frontal sinus extended over to the right of the median line.

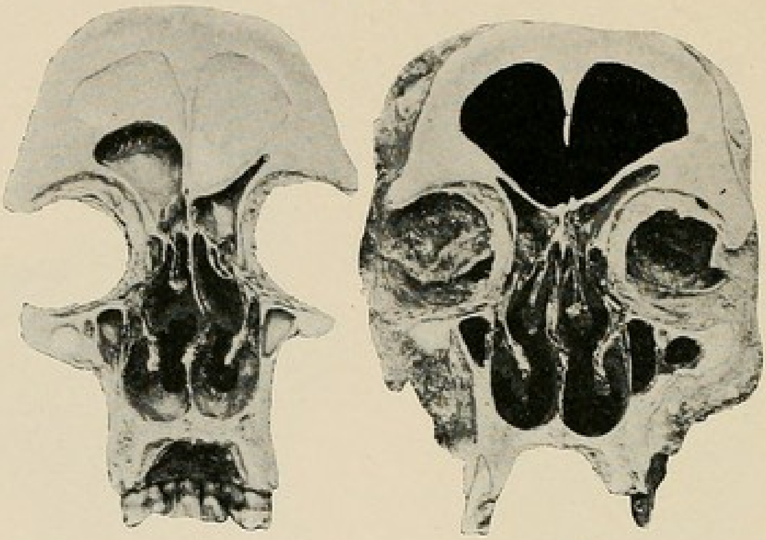
FIG. 60.



A B

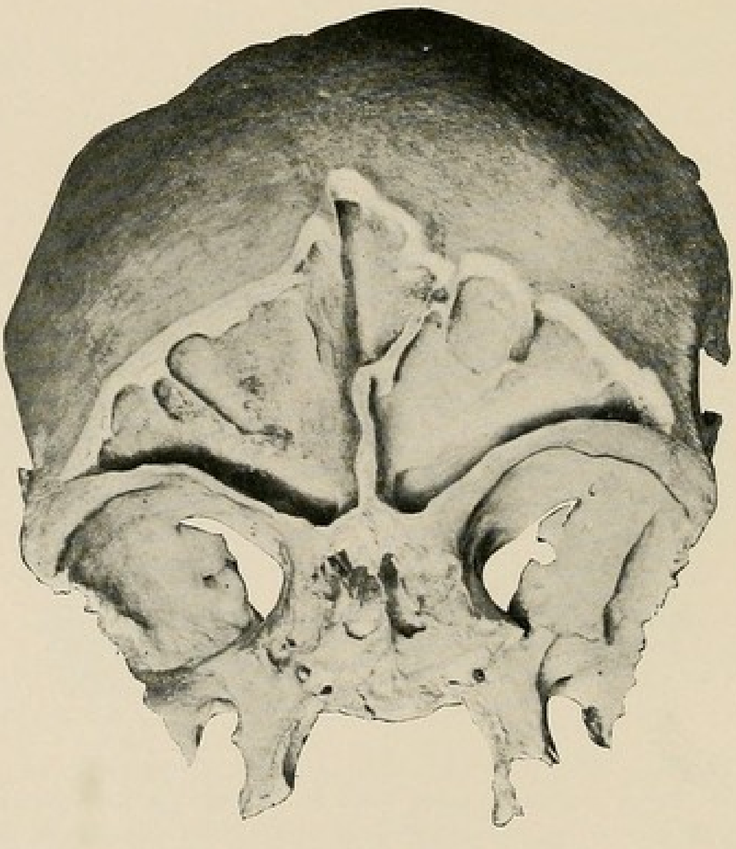
Two antero-posterior sections (made from B of Fig. 59) through the frontal sinus, center of orbit, maxillary sinus, and cell of the orbital process of the palate bone, showing the frontal sinus extending backward over the orbit to the region of the optic foramen. It also extends under the external angular process of the frontal bone.

FIG. 61.



Two vertical transverse sections through the frontal sinuses and nasal chambers, showing the frontal sinus extending below the level of the middle of the orbit.

FIG. 62.



Large frontal sinuses extending from one external angular process of the frontal bone to the other.

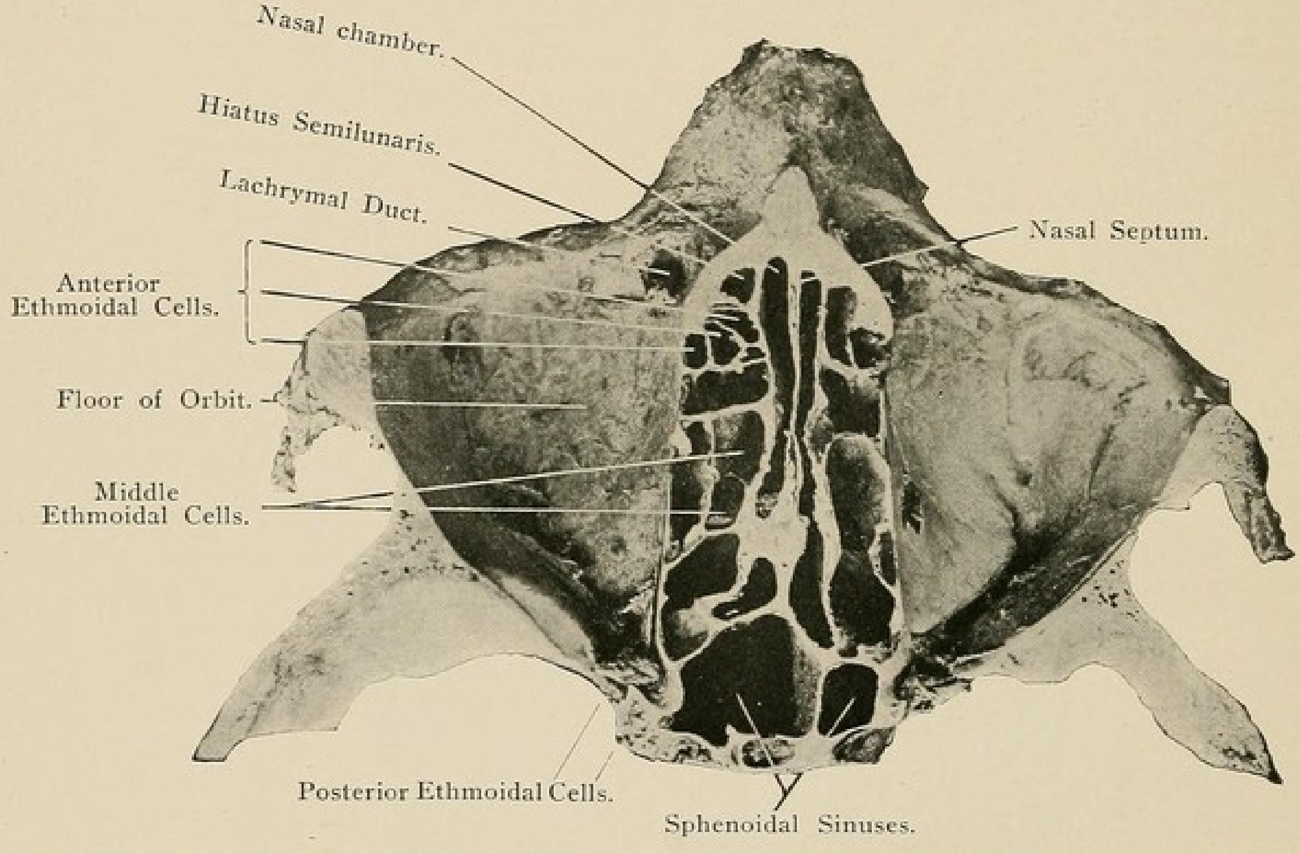
extended upward under the region of the frontal eminence and downward to the middle of the orbit or almost on a level with the upper portion of the maxillary sinus.

Fig. 62 is an illustration of large frontal sinuses, extending from one external angular process of the frontal bone to the other, with but a thin complete septum between. This septum is not in the center, but is carried to the left side. The sinuses pass backward over the greater portion of the orbits, and upward toward the frontal eminence. There is quite a depression over the frontal crest, which is very large in this specimen. There are also several partial septa running in various directions in the two sinuses.

THE ETHMOIDAL AND OTHER CELLS WHICH HAVE THEIR FINAL OUTLET IN THE NASAL FOSSÆ.

The ethmoidal cells are situated principally between the two orbits. Fig. 63 is an upper view of a horizontal section

Fig. 63.



Upper surface of a horizontal section cut through the orbits and upper part of nasal fossa.

cut through the center of the orbits and the upper part of the nasal chambers, showing clearly the position of many of the cells, as does also Fig. 39. Many of these ethmoidal cells are formed by the union of the orbital plates of the frontal bone and the ethmoid bone and between the ethmoid bone and the maxilla; others are within the ethmoid alone. They are divided into three groups, anterior, middle, and posterior.

The anterior ethmoidal cells are the smallest of the three divisions. They open by several small orifices into the anterior portion of the hiatus semilunaris. Occasionally a chain of cells is found opening one into another and finally into the hiatus.

The middle ethmoidal cells vary more in size than either the anterior or the posterior. The inner covering or wall of the cells is spheroidal in form and is known as the **bulla ethmoidalis.** It is situated in the upper portion of the lateral wall of the hiatus semilunaris, and extends downward and inward toward the unciform process. The openings of the cells are in the outer portion of the bulla ethmoidalis and they discharge into the hiatus semilunaris.

The posterior ethmoidal cells are usually two or three in number. They are found on about the same plane as the anterior and middle ethmoidal cells, are irregular in shape, and usually have their general outlet into the superior meatus.

The cells of the orbital process of the palate bone are two in number, one on each side. Each cell is small and situated below the posterior part of the floor of the orbit. It is, like many other air cells, irregular in shape and size. It opens into the third or superior meatus. It occasionally extends backward near to the sphenoidal sinus or outward around the posterior wall of the maxillary sinus, from which it is separated by a thin plate of bone. (See Fig. 48.)

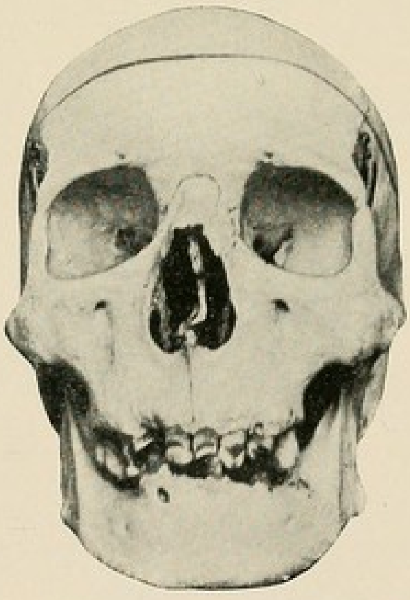
The sphenoidal sinuses are two, one on each side, irregular in shape and size, situated in the body of the sphenoid bone. (See Figs. 50 and 51.) The septum between them is generally deflected to one side or the other. (See Figs. 63 and 81.) Incomplete septa may also be found at the posterior portion of these cavities, which divide them into several incomplete compartments. (See Fig. 81.) Sometimes these sinuses may extend backward to the basilar process of the occipital bone, or forward to the cribriform plate of the ethmoid bone, or laterally into the base of the great wings of the sphenoidal bone, or into the clinoid process. (See Fig. 51.) They are lined with mucous membrane, which is continuous with that lining the upper and posterior portion of the nasal cavities. They empty into the highest meatus.

Cell of the crista galli. Sometimes a cell is found within the crista galli. (See Figs. 74, 82, 90, 91, 92, and 93.) In such a case the opening is in front and communicates with one of the frontal sinuses. It might be termed an extension of the frontal sinus into the crista galli.

VARIATIONS IN THE ANATOMICAL STRUCTURES OF THE FACE.

It has been the endeavor thus far to describe the jaws and their associated parts and to speak only of what might be termed typical anatomy. At the same time, great variations have been referred to. These variations are so common that it is difficult at times to state which is normal and which is abnormal anatomy. Some of the most important and com-

Fig. 64.



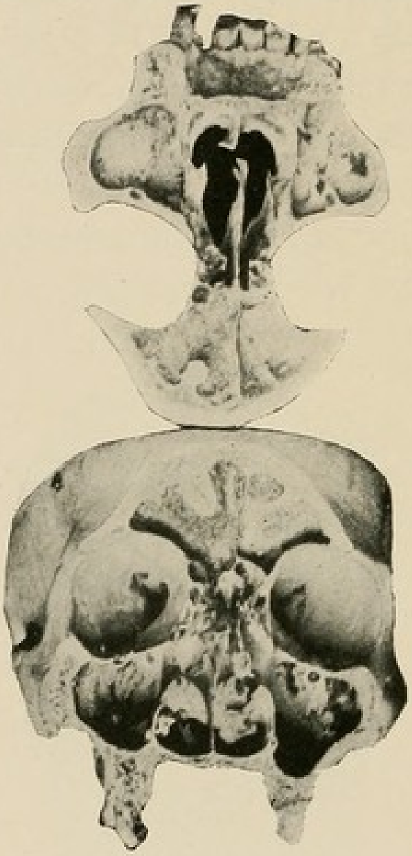
Front view of asymmetrical skull, showing the right side of the face fuller than the left side.

mon variations found in the writer's dissections are described in pages following.

Fig. 64 is a front view of a skull which has an unsymmetrical arch of the mouth. The greater portion of the teeth have been lost in early life. The canine fossa of the right side is lacking, the face being bulged out at that point. The teeth have not been in normal position. The septum is deflected toward the right side. In a skull of this character the internal structures will usually be decidedly unsymmetrical. One might suppose that a large antrum would be found under the fullness of the canine fossa, but in this particular case it is not so found.

Fig. 65 represents a vertical transverse section of the

FIG. 65.



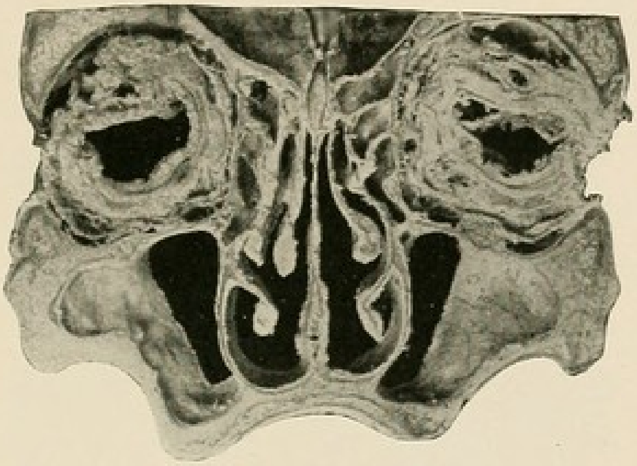
Vertical transverse division of Fig. 64, showing a larger maxillary sinus on the left side than on the right.

skull shown in Fig. 64. It will be seen that the right antrum is smaller than the left, the fullness of the region in the infra-orbital foramen and the canine fossa being due to the thickness of the bone. The frontal sinus of this specimen is large and extends downward between the orbits lower than usual.

Fig. 66 exhibits a condition occasionally met with, the floor of the antrum dipping downward and passing partly under the floor of the nose. The same condition will be found in Fig.

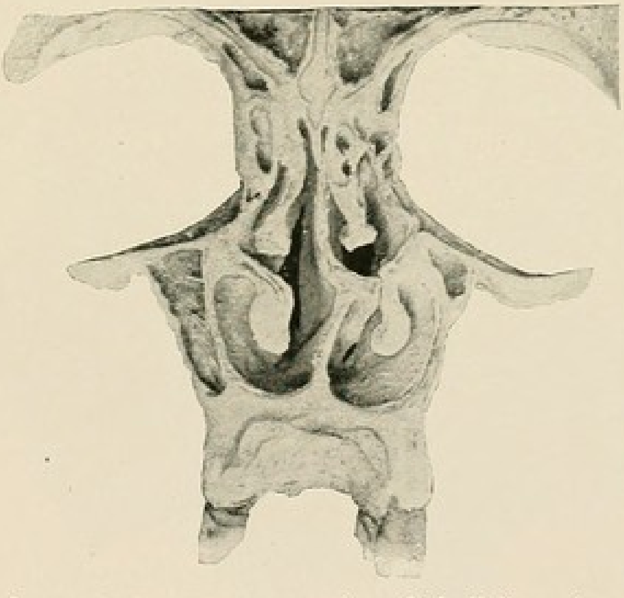
94, and in B, Fig. 83. Resorption has taken place between the plates forming the floor of the nose and the roof of the mouth. Sinuses like these could be drained directly by an opening

FIG. 66.



Anterior view of a vertical transverse section of skull through center of orbits, nasal chamber, and maxillary sinus, the lower inner corners of the maxillary sinuses passing partly under the nasal fossæ.

FIG. 67.



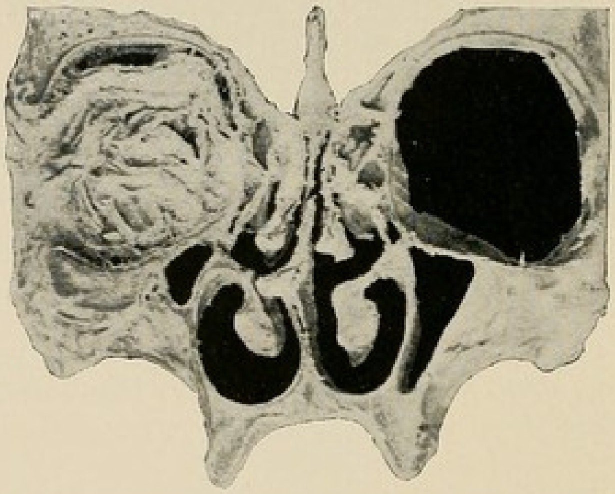
Posterior view of a vertical transverse section of skull in region of second premolar, showing lack of symmetry in nasal fossæ and maxillary sinuses, with the septum and "spur" passing over to the inferior turbinate.

through the palatal surface of the mouth. In skulls of this character the vault of the mouth is high.

Fig. 67 exhibits an entire lack of symmetry between the nasal fossæ and the sinuses of the right and left sides, the inferior meatus of one side being closed anteriorly by the deflected nasal septum and the "spur" upon it. In such cases as this, inspissated mucus often collects and the outlet of the lachrymal duct may be interfered with.

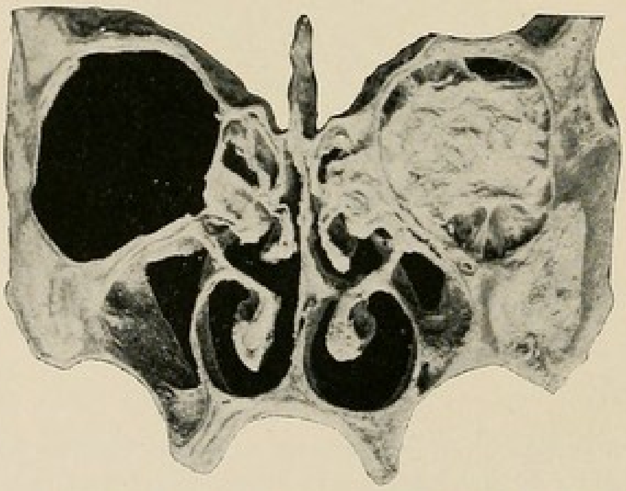
Figs. 68, 69, and 70 are from the same subject as Fig. 67. An instrument passed through the axis of the alveolar

Fig. 68.



Anterior view of a vertical transverse section of the skull shown in Fig. 67, showing an asymmetrical condition of the two sides.

Fig. 69.

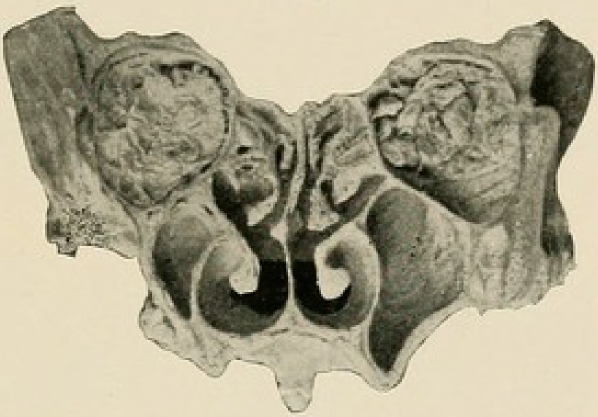


Posterior view of section shown in Fig. 68.

process shown in the right side of Fig. 69 or the left side of Fig. 68 or Fig. 70 would perforate the nasal fossa, instead of the floor of the antrum.

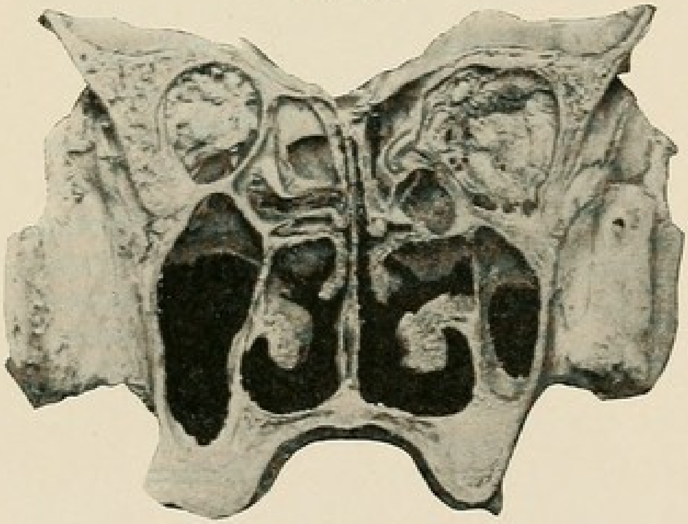
Fig. 71, which is taken from a different skull, shows an almost straight septum, with bilateral symmetry as to the nasal chamber; the maxillary sinuses vary, however, throughout the depth of the skull. On the right side the antrum would not be reached by drilling through the alveolar process,

FIG. 70.



Anterior view of vertical transverse section cut from the posterior part of the nasal fossæ and maxillary sinus. It is from the same skull as Figs. 67, 68, and 69.

FIG. 71.



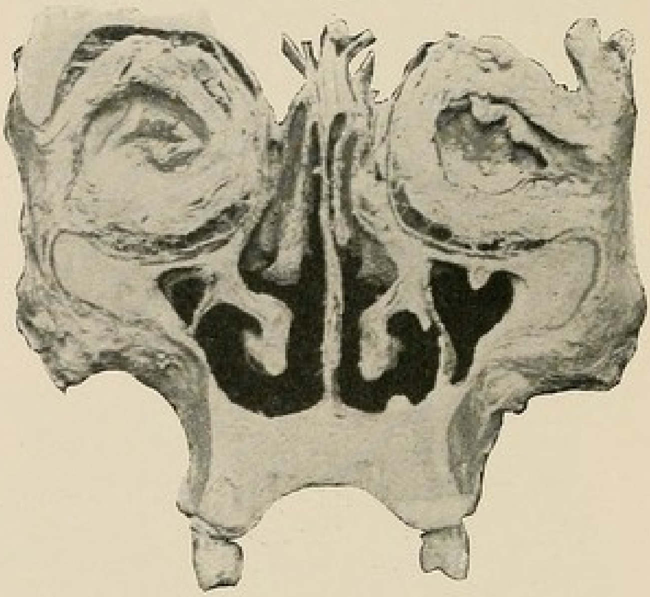
Anterior view of a vertical transverse section showing lack of uniformity in the two maxillary sinuses.

while on the left side the sinus is just above the process, and the floor is below the level of the floor of the nose.

Fig. 72 is from a vertical transverse section in the region of the first premolar. The septum is almost straight, but there is a great variation in the maxillary sinuses. The outer wall of the nasal chamber of the right side is also the outer plate of the maxilla, the floor of the antrum being on a much higher plane. In the floor of the left nasal chamber is an elevation which covers a tooth root, more than likely that of a supernumerary tooth.

In Figs. 68 and 72 the nasal walls of the right inferior meatus pass outward under the maxillary sinus to the facial portion of the maxillary bone. In Figs. 75 and A, Fig. 83, the same condition will be observed on both sides of the illustra-

FIG. 72.



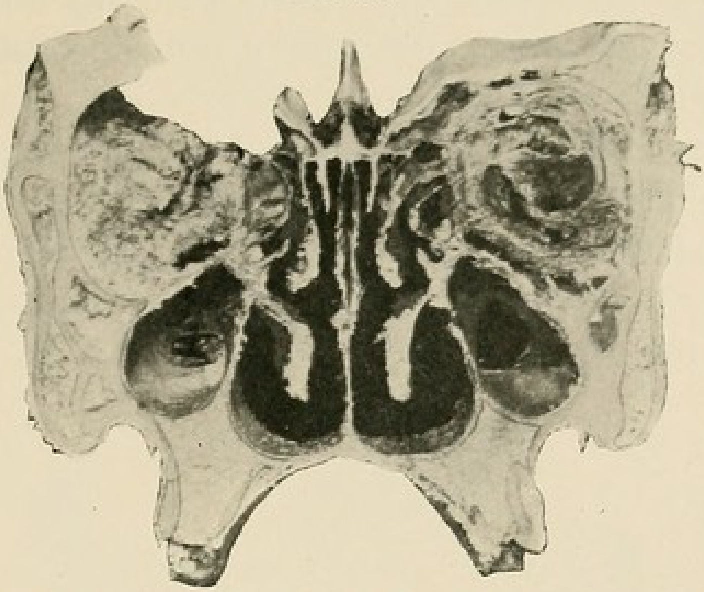
Anterior view of a vertical transverse section, near the first premolar, showing variations in the maxillary sinuses and the nasal fossæ.

tion. In the event of attempting to drill into the maxillary sinus from the canine fossa in such cases as are represented in these figures, as is sometimes advised, the opening would be made into the nasal chamber instead of into the sinus.

Fig. 73 is a view of a vertical transverse section from a skull in the region of the second molar. The septum is straight, the nasal chamber and the appendages and the maxillary sinuses are small, and do not extend downward in the direction of the teeth and the alveolar process.

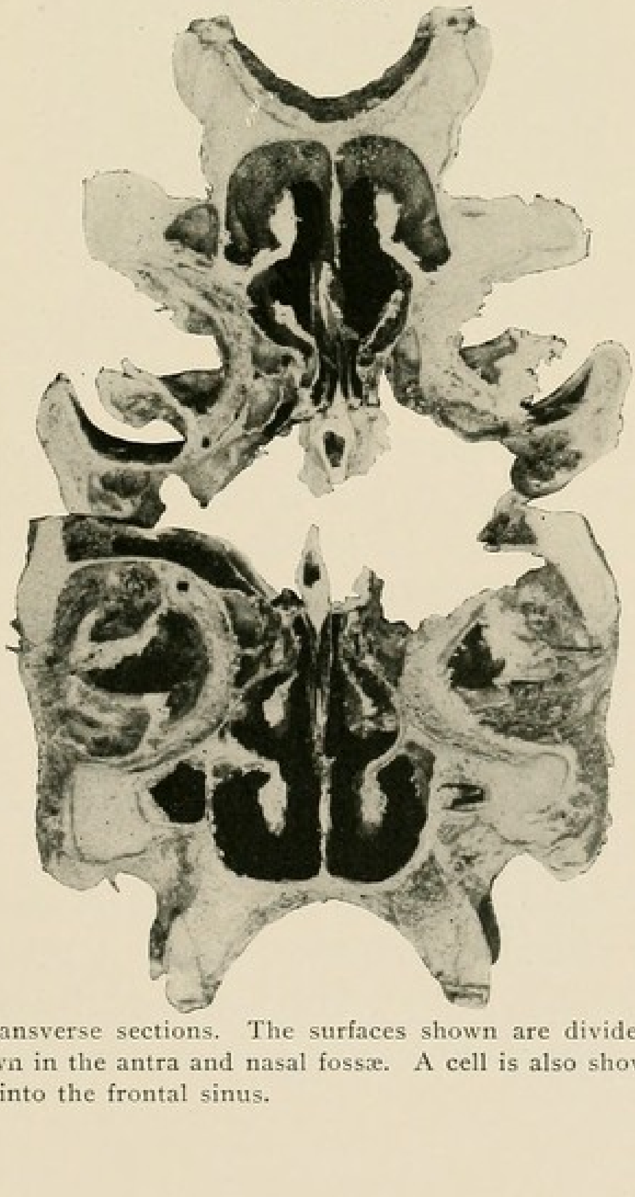
Fig. 74 shows two sections from the same skull as Fig. 73, cut more anteriorly, in the region of the premolars. The parts

FIG. 73.



Posterior view of a vertical section made in the region of the molar teeth, showing small antra and large nasal fossæ.

FIG. 74.



Two vertical transverse sections. The surfaces shown are divided from each other. Variations are shown in the antra and nasal fossæ. A cell is also shown within the crista galli, which opens into the frontal sinus.

are almost symmetrical. The crista galli has been cut transversely, showing within its walls a cell of considerable size, opening into the frontal sinus.

Fig. 75 is made from the skull of an old subject, in which the bones have become much resorbed. It is comparatively symmetrical, with the floor of the sinus much higher than usual, and the nasal fossa extending outward to the external portion of the maxillary bone.

FIG. 75.

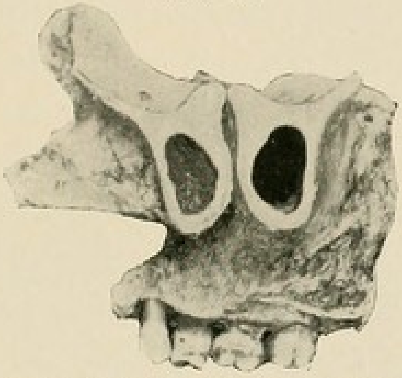
Anterior view of a vertical transverse section from the skull of an old person, showing large nasal fossæ with small antra.

Occasionally in surgical practice abscesses are found opening on the face in the region of the malar bone. These are usually looked upon as of superficial origin, but sometimes when carefully examined they are found to be associated with the maxillary sinus. Fig. 76 will partly explain why, in some cases, abscesses of the maxillary sinus open at this point. The section is made at the region of the maxillo-malar articulation. The maxillary sinus passes far into the malar bone, extending backward into the zygomatic process.

Fig. 77 is from a skull in which the nasal chamber extends outward over the alveolar process until it reaches the outer wall of the maxillary bone. The points of the palatal roots of the first and second molars appear in the floor of the nasal chamber. The floor of the maxillary sinus is well up on the side of the bone.

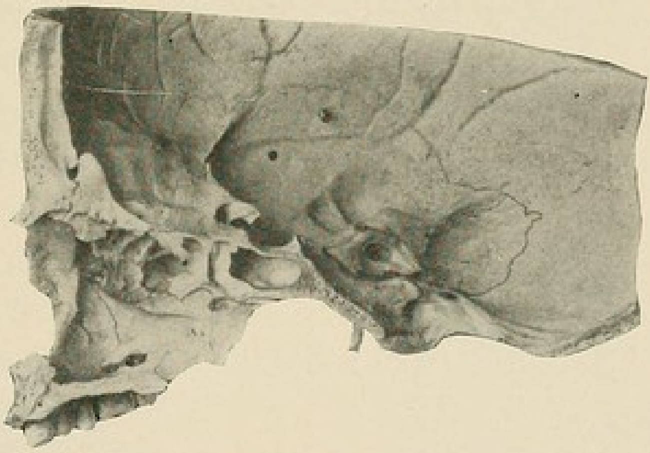
Fig. 78 is a picture from the external or facial surface of

FIG. 76.



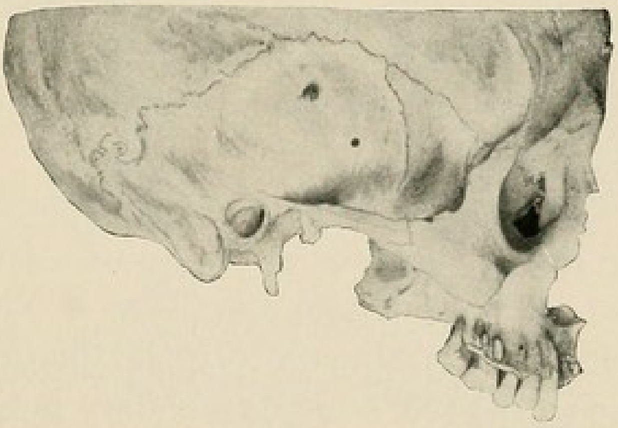
Section through the maxillo-malar articulation, showing that occasionally the maxillary sinus passes into the malar bone.

FIG. 77.



Interior view of the external wall of the nasal fossa, showing portions of the palatal roots of the first and second molar teeth in the floor of the nose.

FIG. 78.



External view of facial surface of Fig. 77, showing the absorption of the outer part of the alveolar process, leaving a line of bone near the free margin of the process.

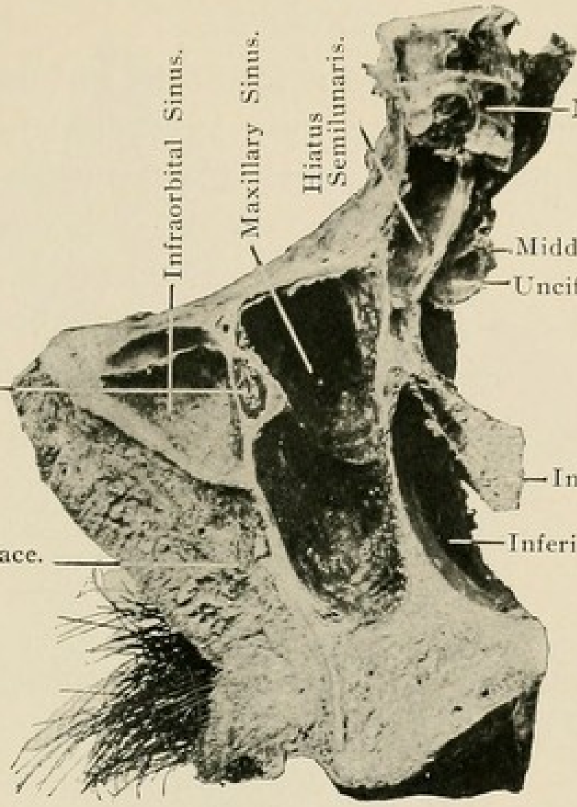
Fig. 75, which illustrates that the resorption of the alveolar process from over the buccal roots of the teeth may progress while that portion of the bone along the free margin of the process is left intact.

Fig. 79 shows a vertical transverse section of the upper jaw. In B the roof of the maxillary sinus is almost horizontal, which is a very unusual condition. The illustrations show what is apparently a division of the sinus into two, the smaller or outer division forming an infraorbital sinus. This condition is caused by a bony septum passing down from the center of the floor of the orbit, cutting off a portion of the sinus, and forming an extra chamber, which of course is continuous with the true sinus. In the center of the septum-like wall is a tube or canal conveying the infraorbital nerves and vessels. Above this and at the junction of the septum with the floor of the orbit is an adjunct infraorbital canal and nerve. At the upper inner corner of B is the normal opening of the maxillary sinus, the ostium maxillare, communicating with the hiatus semilunaris. This section beautifully illustrates how the hiatus semilunaris is bounded on the inner side by the unciform process, on the outer side by the wall of the sinus, and above by the bulla ethmoidalis, containing the middle ethmoidal cells.

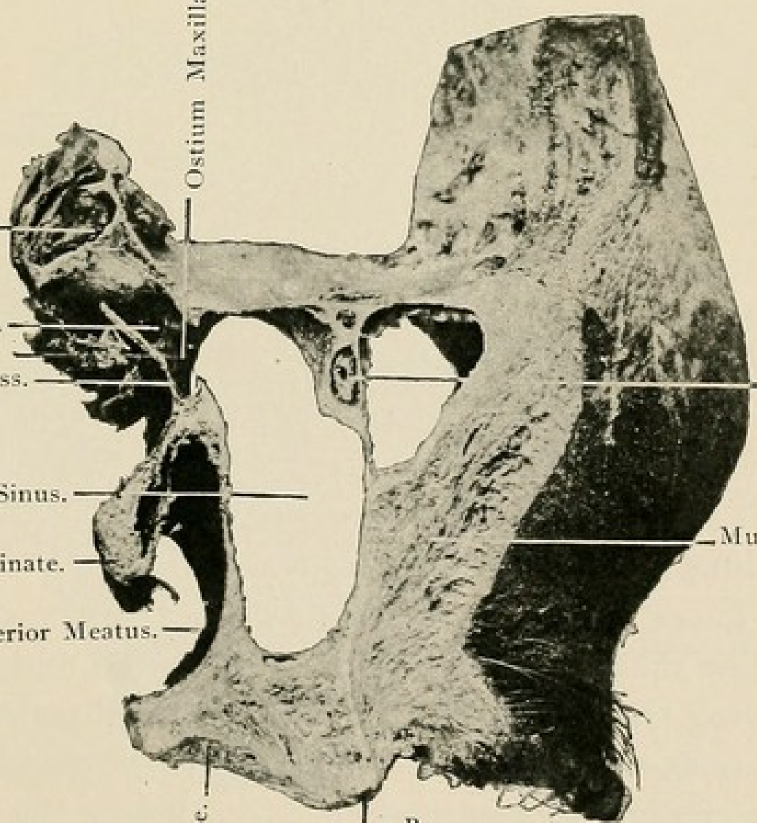
Fig. 80 illustrates a vertical transverse section of the face. It gives a good sectional view of the posterior ethmoidal cells. The white line is on a level with the floor of the orbit in the anterior portion of the section. It will be noticed, as is often the case, that the roof of the maxillary sinus runs up as it passes backward until it is far above the level of the floor of the orbit at its anterior margin.

Fig. 81 shows two sections made by a horizontal transverse section a little below the roof of the sinus. In this case the commencement of the ostium maxillare is within the roof. It passes backward and inward to the hiatus semilunaris. A probe placed in the left ostium maxillare indicates its position. Immediately to the left of the probe is a section of the

FIG. 79.



A



B

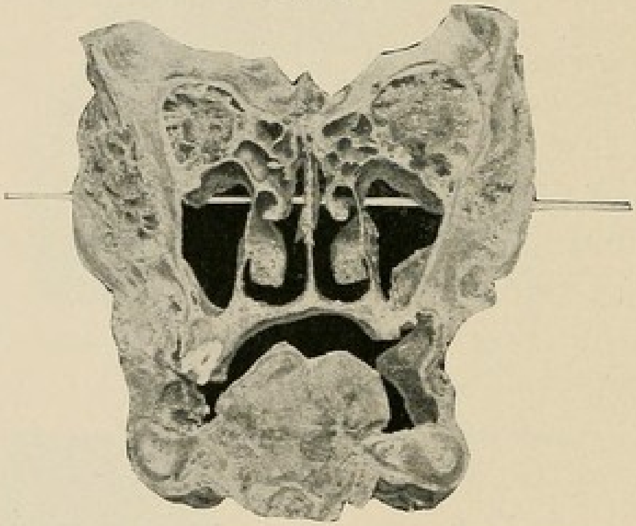
Vertical transverse division of the upper jaw.

lachrymal duct. On the opposite side, the lower wall of the right ostium has been removed.

That the great variations found in the nasal chamber and maxillary sinuses may be fully appreciated, skulls of widely different types have been selected and photographed together.

Fig. 82 gives a posterior view of two sections made from different skulls. They show great variations in the depth of the face, and the size, shape, and position of the maxillary sinus. In A the sinuses are much smaller than in the shorter-

Fig. 80.

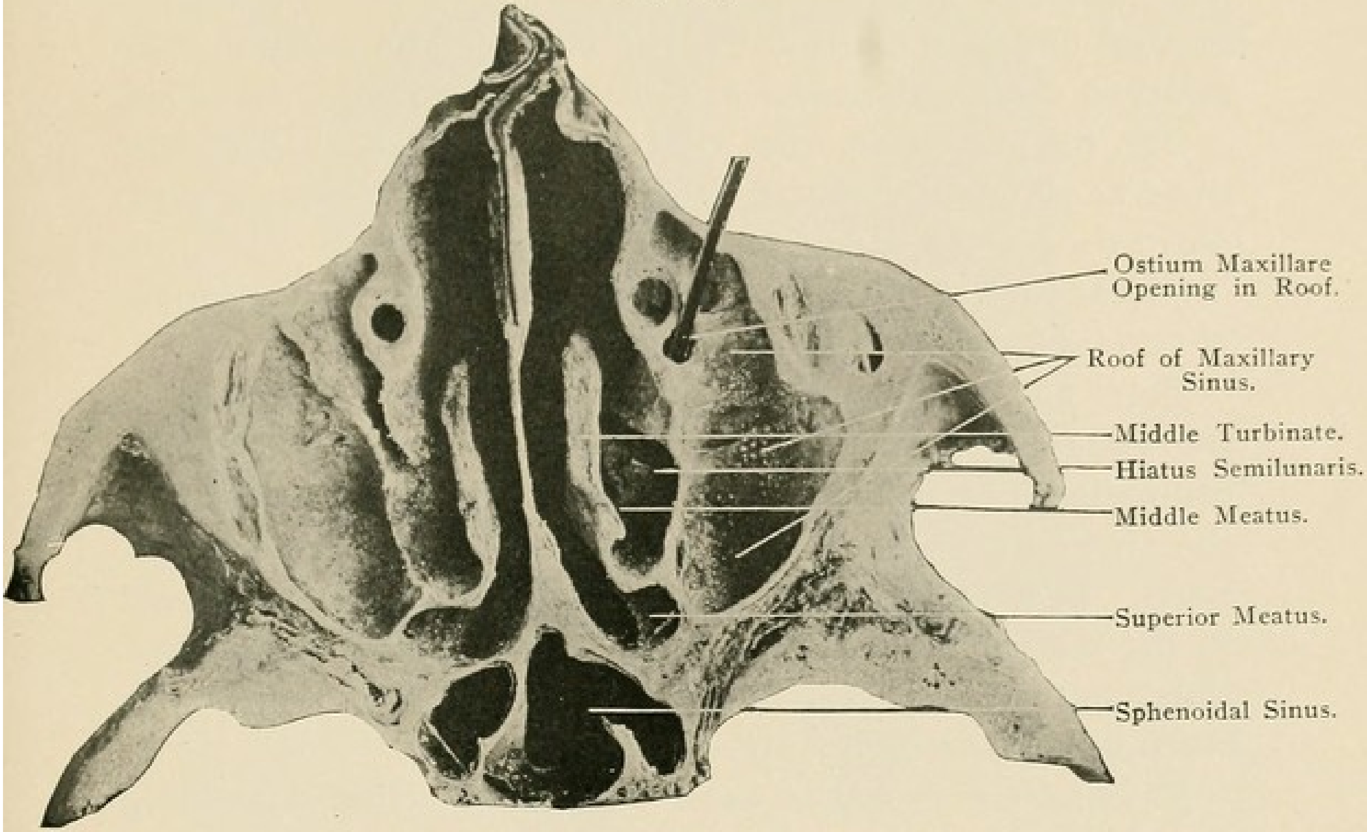


Posterior view of vertical section through the orbits, maxillary sinuses, posterior ethmoidal cells, and the third molar teeth.

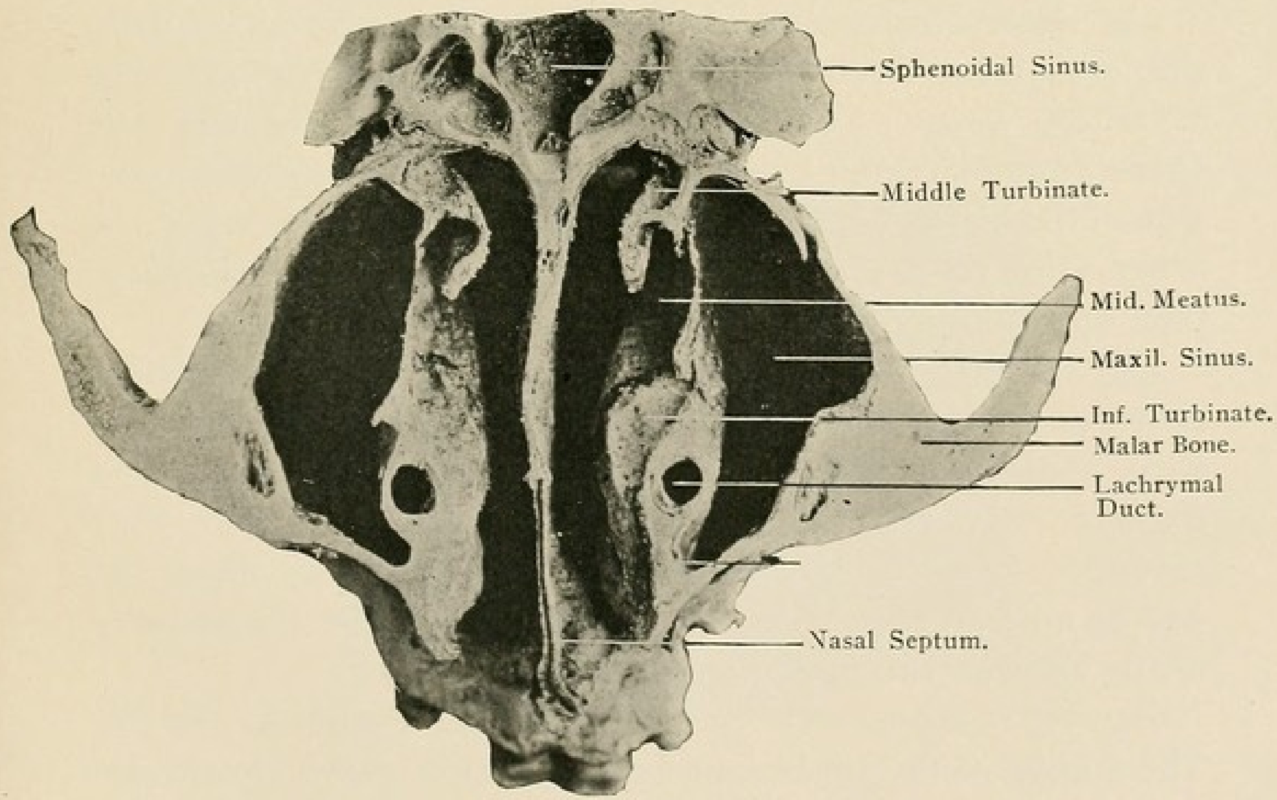
faced picture B. In A the septum has a spur extending outward until it comes in contact with the inferior turbinate, and the frontal sinuses pass well down below the level of the center of the orbits. In both illustrations there are distinct cells in the crista galli, which open anteriorly into the frontal sinuses.

Fig. 83 was made in the same manner as Fig. 82, and shows two sections cut in about the same position from two different skulls. There is again a great difference in the depth of the faces. The maxillary sinuses in A are small and placed high up, allowing the lower portion of the nasal chamber to extend outward over the alveolar process. In B the maxillary sinuses are large, their floors extending down below the floor of the

FIG. 81.



A



B

Two illustrations. A shows the roof of the maxillary sinus and upper portion of the nasal fossæ; B shows the maxillary sinus and nasal fossæ.

nasal chamber, and passing inward over the roof of the mouth, so that only a small space is left between the sinuses. The enlarged sinuses allow but little room for the nasal chambers.

Fig. 84, also made from two different skulls, shows variations in the depth of the nasal chambers. A gives a good illustration of the fourth meatus and a partial fifth.

(Great variations in the size and shape of the under surface of two jaws may be seen in Fig. 129.)

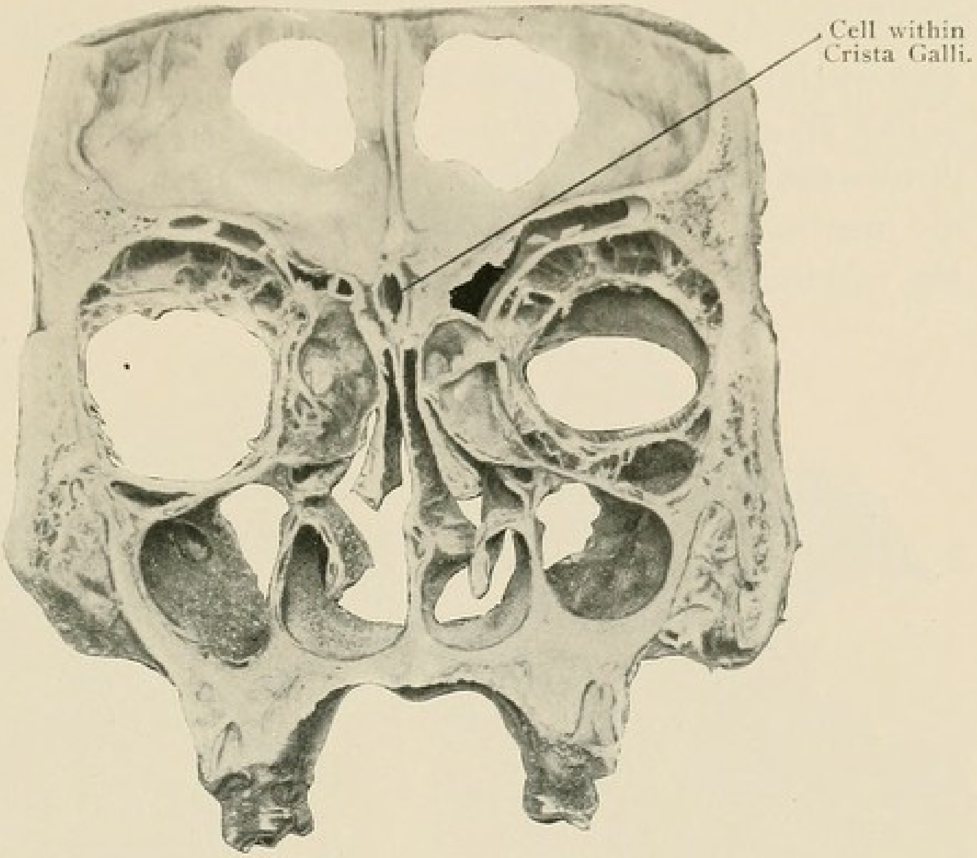
Figs. 82, 83, and 84 serve to show how great may be the variations in the sinuses and nasal chambers. Similar comparisons between the sphenoidal and frontal sinuses, and the ethmoidal and other cells, would show as marked differences. Bilateral variations almost equally extensive are found in the individual skull, except as to the depth of the face. Diagnosis and surgical manipulation in such cases will vary as much as the anatomical structures differ.

In Fig. 85 is shown an antero-posterior section illustrating the close relation between the frontal and maxillary sinuses. It also shows that in this instance fluids could (as they actually did) pass from the frontal sinus and ethmoidal cells into the maxillary sinus. Of the two probes passed through the ostium maxillare, one goes directly through the posterior portion of the hiatus semilunaris into the middle meatus, while the other (the vertical one) passes into the hiatus semilunaris, then upward and a little forward into the frontal sinus.

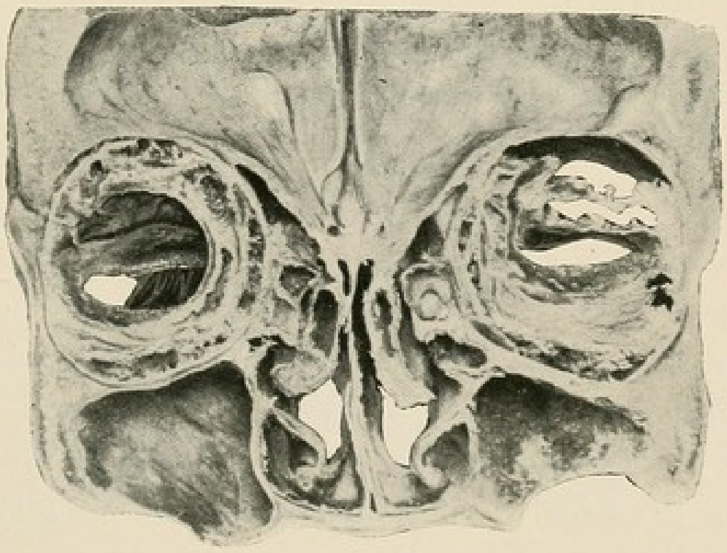
Fig. 86 is an anterior view of a transverse vertical section, showing the lower portion of the frontal sinuses on both sides, with a probe passed from the right sinus downward and slightly outward along the hiatus semilunaris, and then through the ostium maxillare into the maxillary sinus. It will be noticed that there is quite a difference in the anatomy of the anterior ethmoidal cells bilaterally.

Fig. 87 is a posterior view of the same section as Fig 86. The course of the probe can be traced as it passes downward along the hiatus semilunaris, through the ostium maxillare, and into the sinus without obstruction. There is a lack of

Fig. 82.



A



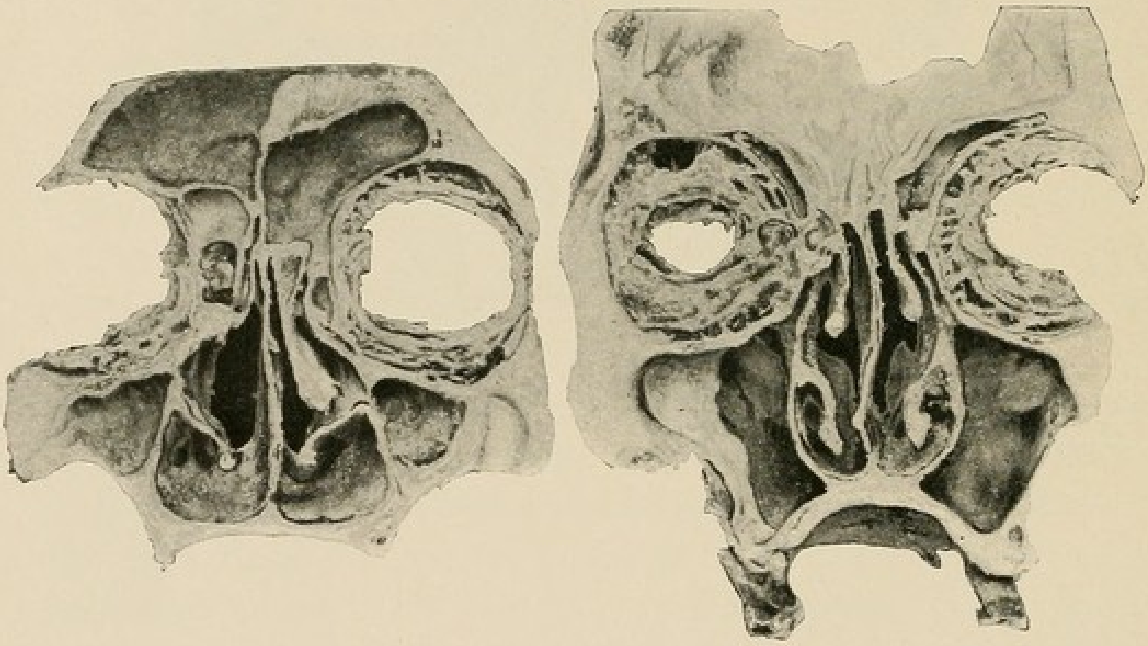
B

Posterior view of two vertical transverse sections made from different skulls in about the same anatomical region, showing great variations as to the depth of face, and size and shape of the maxillary sinuses and nasal chambers.

bilateral symmetry in the unciform process and bulla ethmoidalis. As this is a section of a negro skull, the great thickness of the floor of the antrum is accounted for.

Fig. 88 gives another view of the hiatus semilunaris leading downward and backward from the frontal sinus into the middle meatus, a portion of the walls (bulla ethmoidalis) covering the middle ethmoidal cells having been cut away.

FIG. 83.



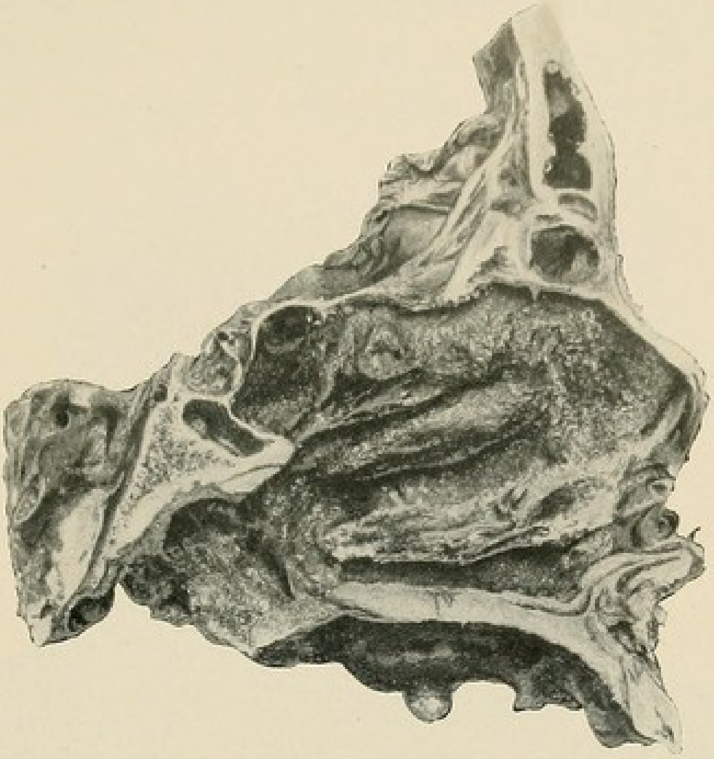
A B

Posterior views of two vertical transverse sections made from different skulls in about the same anatomical region, showing great variations as to depth of face, and size and shape of nasal and maxillary sinuses.

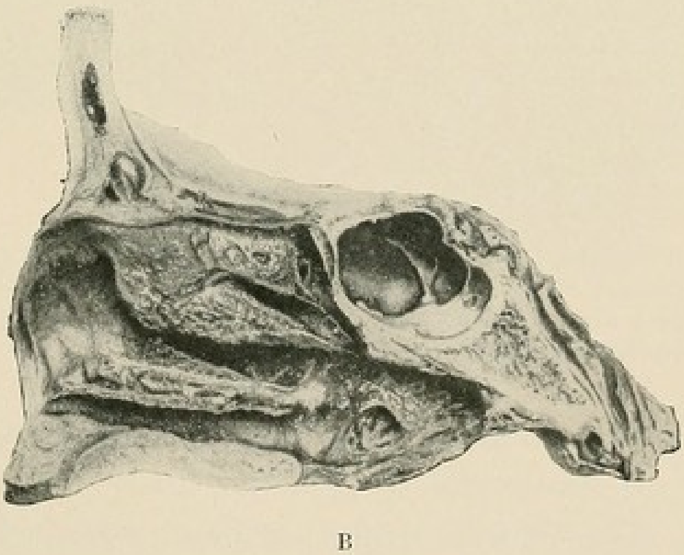
Fig. 89 shows two hiatuses, or infundibula, leading directly into the maxillary sinus. Through the posterior hiatus a probe is shown, the outer wall of the anterior one having been cut away in order that a better view could be obtained.

Fig. 90 illustrates a vertical transverse section, showing a more direct communication between the frontal and maxillary sinuses than do Figs. 86 and 87. It gives posterior and anterior views of the same section, A having that portion of the face removed which extends back to the premolar teeth below, and exposing the frontal sinuses above. The septum of the

Fig. 84.



A

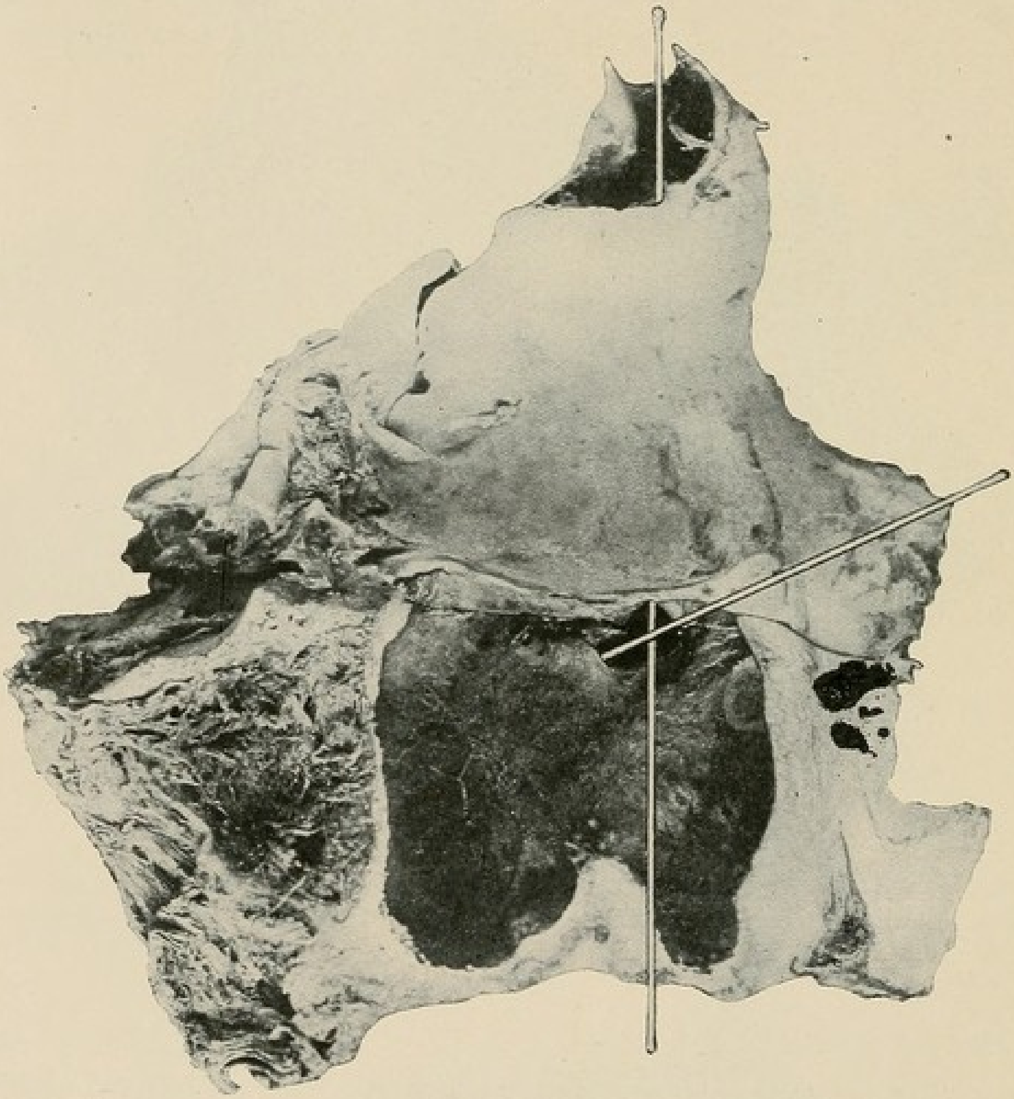


B

Two illustrations from different subjects, showing great variations as to depth and size in the external wall of the nasal chambers. A shows four meati.

nose is deflected and a "spur" reaches over to the right turbinate. The frontal sinuses extend down below the middle of the orbit. Between them there is an inter-frontal cell extending backward into the crista galli, as is shown in B. A wire

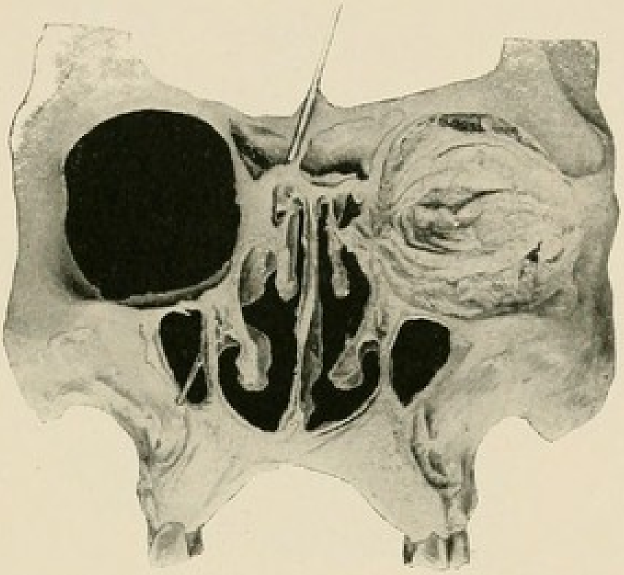
FIG. 85.



Antero-posterior section showing inner wall of the orbit, and the maxillary sinus with two probes through the ostium maxillare. The conical elevation in the floor of the antrum is where a root of a tooth has been left, retarding resorption in this part of the floor, in the remainder of which the process has been active.

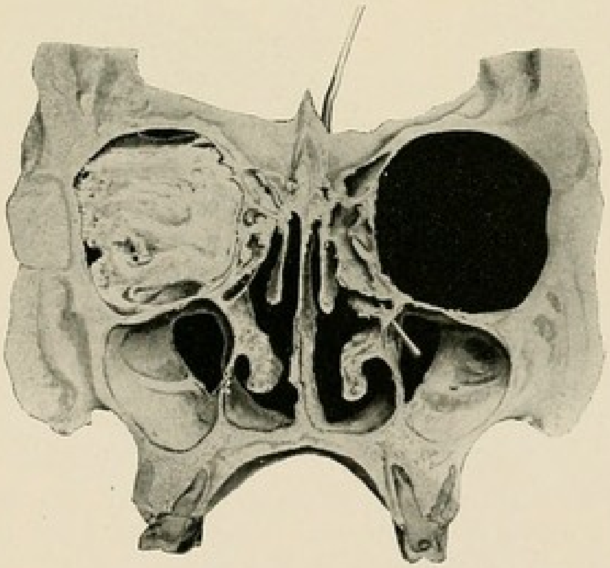
passed downward from the right frontal sinus is again seen in the antrum. B shows the section cut posteriorly to the first molar teeth. The frontal sinuses extend outwardly over the orbits. The wire shown in A is seen passing downward from the right frontal sinus through the infundibulum and hiatus semilunaris and entering the maxillary sinus through the ostium maxillare.

FIG. 86.



Anterior view of a vertical transverse section of a negro skull between the second premolar and the first molar tooth, showing probe passing down through the frontal sinus, the hiatus semilunaris, and ostium maxillare, into the maxillary sinus.

FIG. 87.

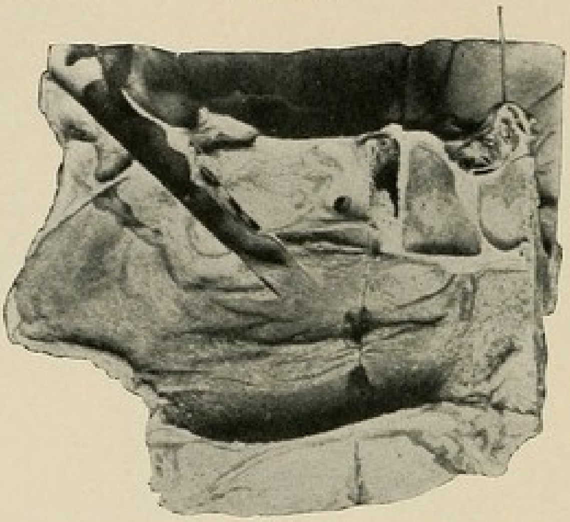


Posterior view of section shown in Fig. 86.

Fig. 91 shows an anterior view of a vertical transverse section in the region of the premolar teeth. Between the orbits are seen the anterior ethmoidal cells, and also a sinus in the crista galli. In this case both antra extend upward and become common with the ethmoidal cells and frontal sinuses.

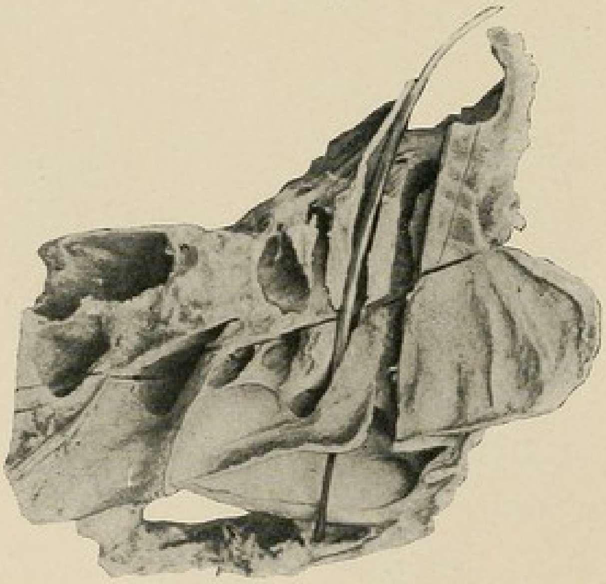
Fig. 92 gives a posterior view of a vertical transverse section

FIG. 88.



Interior view of the outer wall of the nasal fossa with part of the bone cut away to show the hiatus semilunaris and the middle ethmoidal cells.

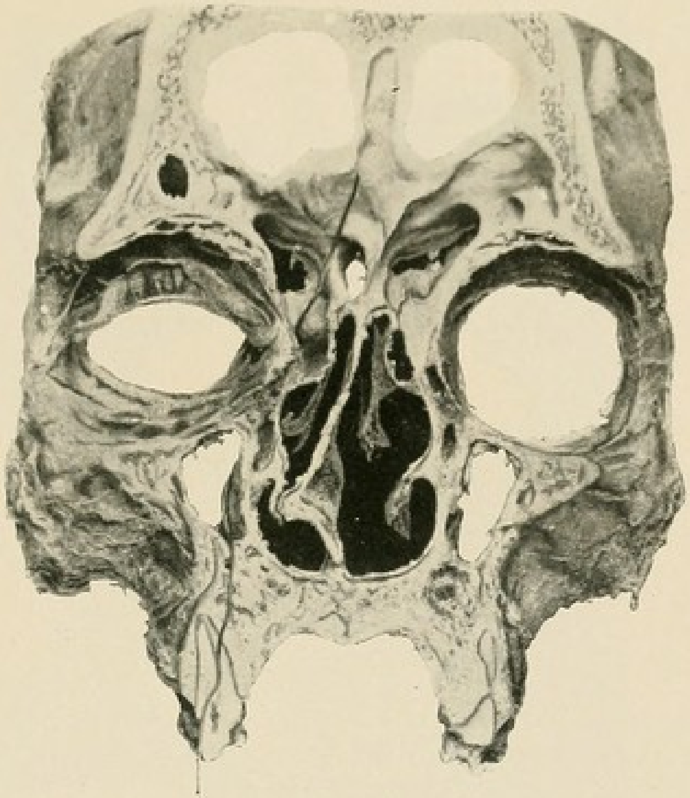
FIG. 89.



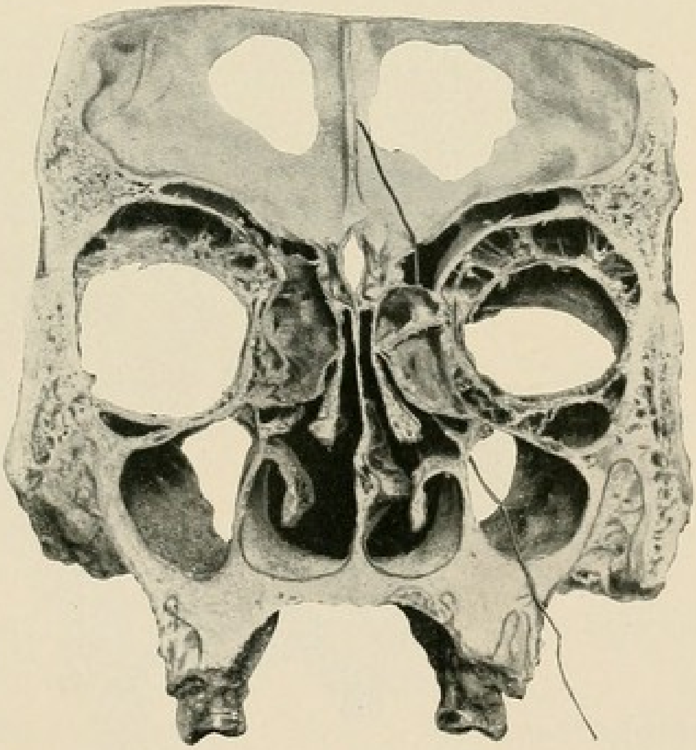
Section showing two hiatuses, both leading directly into the maxillary sinus. The posterior hiatus has a probe passing through it, the anterior one has the external wall cut away in order that a better view may be had.

cut in the region of the first molar teeth and through the crista galli. The septum is deflected toward the left side; the right maxillary sinus extends upward and inward, terminating in a large opening into the hiatus semilunaris without

Fig. 90.



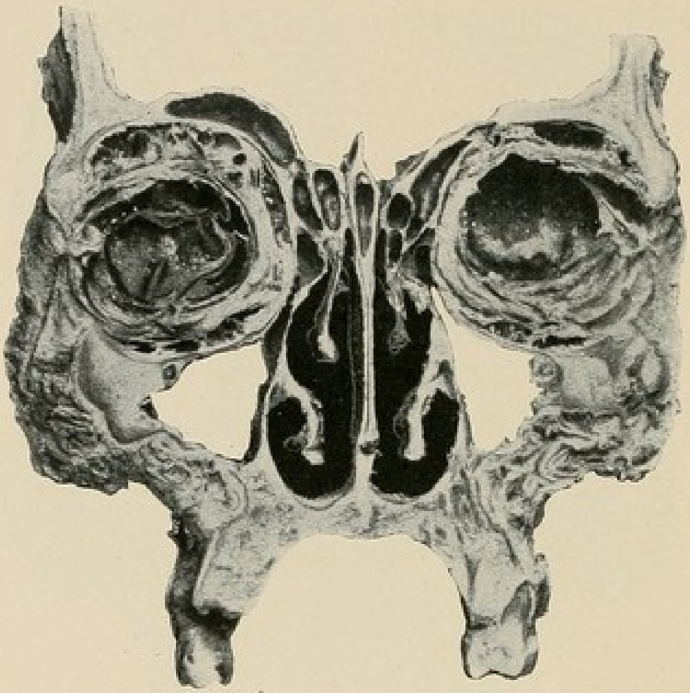
A



B

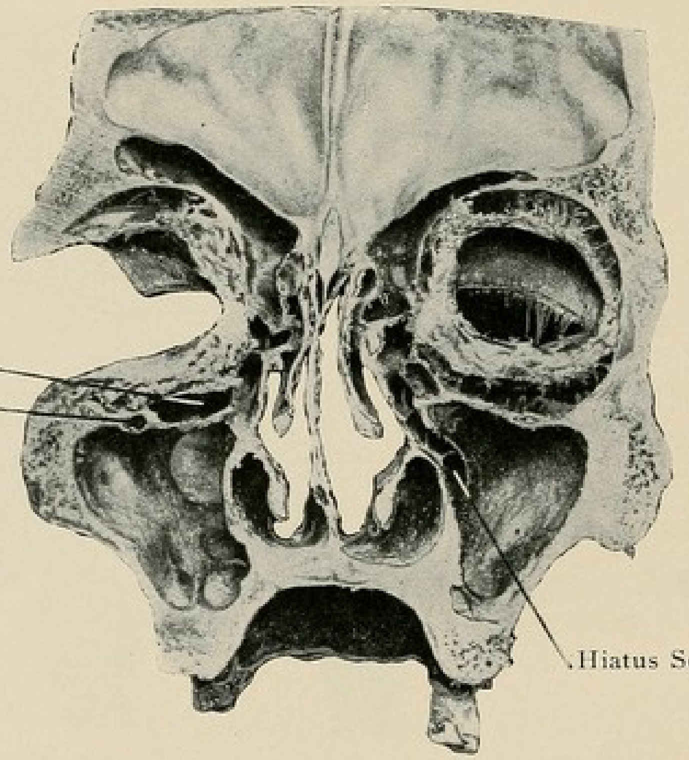
Anterior and posterior views of a vertical transverse section in the region between the second premolar and first molar teeth, showing a wire passing from the frontal sinus into the maxillary sinus. The frontal sinus extended downward to nearly the level of the upper portion of the antrum.

FIG. 91.



Anterior view of vertical transverse section in the region of the first molar teeth, showing anterior ethmoidal cells, and a cell in the crista galli. The frontal sinus extends downward, becoming common with the ethmoidal cells and antrum.

FIG. 92.

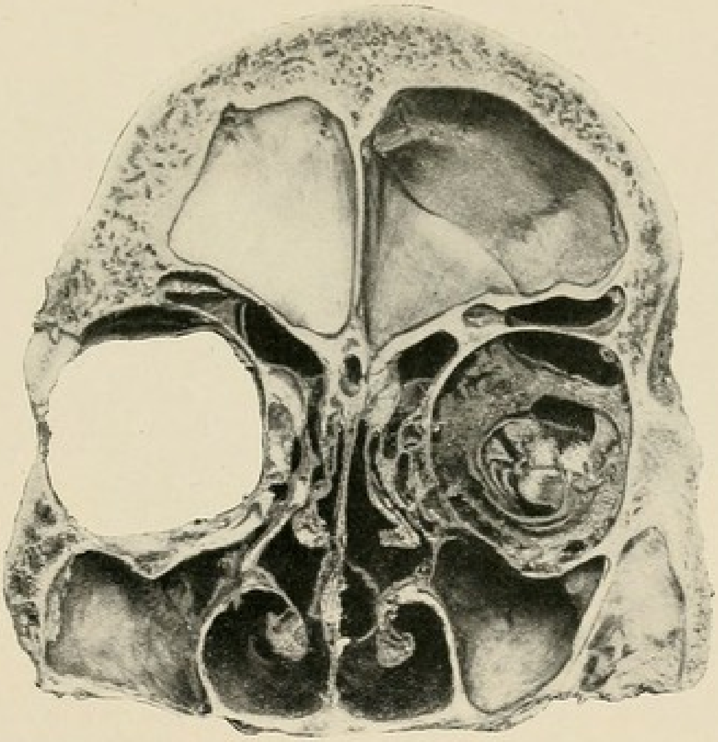


Posterior view of a vertical transverse section through the first molar teeth. The right hiatus semilunaris in this subject communicates with the maxillary sinus without a true ostium maxillare.

a true line of demarkation. The left maxillary sinus extends forward into the infraorbital ridge, forming an infraorbital sinus somewhat similar to those shown in Figs. 51, 54, and 79.

Fig. 93 shows a posterior view of a vertical transverse section from the skull of an aged person. The floor of the maxillary sinus, the nasal fossæ, and the lower border of the alveolar process are almost on a horizontal line. The left maxillary sinus extends upward until it passes into the frontal

FIG. 93.

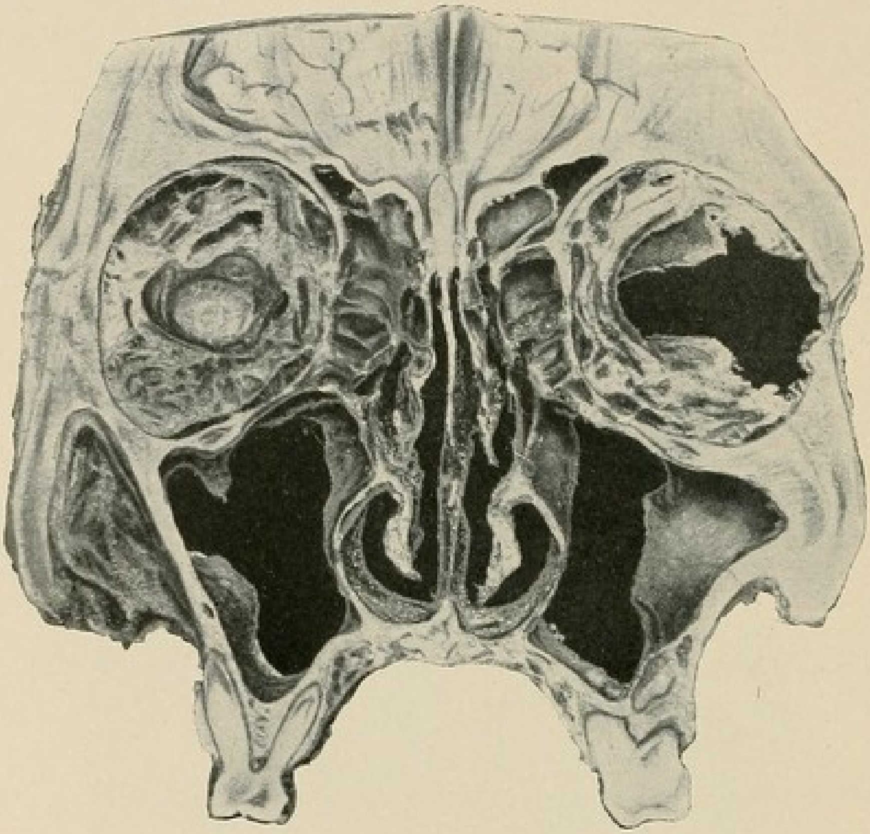


Posterior view of a vertical transverse section in the region of the ostium maxillare. From the skull of an aged person. The floor of the nasal fossæ, the alveolar process, and the floor of the antrum are nearly on the same level. The left maxillary sinus extends upward through the region of the anterior ethmoidal cell into the frontal sinus without a line of demarkation between them.

sinus, without any line of demarkation between sinuses or cells. In the crista galli is seen a small sinus or cell which extends forward into the frontal sinus. This last formation is also shown in Figs. 74, 82, 90, and 91.

Fig. 94 shows a posterior view of a vertical transverse section cut back of the first molar teeth. The maxillary sinuses are almost cuboidal in shape and extend down below the floor of the nasal fossæ inward and toward the median line, outward into the malar bones, and upward into the ethmoidal cells. The inner walls are not straight, as in Figs. 25 and 26. Starting at the floor of the antrum, almost over the center of the dome of the mouth, the inner wall as it extends upward

FIG. 94.



Posterior view of a vertical transverse section near the first molar teeth, showing maxillary sinuses which are nearly cuboidal in shape and which extend downward below the floor of the nasal fossæ. The nasal chamber is narrow and the walls dividing it from the sinuses are concavo-convex in their vertical direction.

curves outwardly, then inwardly to the point at which the inferior turbinate projects into the nasal chamber. This formation leaves a very narrow or contracted nasal cavity, a conformation also shown in B, Fig. 83.

EFFECTS OF PATHOLOGICAL CONDITIONS IN THE REGION OF THE HIATUS SEMILUNARIS.

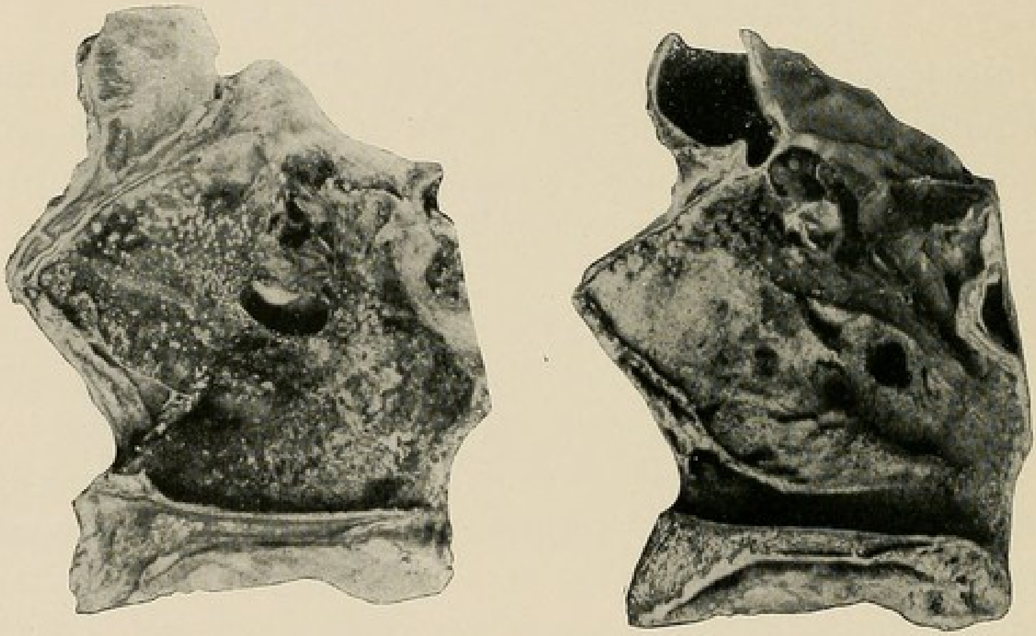
Pathological Conditions of the Bulla Ethmoidalis. Through *pathological increase in the size of the bulla ethmoidalis,* disturbances may be caused in the anterior and superior portion of the nasal chamber, in the frontal sinus, and in the antrum of Highmore, for by its enlargement toward the median line it presses toward and against the septum, closing the space of the nasal fossæ. If this enlargement is downward it presses more upon the unciform process and into the hiatus semilunaris, closing it and preventing the passage of fluids from the frontal sinuses and the anterior ethmoidal cells into the posterior portion of the middle meatus, and forcing them to enter the maxillary sinus. Through general inflammation of the parts there may result an excess of fluids which cannot find exit. This would interfere with the vitality of the teeth through pressure upon the nerves and vessels passing through the maxillary sinus. It would cause a feeling of fullness of all the anterior cells, as well as the frontal sinus, and might even set up disturbance in the anterior portion of the brain-case.

Fig. 95. A shows a view of the nasal septum as seen from the left nasal chamber. An opening in the septum exposes to view the bulla ethmoidalis and the ethmoidal cells. This opening resulted from resorption caused by pressure due to the deflection of the septum and the enlargement of the bulla downward near the unciform process. We have here illustrated an example showing how enlargement of this

structure may be an important factor in causing various diseases of this region, including those of the maxillary and frontal sinuses.

B, Fig. 95, gives a view of the same subject as A, from the same direction, but with the septum removed, exposing the inner surface of the outer wall of the right nasal chamber. Of the two openings into the maxillary sinus as seen in this pic-

FIG. 95.



A B

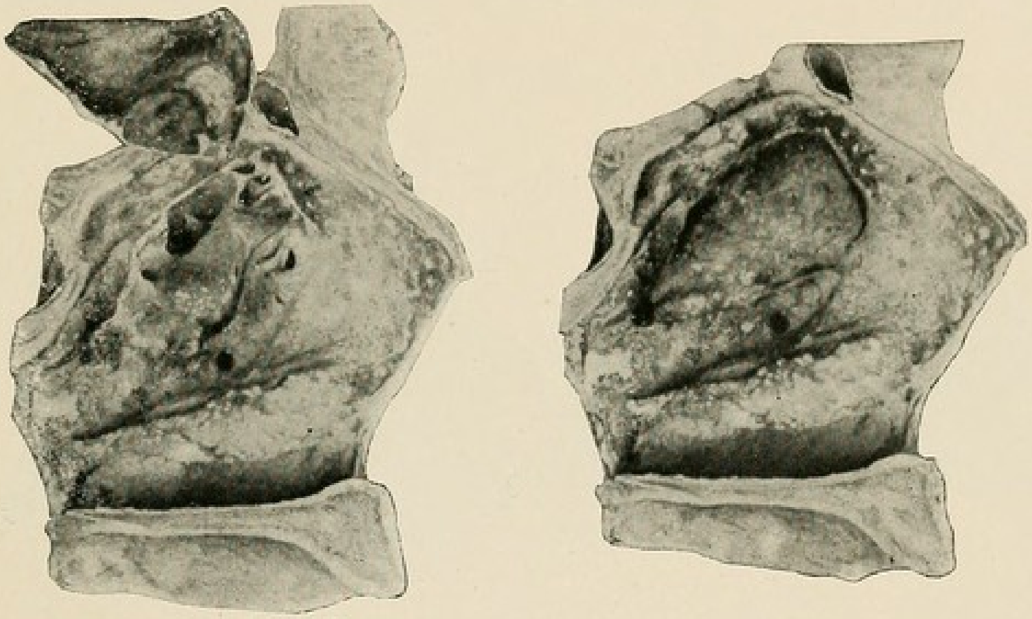
A, the left side of the nasal septum, showing a pathological opening opposite the bulla ethmoidalis. B, same specimen with the septum removed, showing abnormal opening into the maxillary sinus.

ture, the anterior one is normal, the posterior is abnormal. This abnormal opening and the loss of the greater portion of the middle turbinate were caused by resorption due to the pressure of the bulla ethmoidalis before referred to.

The effect of blocking up the hiatus semilunaris in causing the secondary or associated openings between the antrum and the nasal chambers is also shown in Fig. 97.

Fig. 96 shows two pictures from the left side of the same skull shown in Fig. 95. In B the middle turbinate is in position. The abnormal opening into the nasal chamber, seen near the center of the picture, was probably the result of the closure of the hiatus semilunaris, shown in A. In this the middle and a portion of the superior turbinate are cut loose and turned upward, to expose the bulla ethmoidalis extending downward and closing the hiatus. This closure would compel the fluids from the frontal sinus and the anterior and middle ethmoidal cells to pass into the maxillary sinus.

Fig. 96.



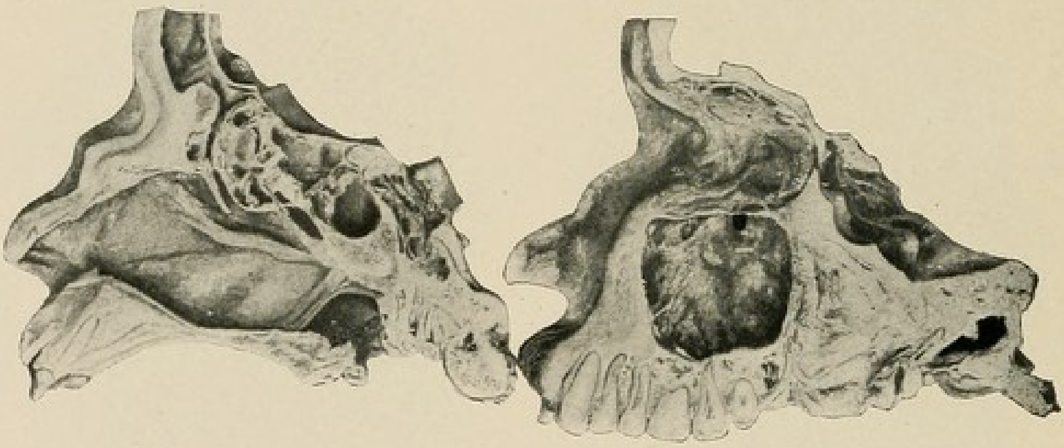
A B

Two pictures of the left nasal chamber from the same subject as Fig. 95. B, showing an abnormal opening into the maxillary sinus. A, same specimen as B with a portion of the middle and superior turbinates cut loose and turned up.

Fig. 97 shows two antero-posterior sections from another skull in which the bulla ethmoidalis has become enlarged. Section B has the outer wall of the maxillary sinus removed, showing the inner wall with two outlets at its upper margin. The anterior opening is the normal ostium maxillare. The posterior one is abnormal and similar to those shown in Figs. 95 and 96, but in this case the opening is nearer to the roof of the sinus. Section A is cut from the inner side of B.

Fig. 98 illustrates the same sections as Fig. 97, with section B turned round to the left side of the other. The illustration affords a view of the nasal chamber divided through the hiatus semilunaris, the bulla ethmoidalis, and the posterior ethmoidal cells. Section B shows the outer wall of the nasal chamber with a greater portion of the turbinate bones removed. Section A shows the septum of the nose. The two together give a very clear idea of the character of the hiatus semilunaris and the bulla ethmoidalis. In this case the bulla is very large and extends downward and forward, closing the hiatus. The illustration is taken from a dried specimen,

FIG. 97.



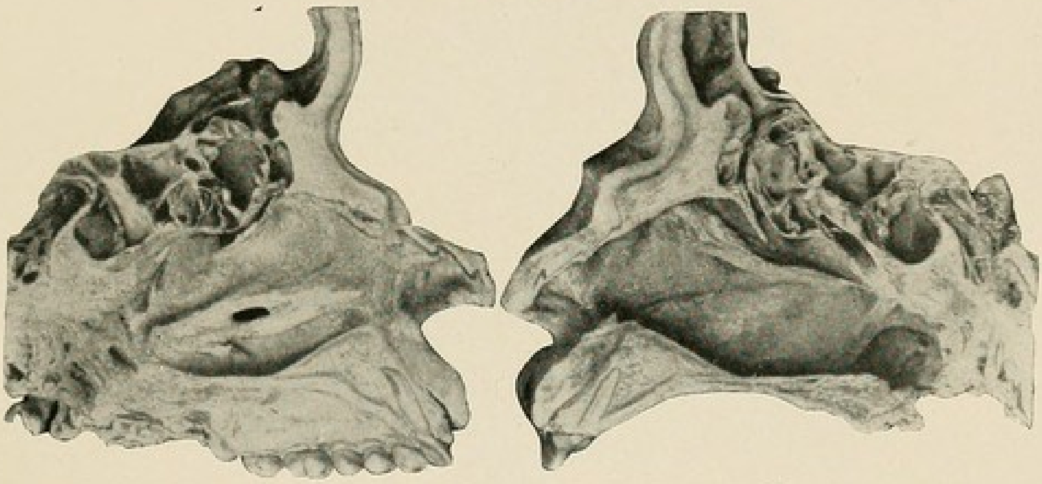
A B

Antero-posterior sections, A through the nasal chamber, B through the maxillary sinus. The former shows a divided bulla ethmoidalis, the latter shows two ostia maxillaria.

showing an incomplete closure, which in the recent state must have been complete. This would have caused the fluids from the frontal sinus and the ethmoidal cells anterior to the closure to be directed into the antrum, as the ostium maxillare is also anterior to the bulla. (The maxillary sinus would become engorged with their fluids, which would naturally work through the walls in the direction of the least resistance,—in this case at the abnormal opening shown in Fig. 97.) These sections also illustrate a condition sometimes met with, when the hard palate is unusually flat. In such cases the floor of the nose, instead of being horizontal, is depressed about the middle, giving a concavity which affords a lodgment for inspissated mucus. The same condition may also occur in the floor of the nose, when the inferior meatus is occluded, as shown in Fig. 67, and is also found in other spaces in and about the nasal chambers. Collections of this character often produce irritation of the mucous membrane interfering with the nourishment of the bone beneath, and at times causing a necrotic condition.

Occlusion of the Outlets of the Frontal Sinus. In Fig. 99, B shows a horizontal section through the anterior fossæ of the

FIG. 98.



A B

Antero-posterior sections, showing where they were cut apart through the frontal sinus, the hiatus semilunaris, the bulla ethmoidalis, and the posterior ethmoidal cells.

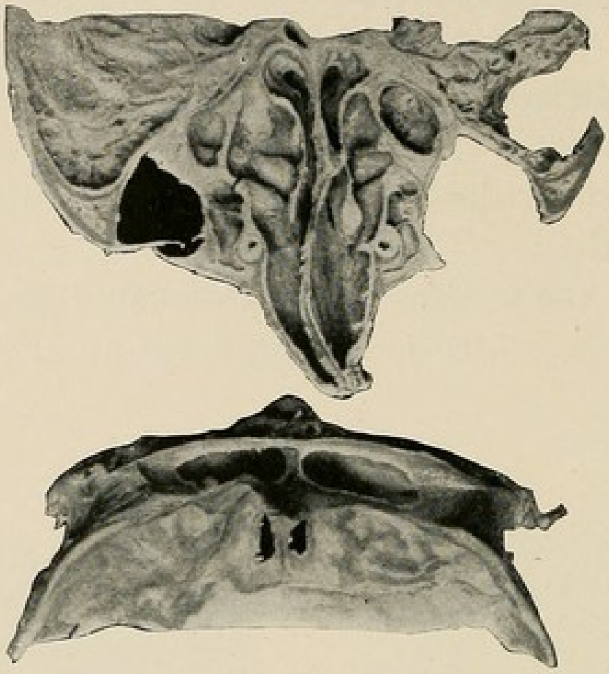
brain-case and through the frontal sinuses, from one of which there has been no foramen of exit, an example of unilateral occlusion. A gives a view of the roofs of the maxillary sinuses and of the nasal chamber.

The section shown in Fig. 100 is made from the same subject as Fig. 99, one inch below B, Fig. 99. It shows the downward excavation which has occurred in the occluded sinus. In the lower surface, A, of the specimen is shown the excavation extending in the direction of the nasal spine. There are marked irregularities of the ethmoidal cells of the two sides.

Fig. 101 also illustrates unilateral occlusion. This section exhibits the floor of the brain-case, showing a perforation

FIG. 99.

A

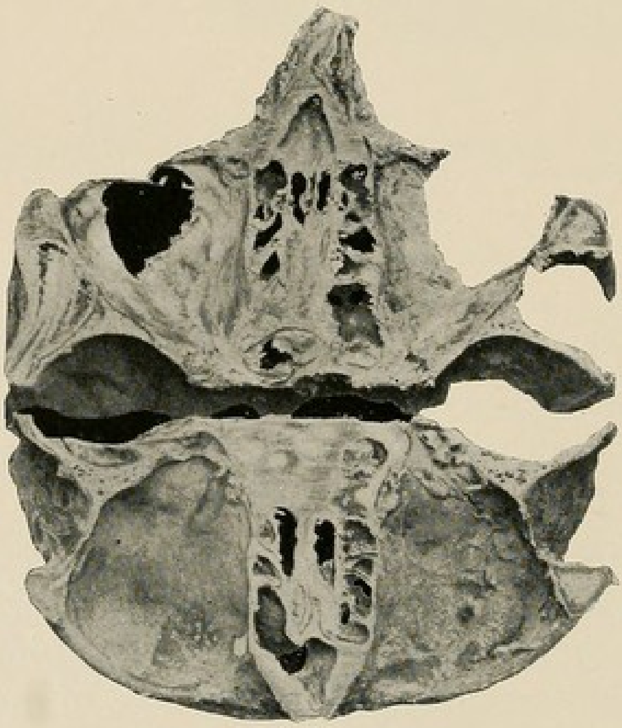


B

A shows the roof of the nasal chamber and the maxillary sinus, B the floor of the anterior fossa of the brain-case and part of the frontal sinuses, to one of which there is no foramen of exit.

FIG. 100.

A

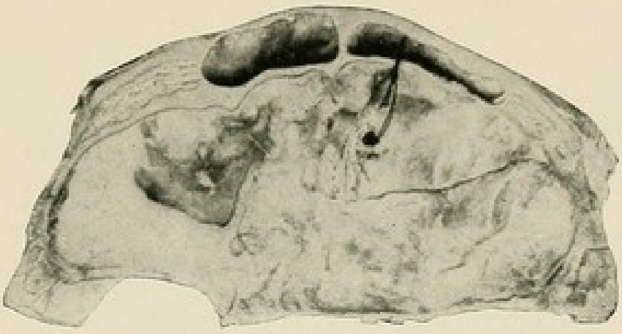


B

Horizontal sections in same subject as Fig. 99, showing surfaces cut through the middle of the orbits and the upper part of the nasal chamber.

at the point indicated by the thread passing through it. It is reasonable to suppose that the retained fluids have burrowed through the cribriform plate, causing the perforation. The crista galli in the specimen, although not clearly shown in the picture, is bent downward until almost flat by what has evidently been a cyst or tumor within the brain-case in this region. Unfortunately, the writer was unable to obtain ante-mortem or clear post-mortem notes of these two cases. It might be supposed, however, that the patients presented cerebral symptoms. In confirmation of this idea, there was evidence in the condition of the skulls that there had been a post-mortem examination of them.

FIG. 101.



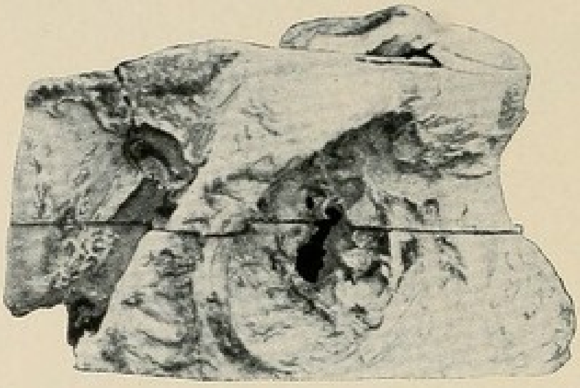
Horizontal section, showing the floor of the anterior fossa of the brain-case and part of the frontal sinuses. The right sinus had no outlet into the hiatus semilunaris, but had an outlet into the anterior fossa of the brain-case.

Fig. 102 is from the same specimen as Fig. 101. It shows the effects of the encroachment of the inflammatory and necrotic condition upon the internal wall of the orbit.

Fig. 103, from the same specimen, shows a horizontal section made through the ethmoidal cells, the nasal fossæ, etc., along the line indicated in Fig. 102. The two faces of the specimen show clearly the broken-down condition produced in the track of the disease. The abnormal arrangement of the cells becomes especially apparent when compared with the typical arrangement shown in Fig. 63.

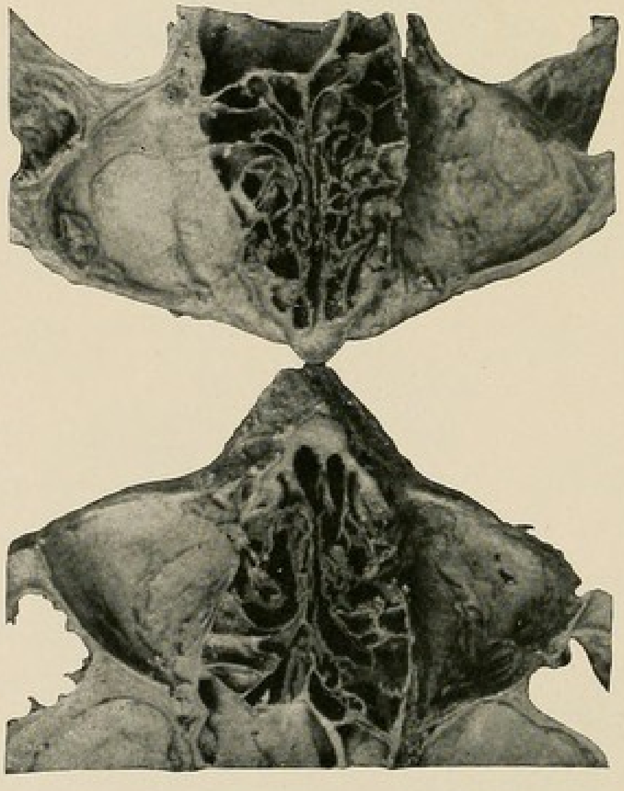
Obstruction of Fluids. There is a fundamental law of surgery that, wherever an obstruction of any of the passages within the body exists, it should be removed, and if possible the course of fluids be re-established in their normal channels

FIG. 102.



From same subject as Fig. 101. View showing diseased condition of the inner wall of the orbit.

FIG. 103.



From same subject as Figs. 101 and 102. Horizontal division through the orbit and ethmoidal cells, showing the diseased condition of these cells.

or conduits. If the hiatus semilunaris, which is the outlet of the fluids of the frontal sinus, becomes closed in any portion, or at the inlets, by bony or other growths, it is good and proper surgery to remove these obstructions. If fluids from the various sinuses and cells are allowed to accumulate in the maxillary sinus without opportunity to escape, the teeth and the alveolar process are liable to become involved, by the teeth becoming sore upon pressure, by being loosened, or by pus or other fluids passing down between them and their sockets. In such a case, after the failure of local treatment, the patient may be referred to a rhinologist. Sometimes the surgeon, baffled by the nasal and antral troubles, will make an outlet from the antrum into the mouth, to give egress to the confined fluids, infected or otherwise. These should pass from the superior and anterior portion of the nose and frontal sinuses into the middle meatus. The mouth should, by all means, be kept free from these foul discharges, and such proper surgical procedure instituted as will restore the natural outlets without infecting the oral cavity.

IMPACTED TEETH.

At the meeting of the American Dental Association for 1895, the writer gave illustrations of a number of impacted teeth.* Since that time he has, in examining different patients, seen other examples of nearly all the forms of impaction then described.

It is evident that there is an active process, varying in degree according to age, going on in the osseous surroundings of the teeth from the time of the development of the first tooth until the eruption of the last molar; even then it does not necessarily cease, for as the teeth are worn down they become more or less diseased, then lost, after which the alveolar process is resorbed, so that in old age the jaws take the shape shown in B, Figs. 150 and 151.

Interference with Development. If the action of this process be interfered with during the development and eruption of the teeth, their normal arrangement will be modified in proportion. Interferences causing impaction can often be attributed to many diseases of children, such as scarlet fever and other constitutional disturbances which cause inflammatory conditions in and about the jaws.

Fig. 104† gives a general idea of the arrangement and position of the teeth, deciduous and permanent, and of their relations, about the sixth or seventh year. The external walls of the alveolar process of the upper and lower jaws have been removed, together with some of the cancellated tissue, exposing the roots of the deciduous teeth and the crowns of the

*See *Dental Cosmos*, January, 1896.
†Fig. 104 is a repetition of Fig. 29.

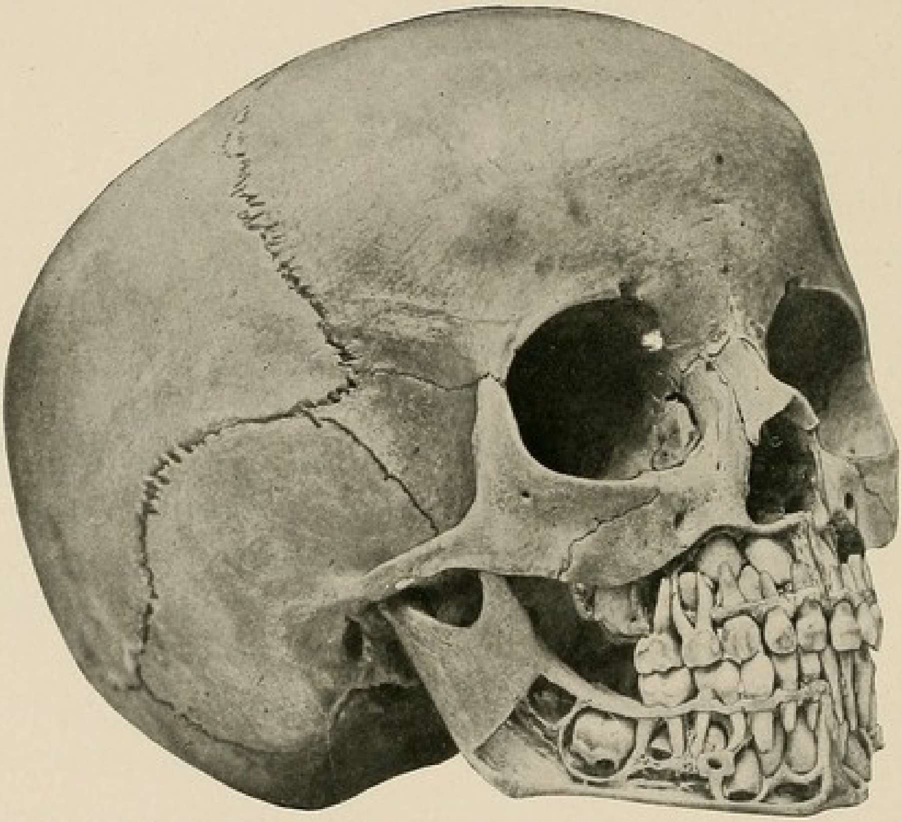
permanent ones. It will be again noticed that at this age nearly all of the space of the maxillary bone is occupied by the dental organs, there being but little room for the maxillary sinus. It would seem clear that by interference with the natural processes at this period of life, the permanent teeth can be deflected or detained from assuming their normal positions, thus modifying the maxillary sinus or nasal chamber. When these chambers are changed in form, size, or position, associated cavities and adjoining structures will also be changed. The shape of the orbit may also be modified to such an extent that the eye may be affected, making it myopic or hypermetropic.

Nutritional Changes. There are two opposite processes associated with inflammation within the jaws, one destructive or suppurative, causing the breaking down of the tissue; the other, a constructive or building up and hardening process, through which the cancellated tissue is transformed into hard and dense bone. (See Figs. 16 and 121.) Through undue hardening of the bone before complete eruption of the teeth, they become incased with their capsules in the surrounding bone, under which circumstance it is impossible for the eruptive force to carry them into their proper positions. They are often held in the place of development, or pushed in the direction of the least resistance, until resorption of the bone-tissue occurs, when they usually make their appearance in an abnormal position.

Supernumerary Teeth. The development of a supernumerary tooth or teeth may also cause impaction of a normal tooth. Two marked cases have come under the writer's observation, the first in a skull belonging to Dr. Kirk's collection, where thirteen small supernumerary teeth are developed in the position of the root of the left upper central incisor, which was found, upon dissection, to be impacted between the floor of the nose and the roof of the mouth. The other case was in the mouth of a patient of Dr. Huey's, of Philadelphia, where thirty-five small supernumerary teeth were found within the alveolar process, in the space which should have held the left central incisor. After removing the supernumerary teeth, the permanent normal incisor could be seen resting between the plates of bone forming the roof of the mouth and the floor of the nose.

In Fig. 104* the crown of the upper first molar is visible. The position of the germs of the second and third molars is

FIG. 104.



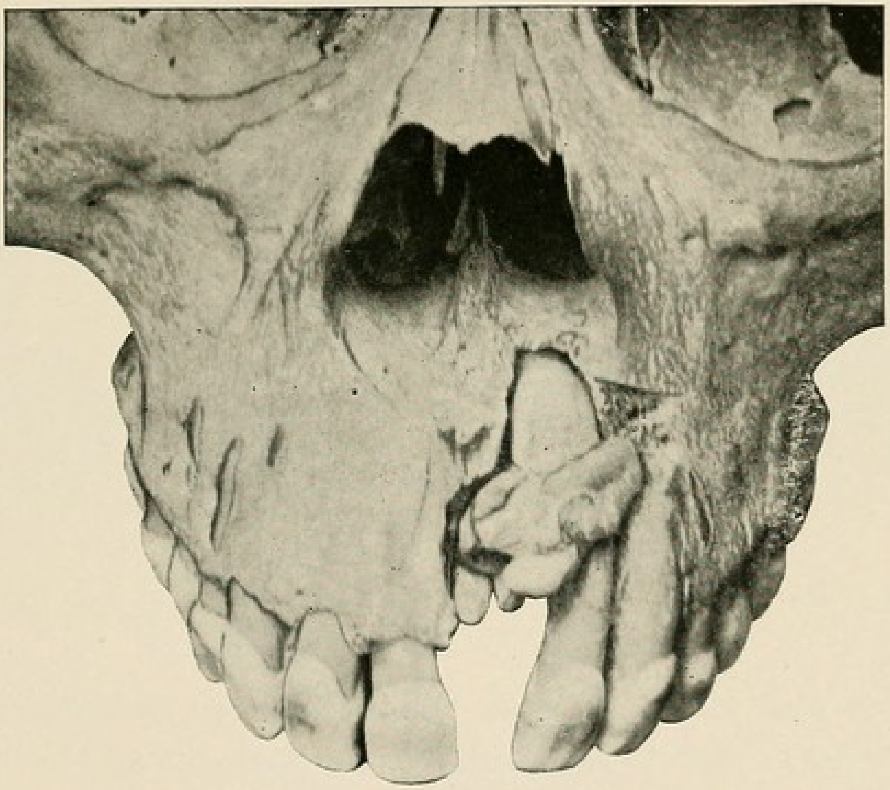
Skull of a child about six years of age, showing all the deciduous teeth in position and the developing permanent teeth.

higher up and further back, therefore they must be close to the under surface and posterior portion of the orbit. This was interestingly demonstrated by a patient referred to the Department of Dentistry of the University of Pennsylvania, who had an impacted upper third molar, the crown of which was in the upper portion of the posterior wall of the maxillary sinus.

*For further description of this illustration, see Fig. 29, of which it is a repetition.

Fig. 105 is a photograph from the skull in Dr. Kirk's collection. It affords also a good idea of the general condition found in the mouth of Dr. Huey's patient. The permanent central tooth was not removed with the supernumerary teeth in this case, as Dr. Huey and the writer had some hopes that it would assume its normal place with the other teeth. Six months after the operation the tooth had advanced more

Fig. 105.



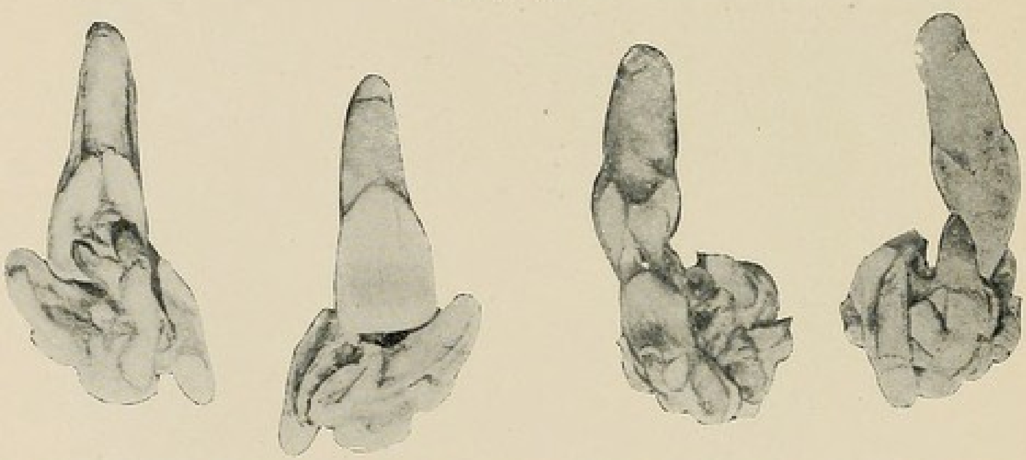
An odontoma and an impacted central incisor.

than half its length, and at this writing, eighteen months afterward, it is about in its normal position.

Fig. 106 is an illustration of the central incisor and supernumerary teeth taken from the skull shown in Fig. 105.

Fig. 107 is an illustration made from a section which was constructed in order to give an idea of the position of the tooth in this patient's mouth. If this crown, as shown in the illustration, had roots of normal length, they would extend back across the spheno-maxillary space, the points of the roots would be near the sphenoidal sinus, and the roots would more than likely be covered by a thin lamina of bone developed from the maxilla. In cases where teeth have been found impacted in the upper part of the maxilla, similar to that shown in this illustration, they are commonly spoken of as having passed upward. This, in the opinion of the writer, is incorrect. It is more likely that many of the teeth so found impacted have never passed down from their place of development. In this particular case, through some inflammatory process, the tooth and its capsule became adherent to the

FIG. 106.



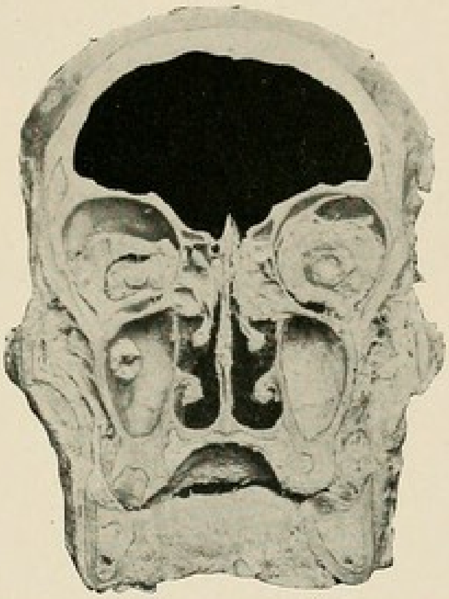
Views of the impacted tooth and odontoma removed from the jaw illustrated in Fig. 105.

posterior wall of the maxilla, the intrinsic force being insufficient to force the tooth into proper position at the time it should have made its descent. It is somewhat analogous to an adherent testicle in the abdominal cavity or in the inguinal canal. There is no more reason to think that the tooth passes upward than that the testicle passes up from the scrotum into the inguinal canal or abdominal cavity.

Fig. 108 represents three impacted permanent teeth, a central, lateral, and canine, which were removed from a living subject in 1891.

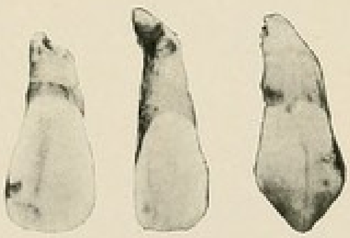
Fig. 109 is taken from a specimen belonging to Professor James Truman's collection. It shows an impacted right canine; the external bone has been cut away, exposing the tooth and its root. The tooth is a little below the place of development. The apex is curved forward and inward, the inward portion passing just into the nasal chamber as shown in Fig. 107. A little external to the apex of the root is an opening into the maxillary sinus.

FIG. 107.



An illustration representing an impacted tooth in the posterior wall of the maxillary sinus.

FIG. 108.



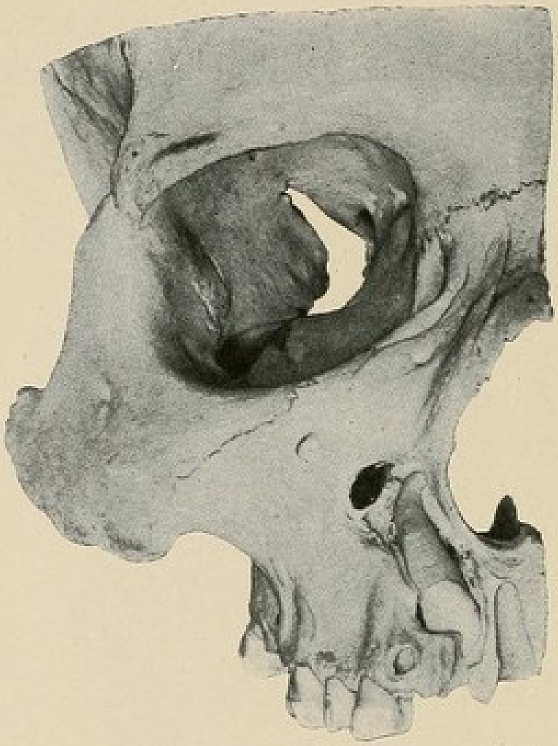
A central, a lateral, and a canine tooth removed from the maxillary sinus of a patient who had been suffering with neuralgia.

Fig. 110 is a view from the other side of the specimen seen in Fig. 109, showing the apex of the impacted canine in the external wall of the nasal cavity.

Fig. 37 shows an impacted canine with its crown immediately over the alveolus of the right central, the root passing upward and backward.

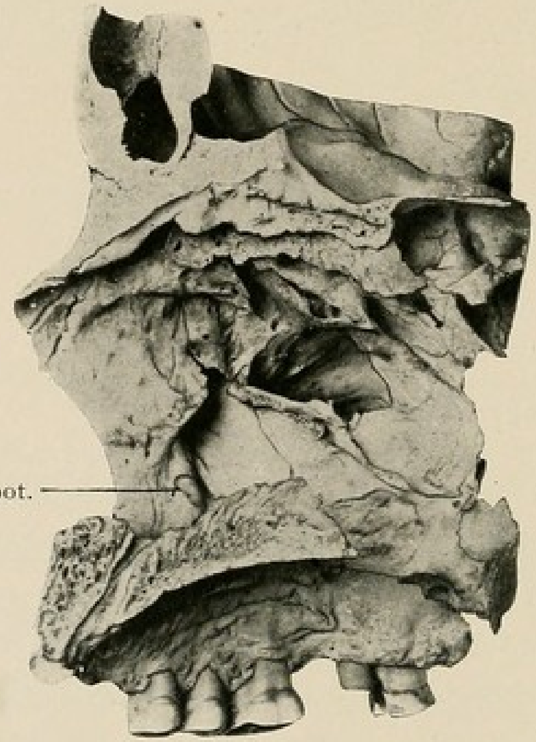
Loss of Teeth through Impaction. Fig. 111 shows two

FIG. 109.



An impacted canine tooth with the apex of the root within the nasal fossa.

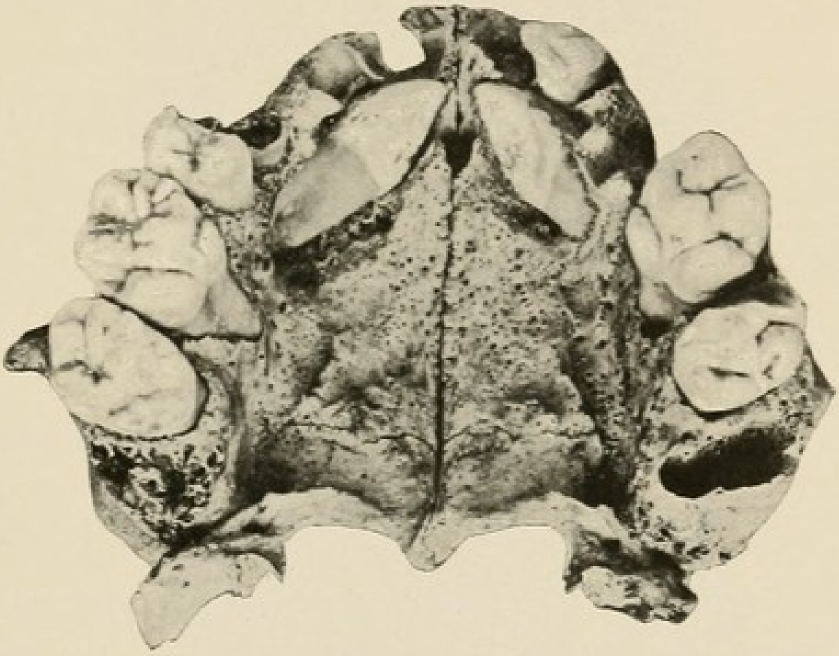
FIG. 110.



External wall of the nasal chamber, seen from the inside, showing the apex of the impacted canine tooth illustrated in Fig. 109.

canines impacted in the upper jaw, lying at nearly right angles to each other. They were entirely covered with bone, and were exposed by a surgical bur. The end of the root of the right canine is somewhat curved. There is only a slight layer of bone between it and the floor of the sinus. This layer of bone is perforated by three small openings. This malposition caused the loss of the left first and second premolars, also of the right first premolar.

Fig. 111.

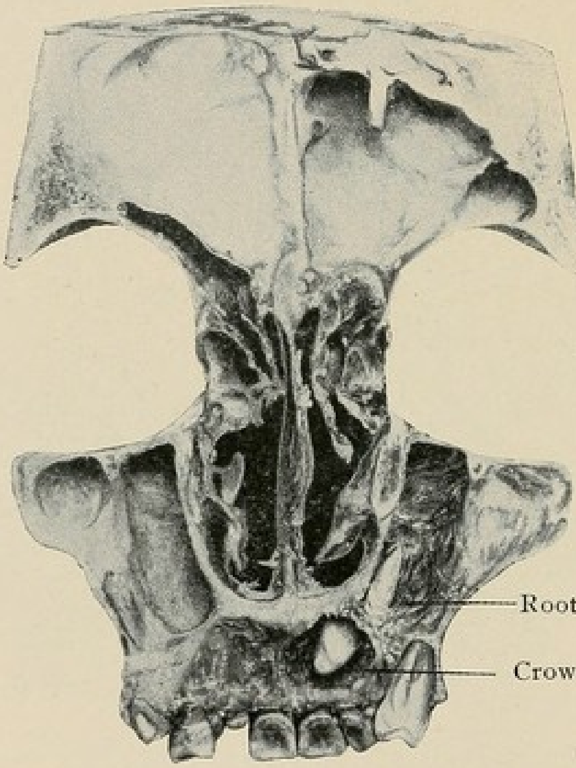


Two impacted canine teeth. Their malposition caused the loss of the left first and second premolars, also the loss of the right first premolar.

Fig. 112 is a posterior view of a transverse vertical section of a face, made in the region of the first premolar teeth. Besides other interesting points, the crown of the canine tooth has penetrated the palatal surface of the mouth and the root is within the anterior portion of the antrum. Before the dissection was made, the root was covered with a thin lamina of bone. Similar conditions are often found, involving not only the canine tooth, but also the third molar, and occasionally other teeth, which often remain in such positions for years without giving any trouble until after middle life, when by natural resorption of the bone the crown and root become exposed within the antrum or nasal chamber, at which time they may cause some disturbance.

Fig. 113 illustrates an impacted left central incisor, which lies diagonally across the alveolar process, with the apex of the root near the outer side of the left anterior nares. The crown passes across the anterior palatine fossa. Impaction of

Fig. 112.



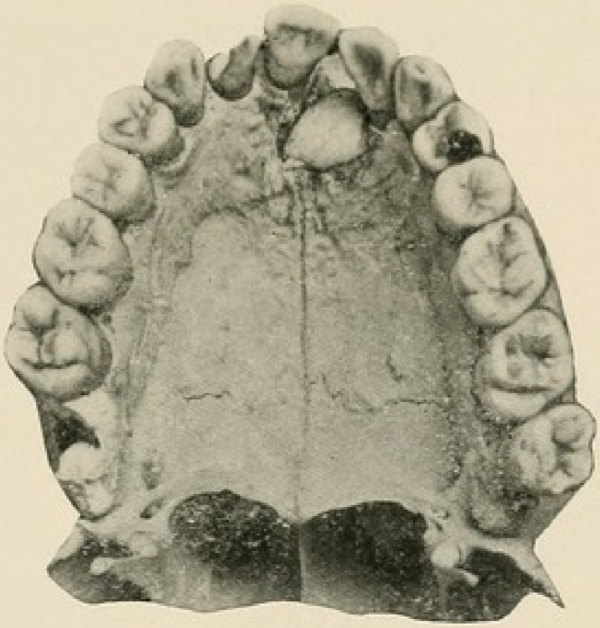
An impacted canine tooth, the crown in the roof of the mouth, the greater portion of the root in the maxillary sinus.

this kind would more than likely interfere with the true function of the nerves and vessels passing through this fossa.

Fig. 114 illustrates a supernumerary lateral incisor impacted immediately below the floor of the nose. There was no enlargement of the external plates of the incisor fossa, the floor of the nose, or the roof of the mouth. The tooth was accidentally discovered when cutting the bone transversely.

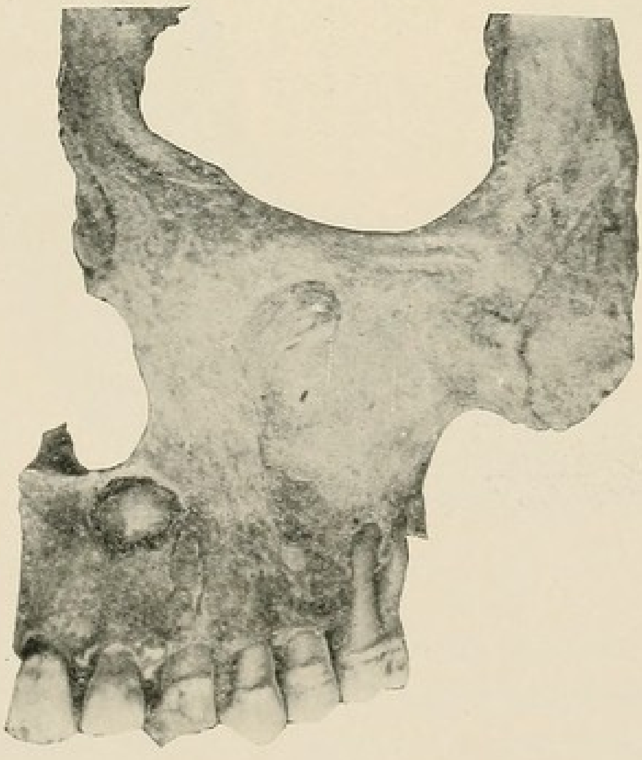
Fig. 115 exhibits an impacted and misplaced third molar. The occluding surface of the molar was even with the external plate of the alveolar process, the roots being compressed and somewhat shorter than normal. A complete thin layer of

FIG. 113.



An impacted central incisor, with the crown partly in the anterior palatine fossæ.

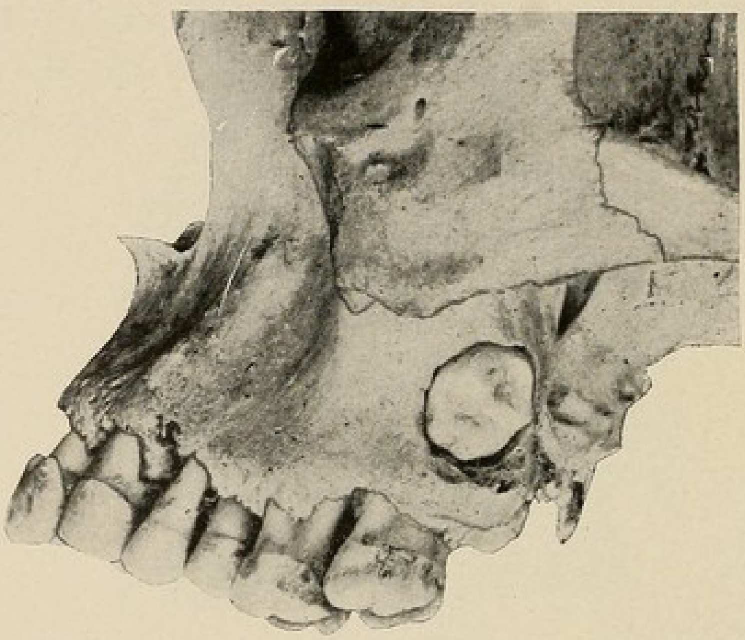
FIG. 114.



An impacted supernumerary tooth.

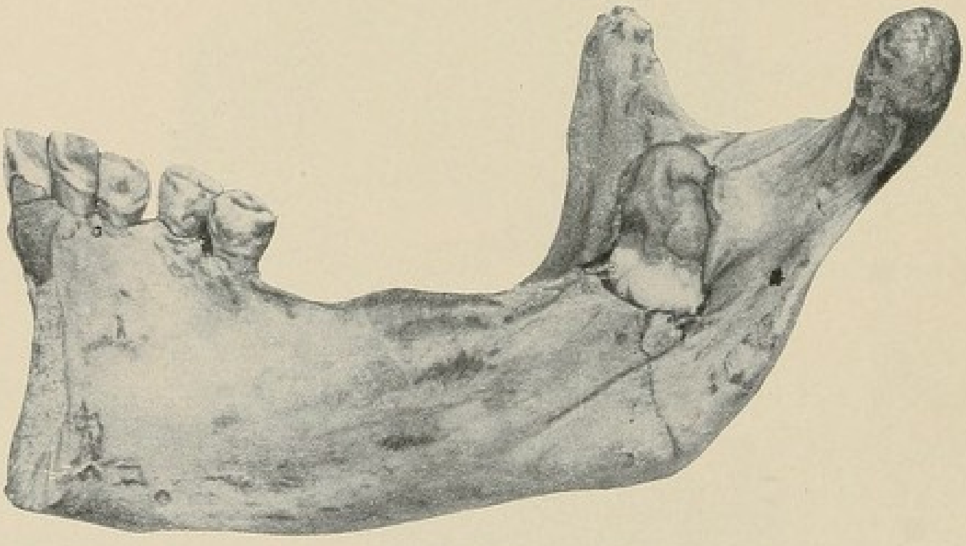
bone made a conical-shaped partition between the tooth sockets and the sinus. A similar condition existed on the opposite side of the jaw.

Fig. 115.



An impacted upper third molar. A similar condition is found on the opposite side of the skull.

Fig. 116.

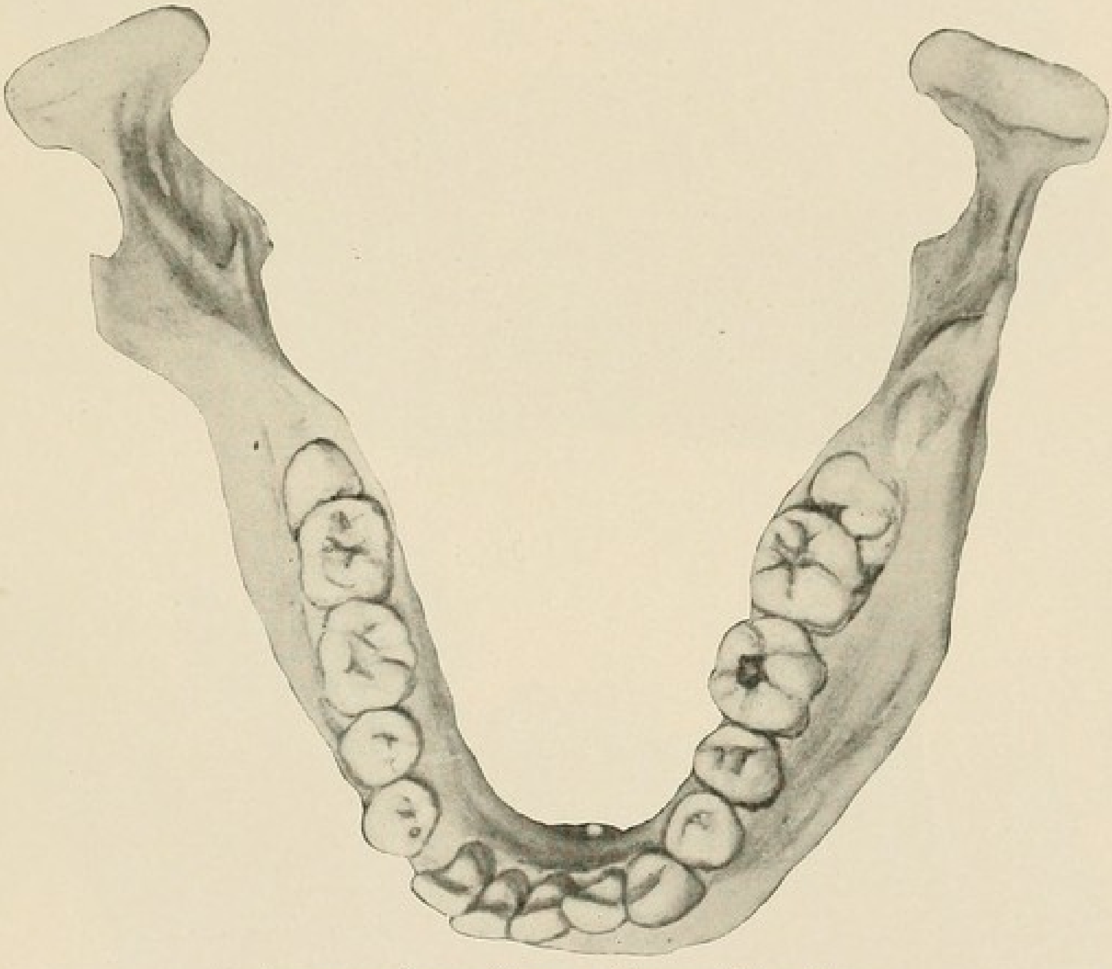


An impacted lower third molar.

Fig. 116 exhibits an impacted lower third molar in the ramus of the jaw just below the anterior portion of the sigmoid notch, the tooth being inverted. In this case the capsule of the germ of the tooth became adherent to the walls of the jaw, and lost its position within the forming cancellated tissue, when the body of the jaw grew downward and forward.

Fig. 117 illustrates the most common kind of impacted lower third molar teeth. They often give great trouble by irritating the inferior dental nerve. They may also cause an inflammatory condition in this region, and the cellulitis may

FIG. 117.



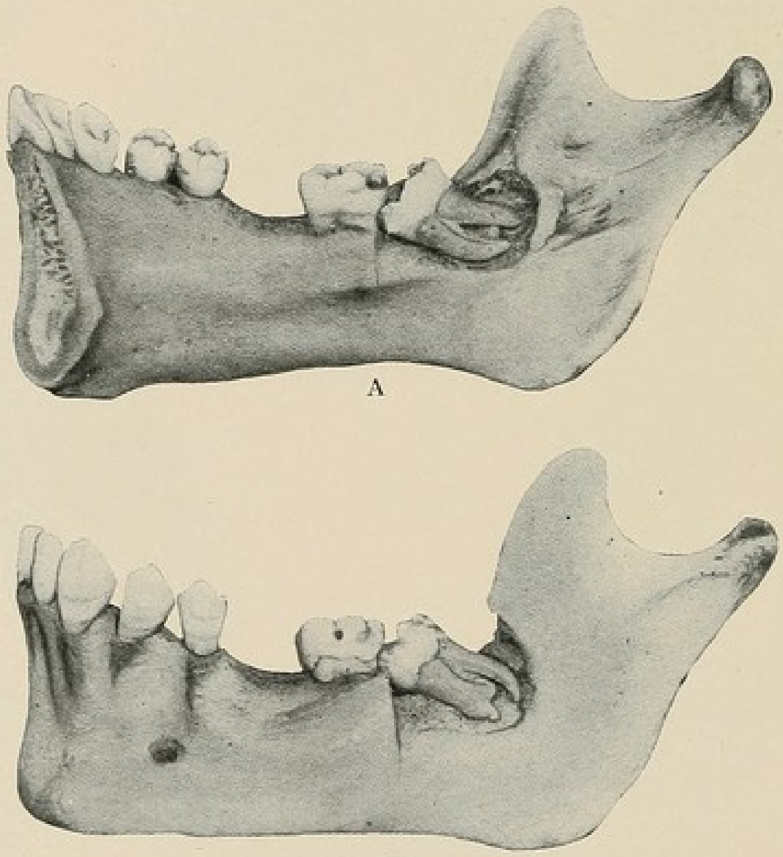
A common form of impacted lower third molars.

extend to the temporo-mandibular articulation and the base of the tongue.

Fig. 118 represents a similar impaction. In B the external portion of the bone covering the tooth has been removed, and in A the internal portion. In both cases it will be observed that the inferior dental canal is encroached upon. It is often necessary to cut away a portion of the bone with the surgical engine before a tooth so situated can be removed.

Impaction Causing Resorption of Adjoining Tooth. Fig. 119 gives two views of an impacted third molar. In A the tooth is in position as discovered when the cap of bone was removed; in B the tooth is rolled out of its socket, showing its inner surface. The bed of the tooth is also seen. The second molar is a pulpless tooth, the distal root of which shows where the impacted tooth has pressed against it, causing the resorption

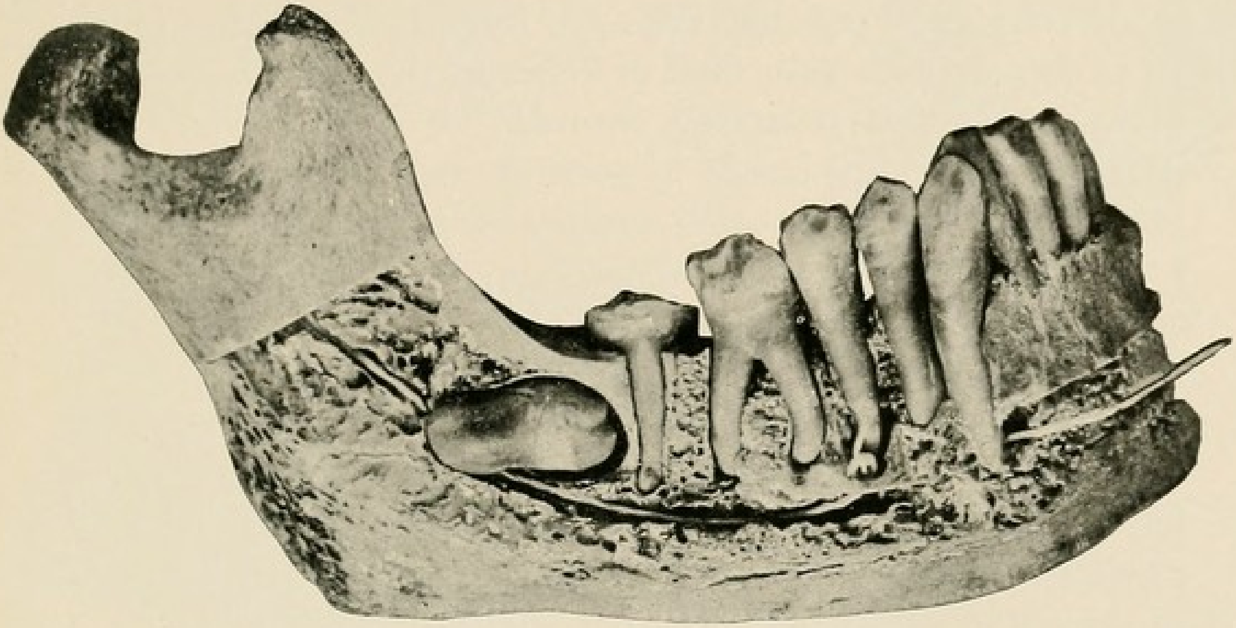
Fig. 118.



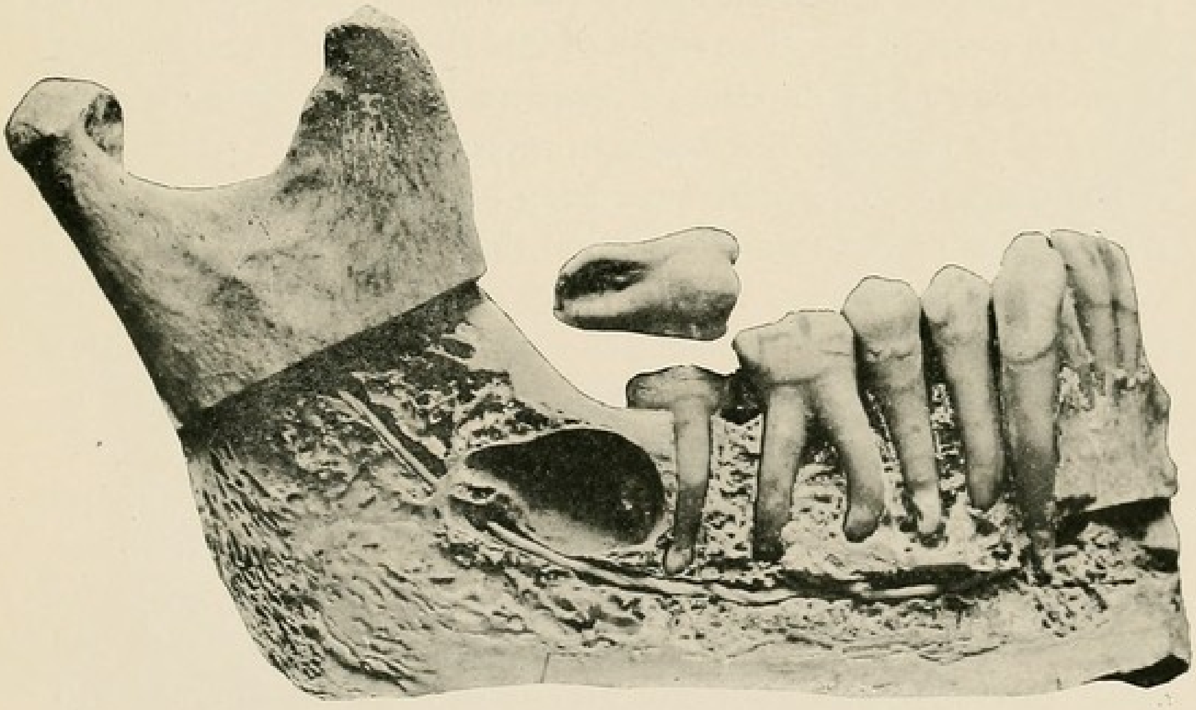
Side view of two impacted lower third molars, the bone having been removed in order to expose the roots.

of a portion of the root until the pulp-canal was fully exposed, which must have caused neuralgia. The roots of the impacted tooth have a slight curve inward at their points; the concavity fits immediately over the inferior dental nerve, and it has probably caused pain by pressure. The ends of the roots are not fully formed, the apical openings being large. It will also be noticed that the roots of the teeth in the jaw are longer than usual, that of the canine, for example, passing below and external to the nerve.

FIG. 119.



A



B

Two views of an impacted lower third molar. In position in A; in B the tooth is turned out of its pocket. Part of the distal root of the second molar has been resorbed, exposing the root-canal, more than likely causing the devitalization of the tooth and thus producing neuralgia, induced by the pressure from the impacted tooth.

Fig. 120 represents another impacted third molar, situated on the inner side of the jaw and pointing slightly downward. The distal root of the second molar is slightly resorbed. Upon uncovering the tooth and taking it from its bed, it was found to be incased in a thin shell of bone, as though the dentinal sack had ossified separately around the tooth. The inner portion of the shell is still in position; the nerve and its accompanying tissue are seen passing into the inferior dental foramen and immediately under or against the shell. Here again must have been an obscure cause of neuralgia.

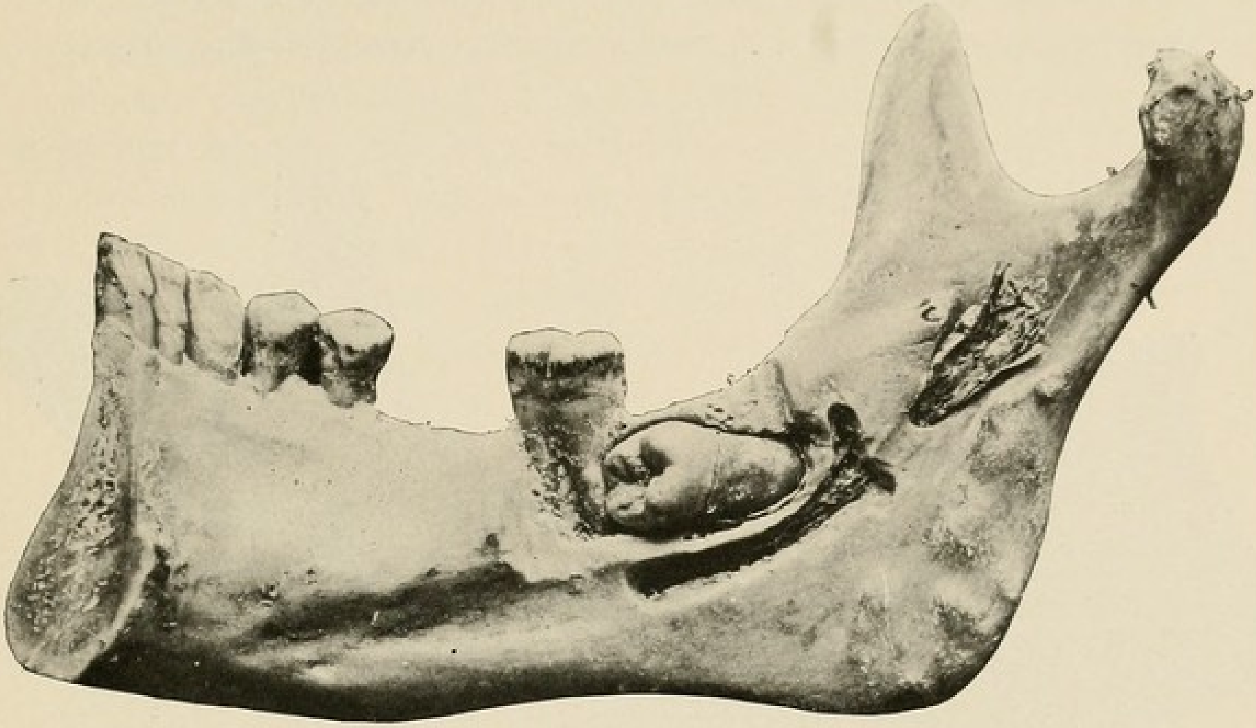
Fig. 121 illustrates the right and left halves of the lower jaw, A showing the internal surface of the right half, while B shows the external surface of the left half. In the former we find the roots of the third molar curved backward at almost a right angle, and enlarged by an abnormal deposit of cementum until the independent character of the roots is lost, the two being fused together.

B shows an impacted tooth pushing directly against the tooth in front of it. The roots of this tooth have also become much enlarged by deposit of cementum, while the surrounding bone is thickened and grown more compact.

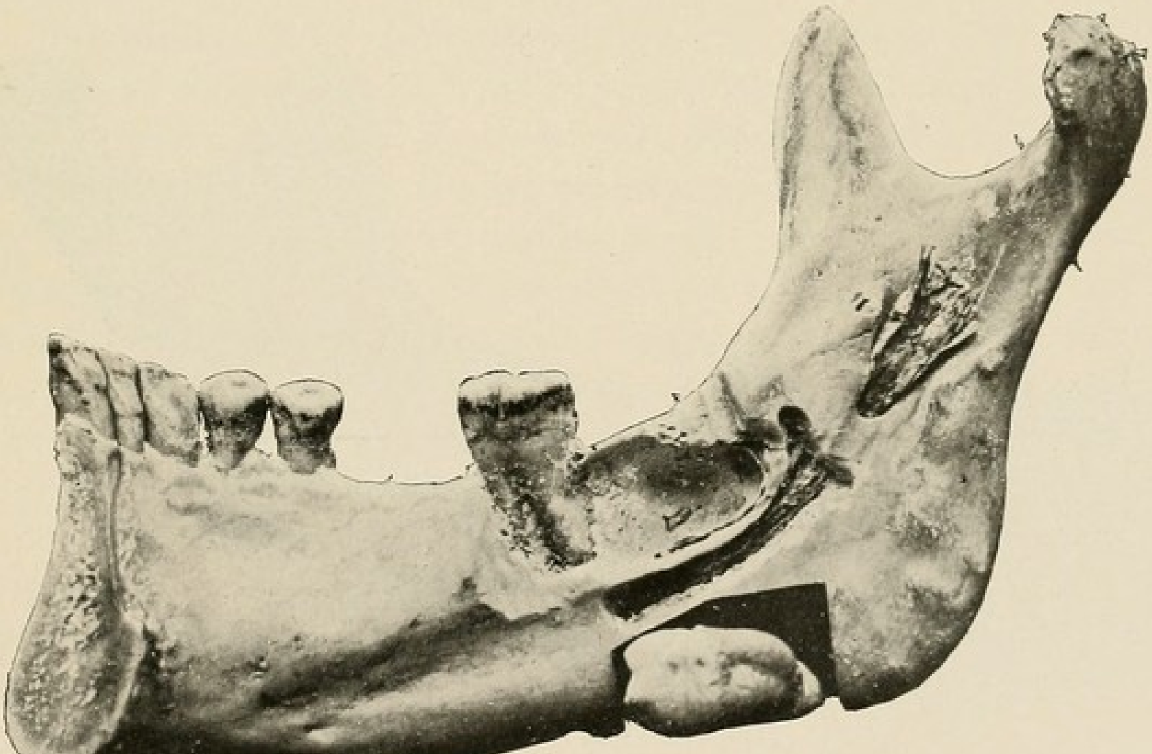
Extraction. It would have been almost impossible to extract either of the two last named third molars without fracturing the jaw, unless the consolidated portion of bone over the roots of the teeth had been first removed. In a case of this kind, it is much better to use the surgical engine bur than to cut or break the parts away with chisel or forceps. A fracture at this point will cause serious results; the mylo-hyoid artery is liable to be lacerated or even severed, and the hemorrhage is difficult to control. It is not easy to keep the region clean or aseptic, and the consequent inflammation will often interfere with free movement of the jaws in deglutition, speech, etc. The glottis even may become closed.

Diagnosis. Impacted teeth are frequently the obscure or hidden cause of various diseases about the mouth and jaws. There is often no external evidence of their impaction; pa-

Fig. 120.



A

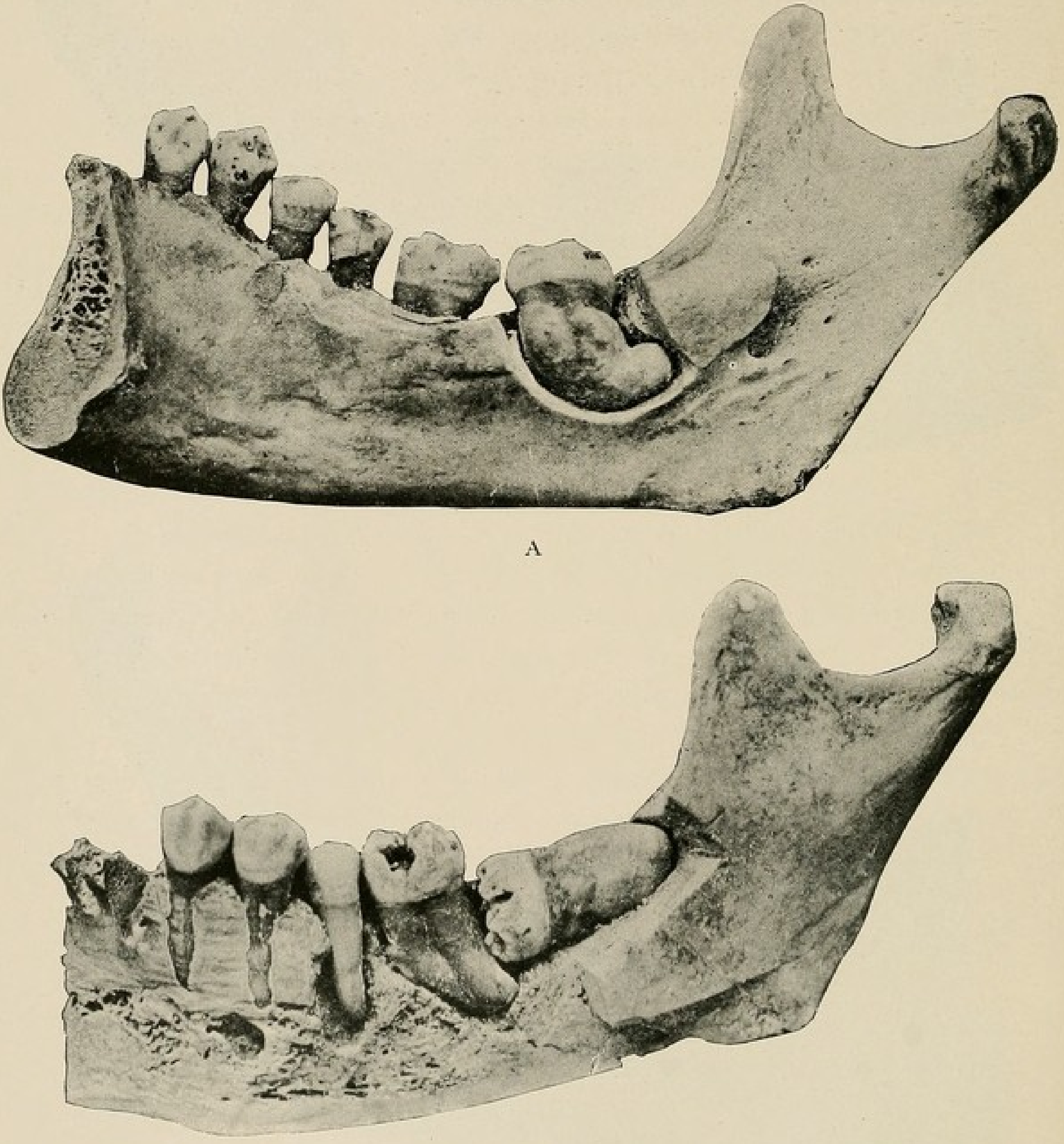


B

Two views of an impacted lower third molar. In A it is in position; in B it is turned out of its pocket.

tients may even claim that the teeth which cannot be seen have been extracted. The use of the X ray as a means of diagnosing such cases has not been as successful as the writer

FIG. 121.



A

B

An impacted lower third molar and a lower third molar with curved and thickened root, both belonging to the same jaw. The bone is much more compact than normal bone.

had hoped it would be. Impacted incisors are liable to give trouble in the nose or to produce neuralgia by the tooth pressing the spheno-palatine nerve as it passes through the anterior palatine fossa. Occasionally they cause a partial separation between the septum and the floor of the nose. Impacted teeth may become either partly lodged in the inferior meatus of the nose, sometimes causing the closure of the lower portion of the lachrymal duct, or they may lie horizontally across the roots of the incisors, especially of the lateral, or the roots of the premolars, causing the devitalization of these teeth. Impacted upper third molars are liable to interfere with the nerves and vessels in the floor of the antrum, near where they pass through the posterior dental foramina into the sinus. They may also cause an enlargement of the tuberosity outwardly until it interferes with the ramus of the lower jaw, and produces a cellulitis which may extend to the temporo-mandibular articulation, causing false ankylosis.

Neuralgia. The three impacted teeth shown in Fig. 108 caused a baffling case of facial neuralgia until they were found and removed. The patient was past middle life and had suffered from neuralgia. He had no teeth in the alveolar process of the right maxilla, the region of pain, almost all of them having been extracted in the hope of giving relief. The antrum was opened by the late Professor Garretson and the writer in search of the cause. It was somewhat surprising to see three crowns protruding into the sinus, the roots being imbedded in the inner anterior angle of the wall of the antrum. After the teeth were extracted by small forceps the parts were treated in the usual way, with relief and subsequent cure. The crowns were in normal shape and quite healthy, the roots more or less defective. The pulps were alive, and it is probable that the nerves were impinged upon at the points of the roots, thus causing the pain. The writer has seen several cases where a greater portion of the root of a single tooth was found within the antrum; but he believes this to be the only case where three such teeth have been reported. In the lower jaw impacted teeth are liable to impinge upon the inferior dental nerve, thus becoming a hidden cause of neuralgia in this region, which may have its symptoms exhibited almost anywhere along the distribution of the nerves, eventually producing neuritis that may pass back along the nerve even into the brain. (See Figs. 118, 119, 120, 121.)

Teeth prevented from passing in their normal course may, through the resorption of the bone, advance in almost any direction and be erupted through the bone even upon its cervical aspect. Impacted or supernumerary teeth may also produce dental cysts of various sizes and forms, some of which may cause the cortical portion of the bone to be pushed outward until large disfiguring tumors are formed. These have sometimes been mistaken for malignant growths, and the entire body of the jaw has been removed on account of this enlargement and the misdiagnosis.

MODIFICATION OF THE NORMAL SHAPE OF THE BONE THROUGH ABNORMAL FORCES.

THE illustrations and descriptions already given demonstrate that there are very marked variations in the character of the bones of the face, and of the sinuses and air spaces situated in and between them. It is evident that there must be some general principles underlying these changes.

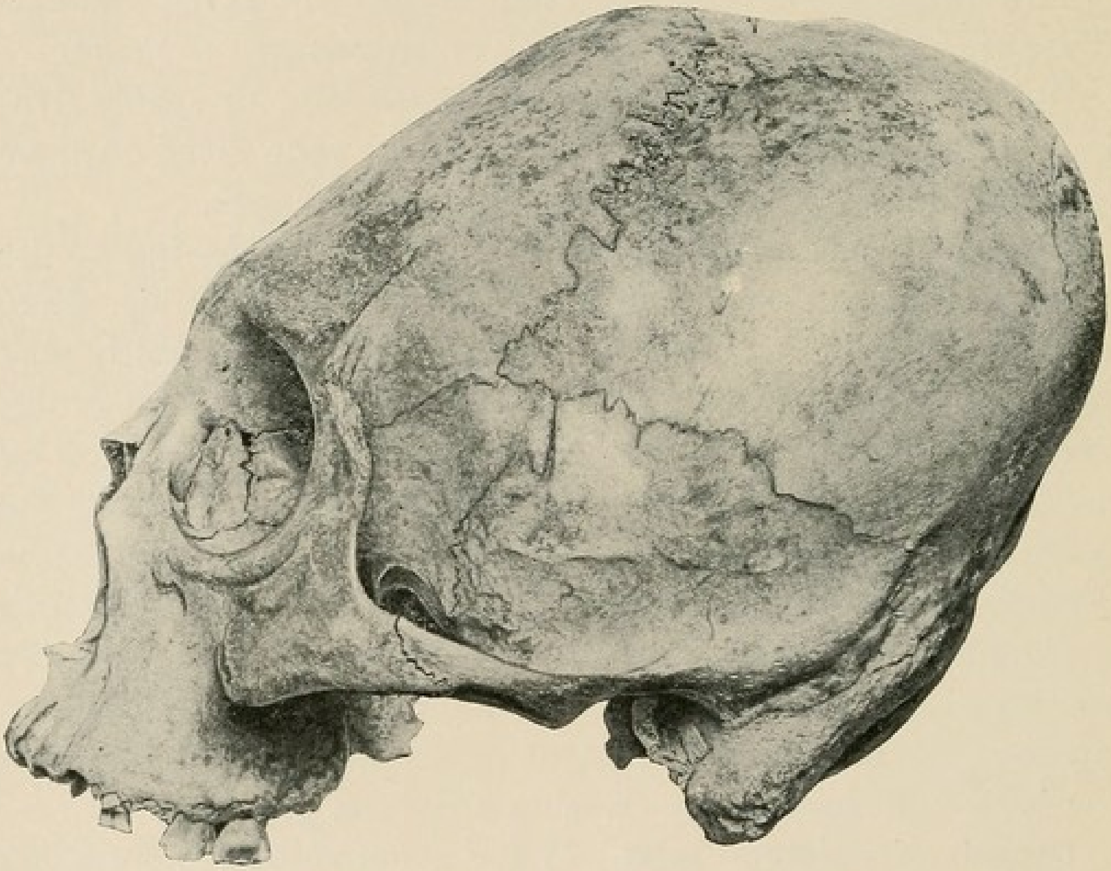
Causes of Variations in Shape. At the beginning of the growth of the embryo, and continuing throughout life, there are two forces constantly acting upon the body which may be described as the intrinsic and extrinsic; the former giving size and bulk to the tissues, but controlled and modified by the latter, which, acting from without, tends to limit the growth and give form to the tissues. If these two forces be normal,—that is, properly balanced,—in potential strength and application throughout life, the result will be a normally developed organism; but if these forces be interfered with in any way, by lack of nourishment or undue external pressure, the individual may fail to develop a normal physique.

Deposit of Calcium Salts. If for some reason there is an insufficient quantity of calcium salts assimilated into the bony tissue, the bones will be soft and fail to give proper shape to the body. The brain-case in such instances is apt to enlarge when the intrinsic growth of the brain forces out the soft yielding structures, while on the other hand an over-amount of calcium salts will harden the bone, and cause it to resist the intrinsic force and prevent proper development.

In early life the undue deposit of calcium salts will solidify the sutures of the brain-case and prevent the expansion of the brain. Microcephalic skulls are sometimes caused in this way. By the use of the surgical engine, artificial fissures have been made in the skull, which allowed the brain-case to expand, and thus enabled the brain itself to enlarge.

The slopes and forms of the heads of the various races are influenced by the growth of the brain, and by artificial means such as that practiced by the Flat-head Indians of North America. (See Figs. 122 and 123.) In other words, the

FIG. 122.



Side view of a skull of Flat-head North American Indian.

brain by its intrinsic forces acting upon the bone-tissue will cause the skull to expand, according to the character of the individual race. If the anterior lobes of the brain are of large size, the forehead will be carried upward and forward; if, on the contrary, the cerebellum is large, the occipital region will extend backward, while the forehead may be low and receding. The two types are well illustrated in Fig. 124. A is taken from a European skull, and B from the skull of a Fan

Tribe negro, West Africa. Fig. 125 is a composite picture of these two skulls, showing their relative shapes. Fig. 126 gives a view of the bases of these two skulls.

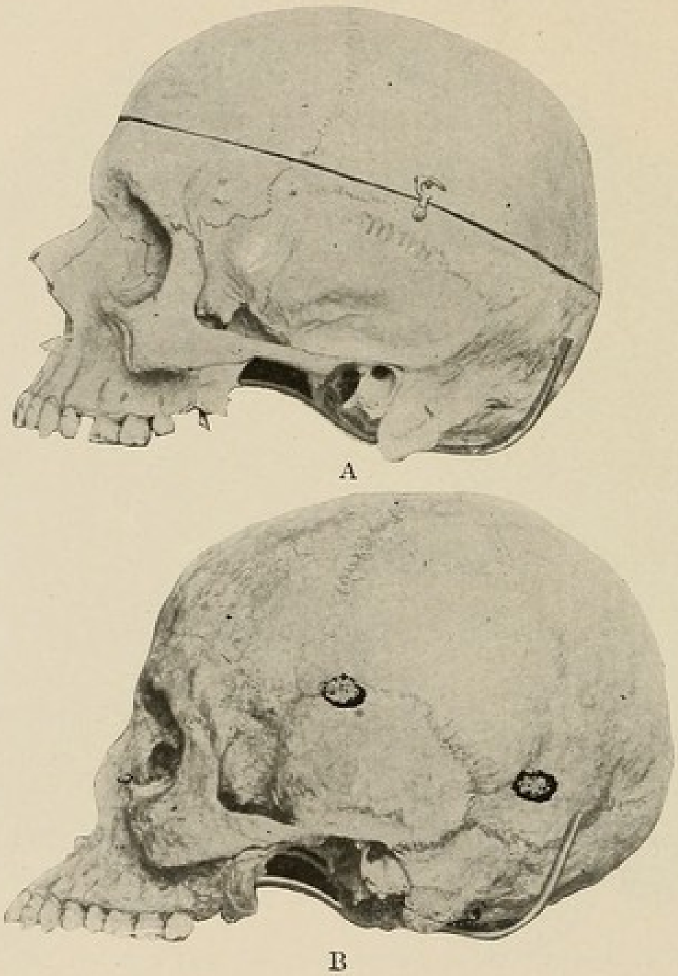
Prehensile Type of Dentition. A little study of these specimens brings out some features of special interest to the ethnologist. In the savage type a great predominance of

FIG. 123.

Front view of same skull shown in Fig. 122.

development in the region of the cerebellum is found, conjoined with what may be called a prehensile type of dentition. This type was doubtless developed through continuous use of the teeth in tearing off portions of the substances which constitute the food of the savage races. The prehensile type of dentition is not found in the civilized races, and as seen in the typical skulls the cerebellum is much less than in the savage. It would appear reasonable that the retention of the large cerebellum—the original type—in the latter results from the low standard of intelligence evidenced by the persistence of the food habit which caused the prehensile type of dentition. The two pictures in Fig. 126 show that the dental arch is actually located further forward in the skull of the savage, A, than in that of civilized man, B. The anterior portion of the

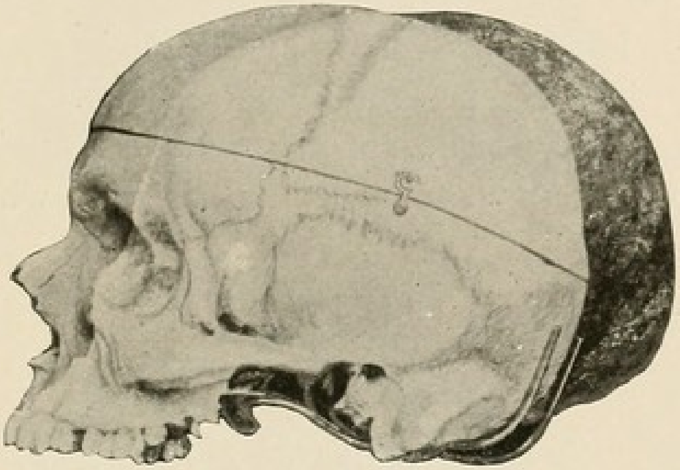
FIG. 124.



Side view of two skulls; A is of the Caucasian race, B of the Fan tribe of West Africa. They show great differences in conformation. (The Fan tribe skull belongs to Professor E. T. Darby's collection.)

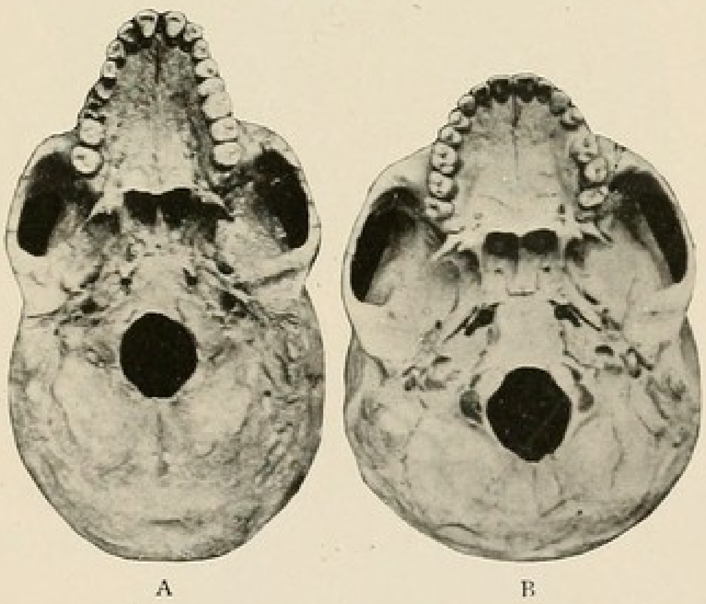
malar process of the maxilla in the savage is on a line with the second molar; in the civilized man it is on a line with the second premolar; a difference equaling the space of the first molar. These observations are confirmed by a comparison of Fig. 128, from the skull of an African negro, and Fig. 24, from the skull of a Caucasian. It would seem probable that the lessened prognathism of the Caucasian race is one of the principal causes of the suggested suppression of the third molar. An example of the occasional rudimentary fourth molar of the prognathous savage is seen in Fig. 127.

FIG. 125.



Composite picture of the two skulls shown in Fig. 124.

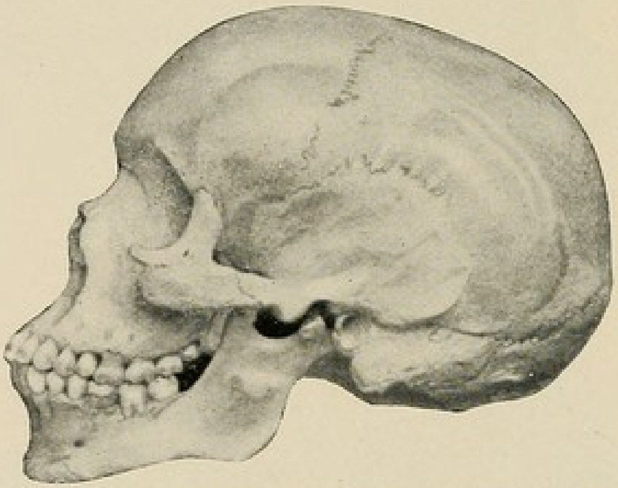
FIG. 126.



Under view of skulls shown in Fig. 124.

Rudimentary or Suppressed Molars. Many skulls of the Caucasian races have only rudimentary third molars; in some skulls the third molar is entirely lacking. This has been received by many writers as evidence that the third molar teeth are being lost entirely, and as an indication that men will eventually become more or less edentulous. The author is of the opinion that the teeth of man are as good and fully formed at the present time as they were three thousand years ago; for if ancient Egyptian skulls are carefully examined, the rudimentary condition or complete suppression of the third molar will be found quite as frequently as in skulls belonging to relatively the same class of people to-day. This condition is also occasionally found in the North American Indians. There is no difficulty to-day in finding jaws with thirty-two

Fig. 127.



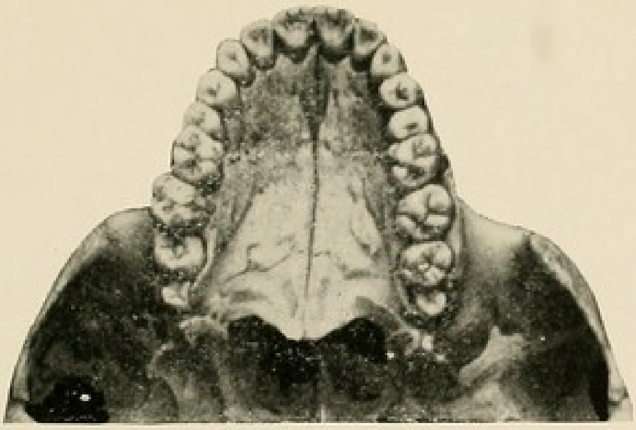
Side view of a prognathous skull of a negro with eighteen teeth in the upper jaw. The roof of the mouth is shown in Fig. 128.

perfectly developed teeth, both in the living subject and in the skull, with perfect arches, and occasionally with rudimentary fourth molars, of which examples will be given.

Fig. 128 shows the under surface of the upper jaw seen in Fig. 127, with two rudimentary fourth molars in the line of the arch.

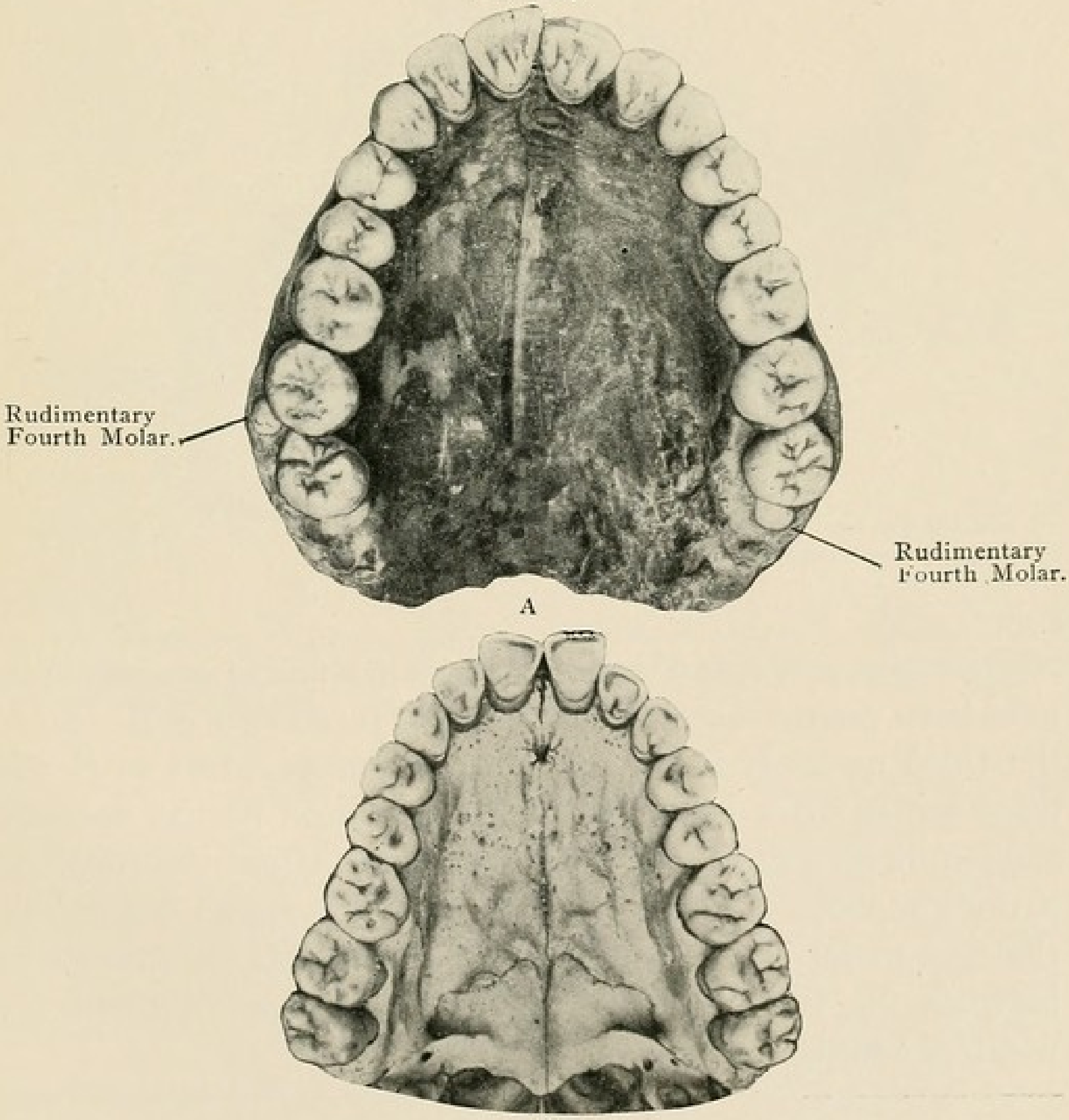
Fig. 129. The under surface of two upper jaws showing the occluding surfaces of the teeth, and their size relatively to each other. B is about the normal size, while A is very much larger. In A there are two rudimentary fourth molars, one in the line of the arch and one on the buccal side of the second molar.

Fig. 128.



The roof of a mouth and occluding surface of eighteen teeth, from same skull shown in Fig. 127.

Fig. 129.

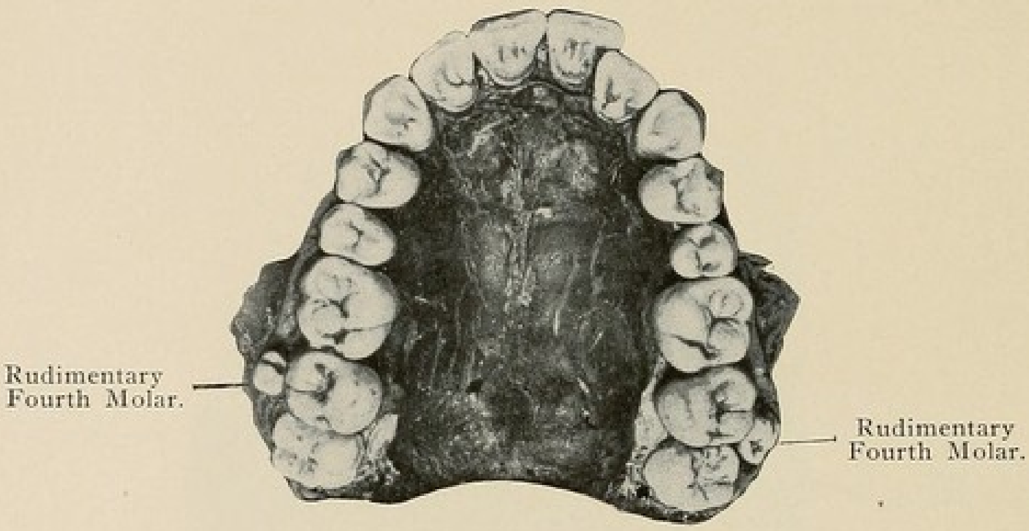


View of two upper jaws. The occluding surfaces of the teeth and roofs of the mouths, and the great difference in relative size, are well shown. A has two rudimentary fourth molars.

Fig. 130 is a view of the under surface of an upper jaw, showing the occluding surfaces of the teeth, with two rudimentary fourth molars situated on the buccal sides of the second molars.

Comparison of Mandibles of a Caucasian and an African Negro. Fig. 131* affords a comparison between the mandibles of the Caucasian and of the Fan Tribe negro (West Africa). They were photographed upon the same plate, showing their

FIG. 130.

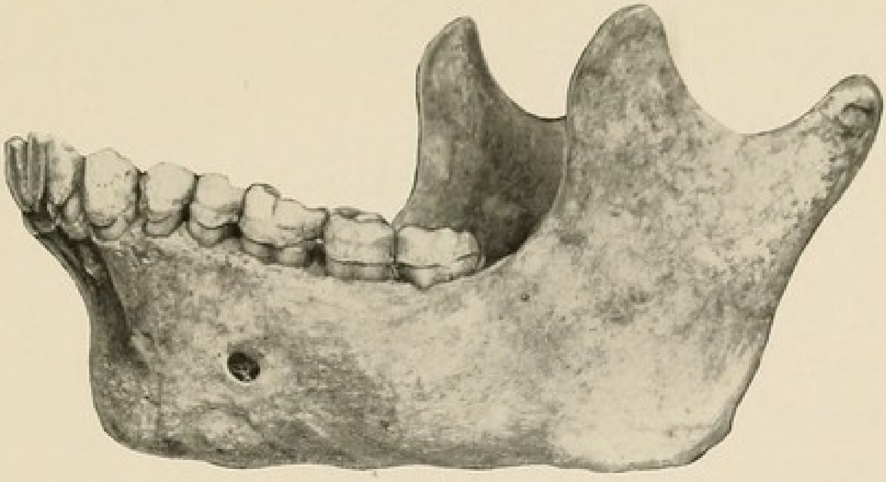


View of the roof of the mouth and occluding surfaces of the teeth from an ordinary-sized upper jaw, showing two rudimentary fourth molars.

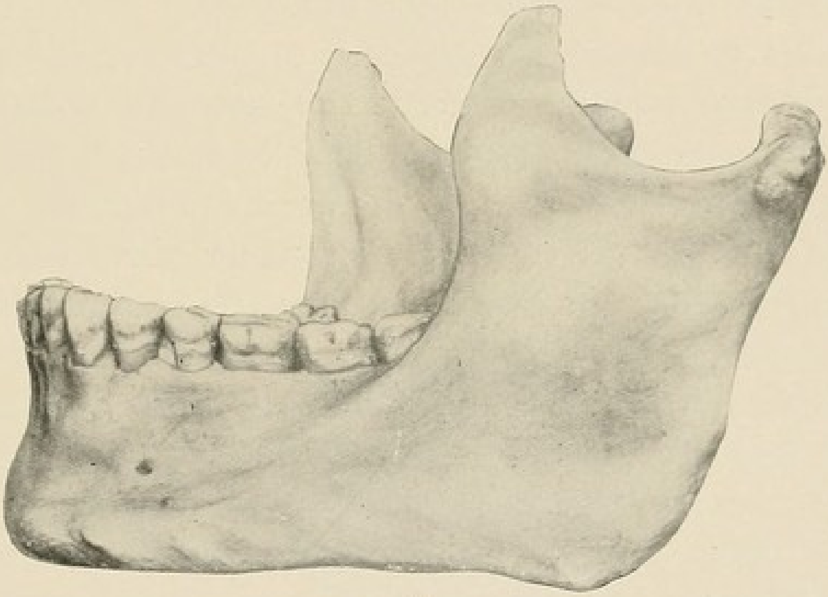
relative size and shape. The teeth and alveolar process in A have been carried much further forward than those in B. In A the third molar is in advance of the ramus, while in B the third molar, to a great extent, is posterior to the anterior margin of the ramus, the difference being about the width of a third molar. Again, in A the mental foramen is beneath the first molar tooth, while in B it is beneath the interspace between the two premolars, again a difference of about the width of a molar tooth.

*Fig. 131 is a repetition of Fig. 2.

FIG. 131.



A



B

Two mandibles, A from the Fan tribe, West Africa, B from a Caucasian, showing the difference in the position of the teeth in relation to the ramus, the mental foramen, and the symphysis menti.

THE INFLUENCE OF MUSCULAR ACTION.

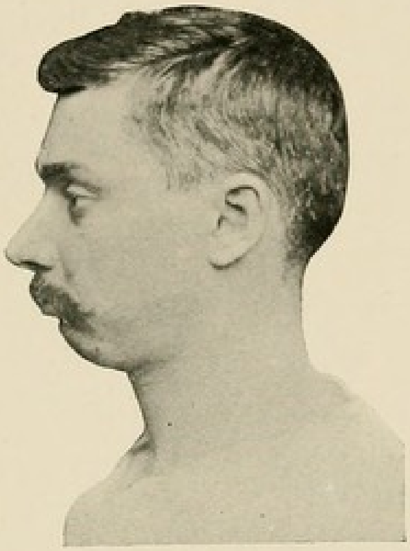
AFTER the birth of the child, muscular action and various forces have direct influence over changes in the shape of the bones, according to the following rules:

The normal application of the forces affecting developing bone results in normal development of the form of the bone. Their abnormal application under the same circumstances results in the development of abnormally formed bone. Abnormal application of forces to the bone in adult life will also change and modify the shape and character of the bone tissue. The changes which may be caused by the application of abnormal forces to the developing individual are well illustrated by the disfigurements resulting from the tight bandages put upon the feet of Chinese girls of the higher class, the use of corsets to contract the waists of the European women of the analogous class, and the flattening of the skulls of certain Indians of North America by binding boards upon the heads of the children. Fig. 122 gives a side view of one of these Indians. Fig. 123 gives a front view, showing that by the compression of the frontal region downward the skull has been extended laterally.

The modification of the bones by abnormal muscular action is well illustrated by the changes found in persons suffering from true or false ankylosis of the temporo-mandibular articulation. The illustrations which follow are taken from a patient and from the bones of two skulls.

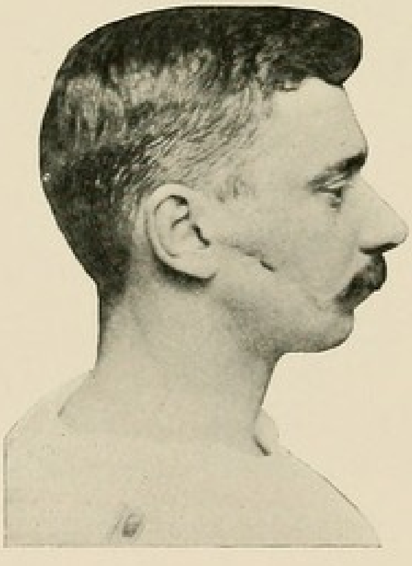
False Ankylosis. Fig. 132 is from the photograph of a patient who has been suffering from false ankylosis. Judging from the general outline of the face, with its protruding lips and receding chin, one might be inclined to classify the individual as a degenerate, but the writer believes that this picture, and others to follow, show that this is a

Fig. 132.



Characteristic appearance in the region of the lower jaw in long-standing ankylosis.

Fig. 133.



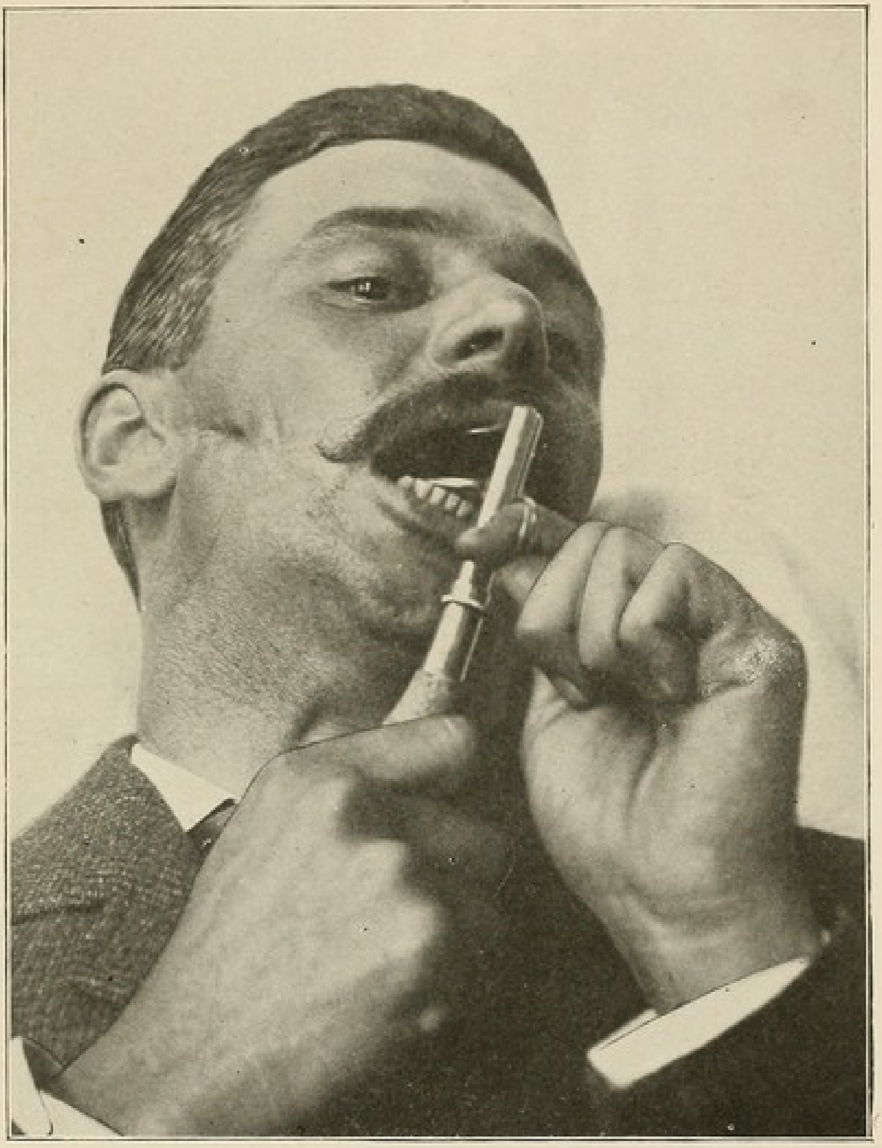
Opposite side of face of Fig. 132, showing scar caused by a gunshot wound, the effects of which produced false ankylosis.

typical face belonging to those who have or who have had ankylosis of the jaw, either true or false. This patient has suffered from a false ankylosis since about nine years of age.

Fig. 133 is taken from the right side of the same face, showing a scar extending upward and backward from the angle of the mouth to the region of the external auditory meatus. The scar was produced by a gunshot wound. The shot in passing severed the masseter muscle as well as a portion of the buccinator. In the healing of the tissues false bands were formed, extending from the lower jaw to the malar bone and the zygomatic arch. The pterygo-mandibular ligament was also shortened, thus preventing the jaws from being opened. The treatment for the false ankylosis consisted in cutting the false bands and using the mouth-gag with a screw to break up the false ligaments. The operator was afterward assisted by the patient in forcing the jaws asunder, as shown in Fig. 134. The main object in using the appliance was to stretch the temporal and masseter muscles of both sides. In a few weeks the patient could open the jaws without the appliance, as shown in Fig. 135. There was at this time sufficient improvement to permit of the mastication of food and the proper care of the teeth. The condition has since been further improved.

Typical Shaped Ankylosed Mandible. In cases of ankylosis of the jaw, especially those of long duration, certain changes in the form of the mandible are noticeable, not only on the affected side when the ankylosis is unilateral, but also on the opposite side. The character of these changes is well shown in Figs. 136 and 137. Fig. 136 is a view of the unankylosed side of a typical case of true unilateral ankylosed jaw. The condyloid process is shortened and its articulating surface is changed. Instead of being rounded at the top it has more of the shape of a Gothic arch. Through this shortening of the condyloid, the coronoid process is apparently elongated. The angle of the mandible is also elongated so that it forms a projecting point, and the base of the bone under the mental foramen is considerably thickened. The mental process is much diminished in size by recession. The bone is all there, but, by the operation of causes to be referred to, a metamorphosis has been induced whereby the base of the bone has been thickened at the expense of the mental process. Owing to the same causes, the base of the bone, between the angle and a point vertically

FIG. 134.

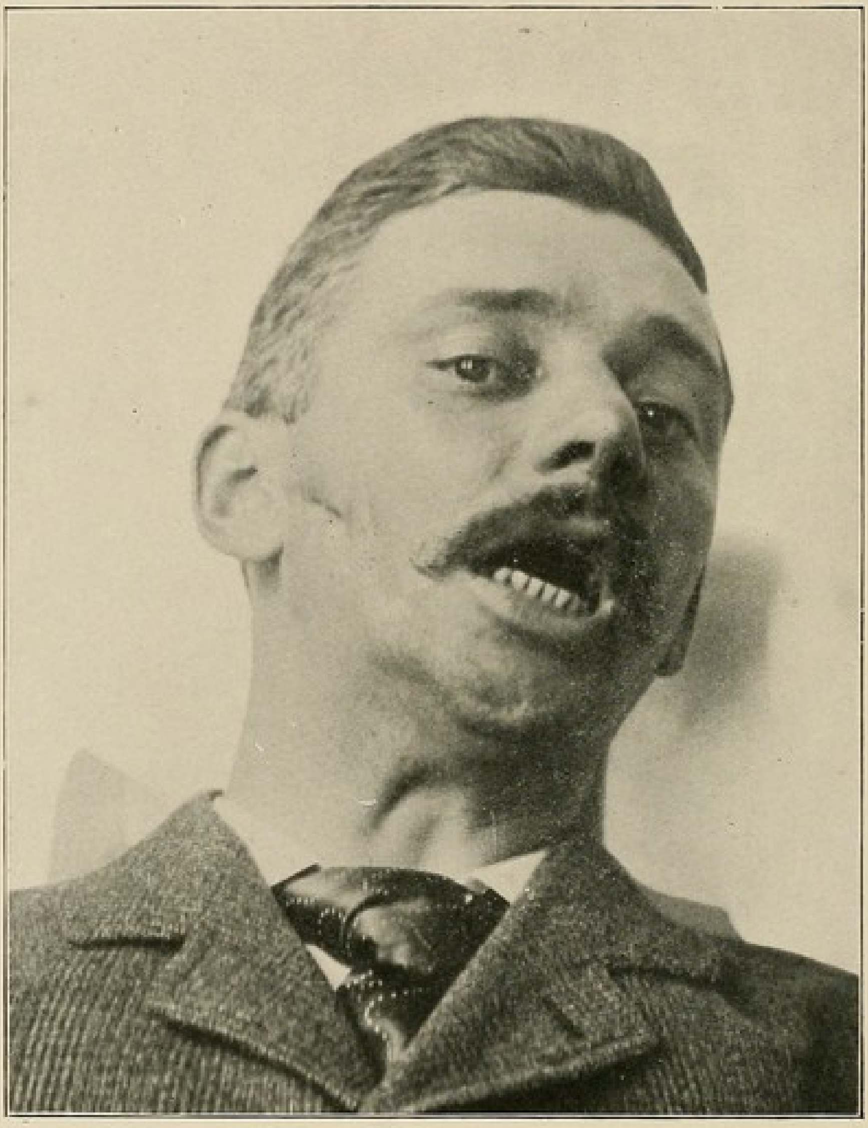


Application of jack-screw for forcing the mouth open in false ankylosis.

underneath the canine teeth, is deeply concave in outline instead of being nearly straight, as in the normal jaw.

Fig. 137 is taken from the other side of the jaw shown in Fig. 136, showing the condyloid process completely changed; it is broadened out, and is sharply serrated on the articulating surface. The articulating surface of the glenoid fossa is also changed to correspond to that of the condyloid, with which it was interlocked. The angle of the jaw on this side is much more changed than on the opposite side, causing a deep depression in the region of the facial notch. The lower jaw, under the mental process, is fuller and more roughened

FIG. 135.



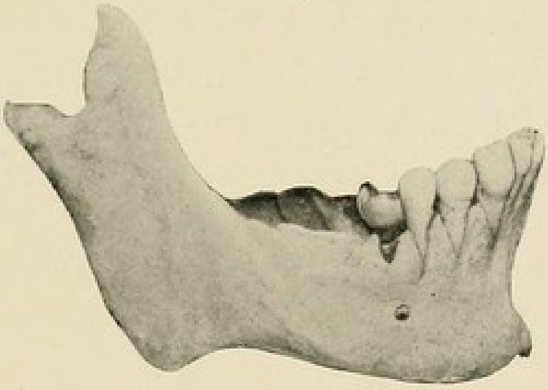
Results of treatment for false ankylosis.

and the mental process more receded than on the opposite side. The concavity of the base of the jaw and the elongated angle are readily seen in the picture of the living subject. (Fig. 140.)

True Ankylosis. Fig. 138 is from a skull with a complete or true unilateral ankylosis of the jaw, taken from the unankylosed side.

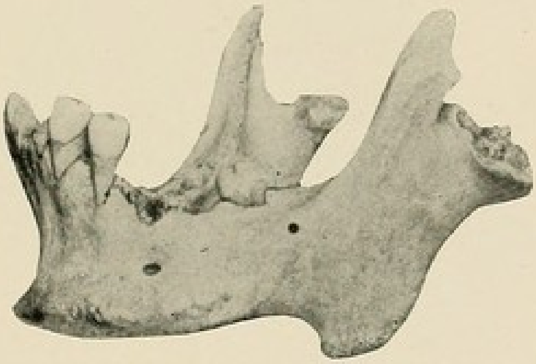
Fig. 139 shows the ankylosed side. The lower jaw closely resembles that shown in Fig. 137, in the descending

FIG. 136.



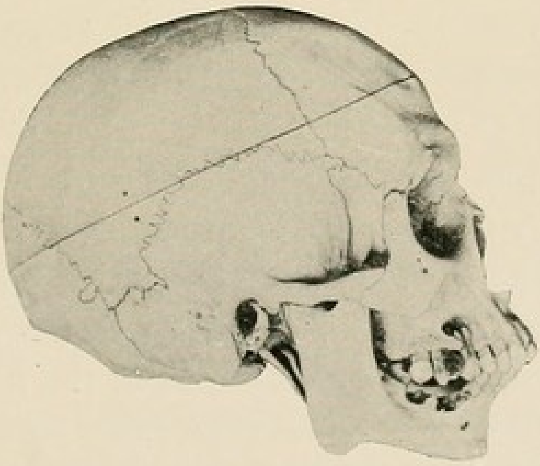
Opposite side of a typical jaw having a true unilateral ankylosed temporo-mandibular articulation.

FIG. 137.



The ankylosed side of Fig. 136.

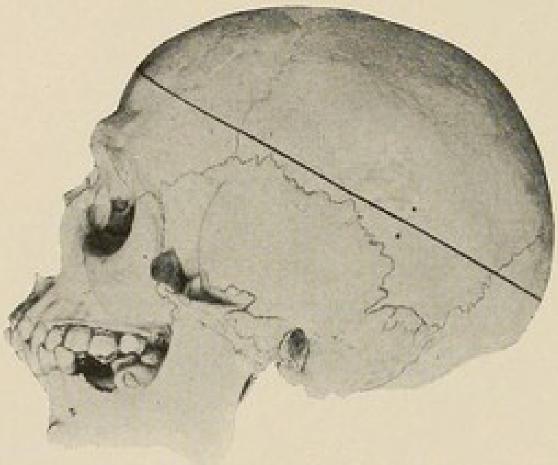
FIG. 138.



A skull with a true ankylosis of the temporo-mandibular articulation on the opposite side.

angle, the receding chin, etc. In all cases of prolonged ankylosis it becomes evident that there is cause for the changes observed in the form of the bones. The muscles of mastication,—*i.e.*, those which elevate the lower jaw,—are inactive, while those which assist in depressing the mandible become more and more active in their work, in an endeavor to overcome the fixation of the temporo-mandibular articulation. By their action the lower jaw, from the symphysis to the angle, becomes modified in proportion to the contraction of the depressing muscles of the jaw. Anteriorly there are the two genio-hyo-glossus, the sterno-thyroid, the sterno-hyoid, the digastric, the omo-hyoid, and the platysma myoides, all of

FIG. 139.



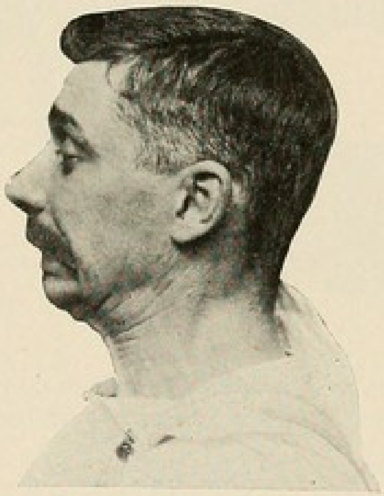
View of the ankylosed side of Fig. 138.

which are abnormally active. Their action, without the normal compensating factor of the mandibular motion, brings about in time the changes noted.

Fig. 140 is a picture of the patient shown in Figs. 132 to 135, showing an endeavor to open the mouth by the assisted action of the muscles. It illustrates the various muscles under spasmodic action, indicating how their frequent use under such conditions may cause alterations in the form of the bone.

Changes in the Temporo-Mandibular Articulation other than by Ankylosis. Teeth becoming diseased or lost on one side of the jaw cause changes in the forms of the various bones, through the necessity of masticating on the opposite side of the mouth, and the consequent use of the jaws in an abnormal manner. In this way great alterations can be made in the temporo-mandibular articulation, and in one or both glenoid fossæ. The eminentia articularis may be entirely lost by resorption. The places of attachment for the muscles of mastication, as the coronoid process, the outer surface of the ramus, the angle of the jaw, etc., become roughened and enlarged on the side in use, and smooth and lessened on the unused side. The spaces where the muscles have their origin, as the external plate of the pterygoid process, the under surface of the zygomatic arch, and the temporal ridge of the

FIG. 140.



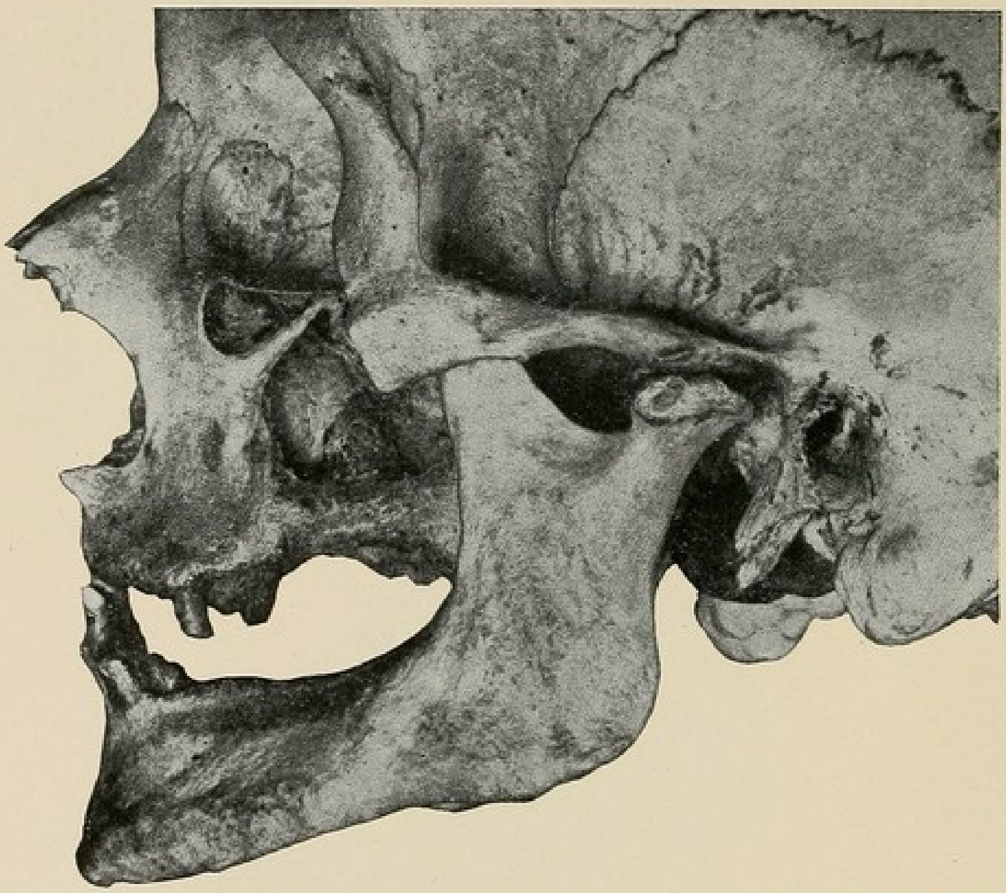
The action of the superficial depressor muscle of the mandible in ankylosis.

skull, will also become enlarged on one side and lessened on the other.

Many illustrations of this could be given, but one will be sufficient.

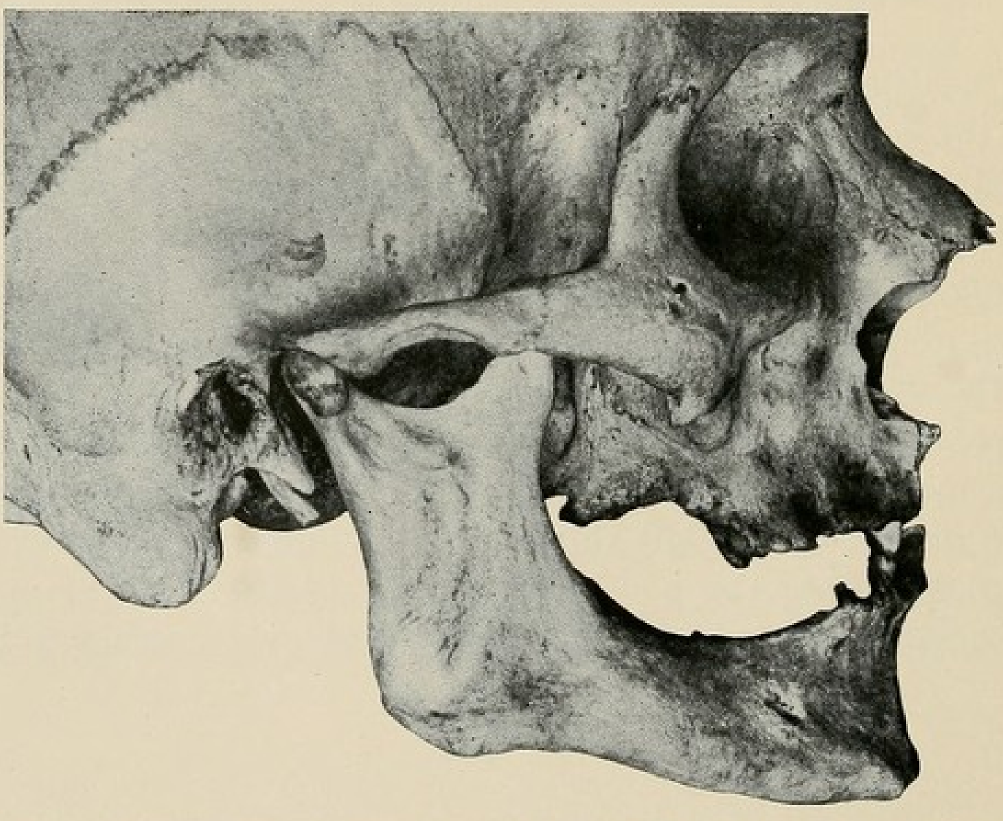
Fig. 141 is a view of the articulation of the left side of the skull of an aged person who had lost all the teeth except three in the upper jaw and three in the lower jaw. They were not opposite to one another in normal occlusion. In order that the cutting or grinding surfaces of these teeth could come into occlusion, the left side of the jaw had to be carried forward, bringing the condyloid process of that side upon the articulating eminence, while the right side remained in a

FIG. 141.



Modification of the left temporo-mandibular articulation through the jaw being forced forward in mastication in order to bring the remaining teeth in occlusion.

FIG. 142.



The right temporo-mandibular articulation from skull shown in Fig. 141, where the condyloid process has not been carried forward.

nearly normal position, as shown in Fig. 142. Upon close examination of the condyle of the left side, it is found to be flattened out, probably because of coming in contact with the eminentia articularis, thus moving the point of articulation forward, or jumping the bite. The eminence is flattened also. The forces of mastication of the left side were but little used, and accordingly the places of origin and insertion of the muscles of that side are much less marked than the normal; while on the right side, upon which alone the function of mastication was performed, the muscles were thus overworked, and the places of attachment and of their origin and insertion are strongly marked in consequence.

HYPERTROPHY OF THE GUMS AND ALVEOLAR PROCESS.

ABNORMAL growth of the bone may produce almost the same effect, so far as appearances go, as the modification caused by abnormal muscular action. In February, 1893, Dr. J. W. Hisey, of Cleveland, brought to the Hospital of Oral Surgery a boy of fifteen years. The boy was well developed, bright, intelligent, and well educated. He was afflicted with the most remarkable case of hypertrophy of the gums and alveolar process that the writer has seen recorded. The case was operated upon by the late Professor Garretson and the writer, February 17 and March 11, 1893.*

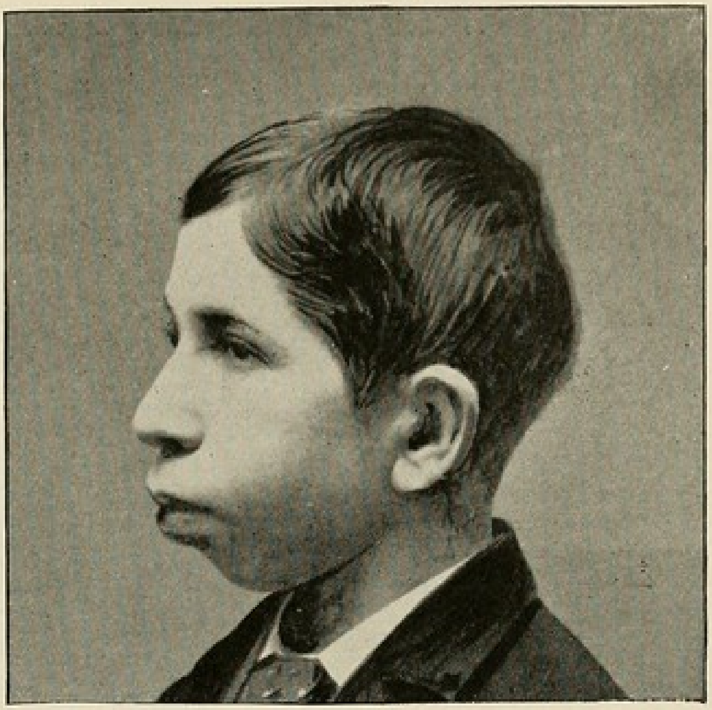
Fig. 143 is from a photograph of the lad taken before the operation. As in the first picture, shown in the ankylosis series, this boy appears to have anything but an intelligent face. On February 17, Professor Garretson decided that it was best to open the upper lip at the median line and carry the incision around to the alæ of the nose. By the aid of the surgical engine and other instruments, the portion shown in Fig. 144 was removed from the upper jaw. It was thought best not to remove the abnormal tissue from the lower jaw at this operation, so it was delayed until March 11, when the mass of tissue shown in Fig. 145 was removed from the lower jaw. This last was accomplished without cutting the lip.

Fig. 146 is from a photograph taken shortly after the second operation, on April 28. Seven weeks after the operation the

*A full description of the operation will be found in the *Dental Cosmos*, June, 1893.

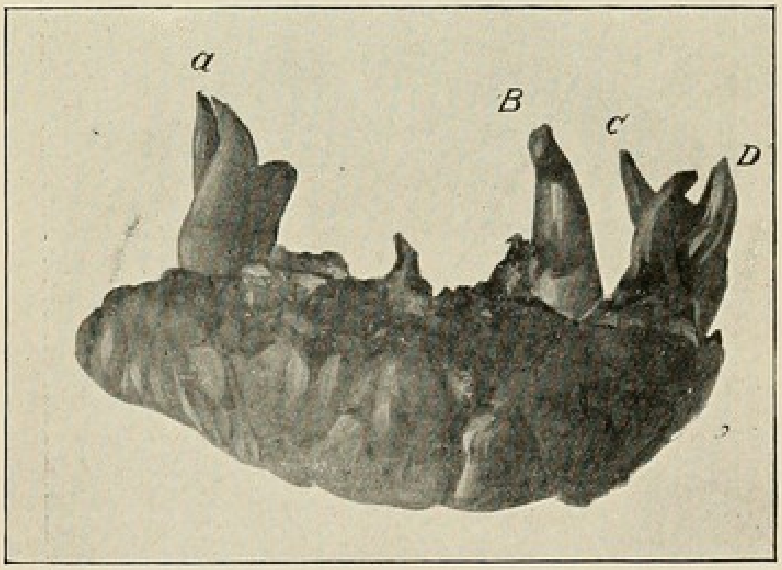
parts were thoroughly healed and the general health of the patient was good. He experienced less difficulty in articulat-

FIG. 143.



From the photograph of a lad suffering from hypertrophy of the gums and alveolar process.

FIG. 144.

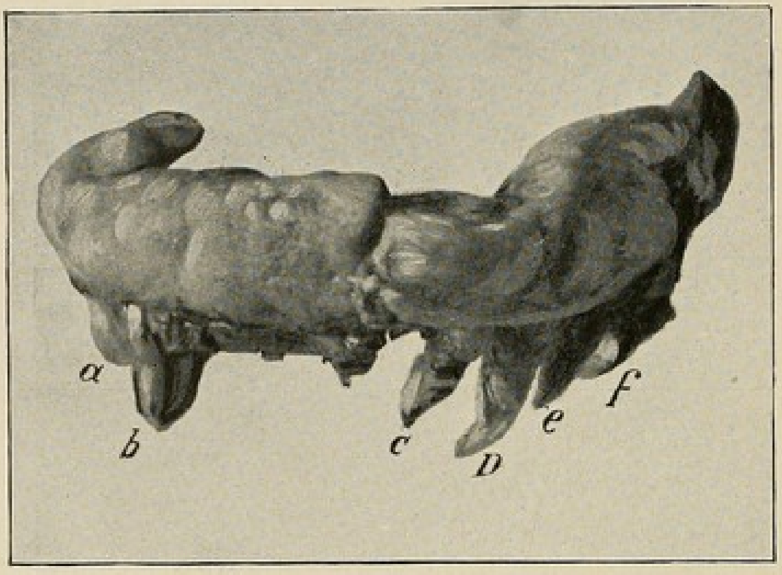


Tissue removed from upper jaw of patient shown in Fig. 143.

ing than previous to the operation, and the improvement in his speech and general appearance was very marked.

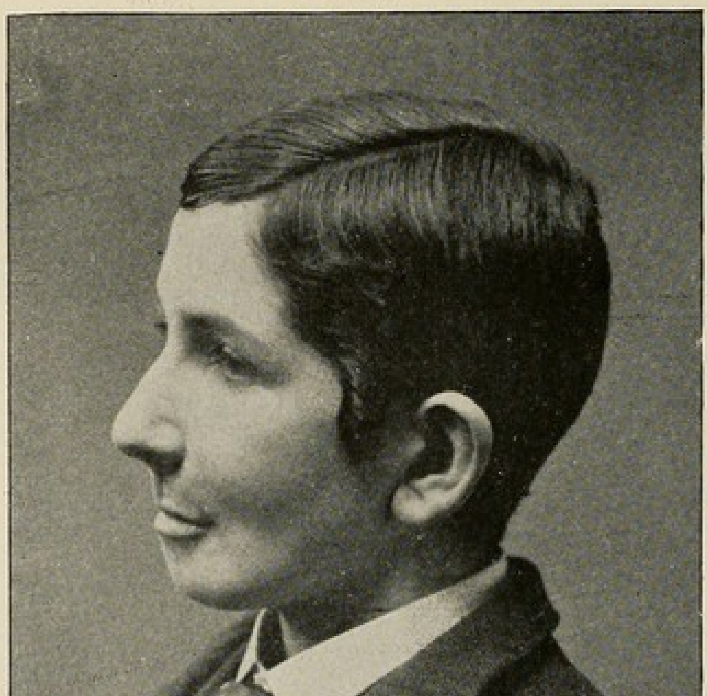
Artificial dentures were supplied in due time. It was an interesting case, and the writer has kept in casual communi-

FIG. 145.



Tissue removed from lower jaw of patient shown in Fig. 143.

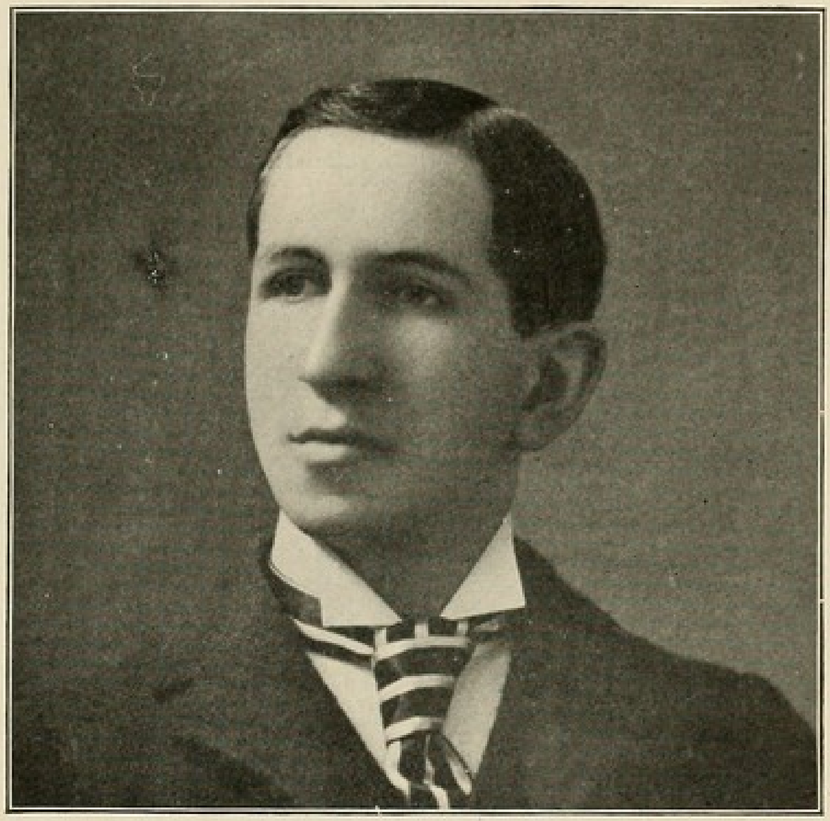
FIG. 146.



From a photograph taken three weeks after the removal of tissue as shown in Figs. 144 and 145.

cation with the patient. In one of his letters, about six years after the operation, he forwarded his latest photograph, to afford an idea of his general appearance. Fig. 147 is made from this photograph. To judge from this, the young man

FIG. 147.



From a photograph six years after the operation upon the person represented in Fig. 143.

certainly does not look like a degenerate. The operation has evidently made a tremendous improvement in his appearance, and it seems to be conclusively demonstrated that Professor Garretson was right in his judgment as to the operation.

THE RELATION OF THE TWO JAWS.

The Relation of the Upper and Lower Jaws Varies Throughout Life. There is also a difference in their relative time of development. The lower jaw is developed slightly in advance of the upper one and is formed from two processes or buds, the upper jaw being formed from four processes or buds,—two from the sides and two from above. Occasionally these four processes fail to completely unite. This lack of union varies from a slight *cleft palate* or *hare-lip* to a double cleft palate and double hare-lip. In a few very exceptional cases there has been an entire lack of union of these parts, leaving the mouth, nasal chamber, and orbits as one common cavity. Various theories have been advanced for this lack of union, the most prominent, perhaps, being that of malnutrition of the parts during the time when the union should take place. While agreeing that malnutrition is probably largely responsible, the writer offers as a plausible explanation of the manner of its operation the idea that as the lower jaw is formed in advance of the upper one, when undue pressure is exerted upon it, it is forced in between the four processes forming the upper jaw, thus mechanically preventing them from coming together.

The normal position of the fetus in utero is such that the weight of the entire fetal body may be readily thrown upon the vertex, and the pressure thus exerted would tend to force the mandible into contact with the sternal region and compress the forming jaws together. The relatively advanced development of the mandible, as compared with that of the forming maxilla, would under the circumstances referred to, and especially in cases of low nutritional standard, interfere with the normal closure of the brachial arches and tend to produce a permanent coloboma.

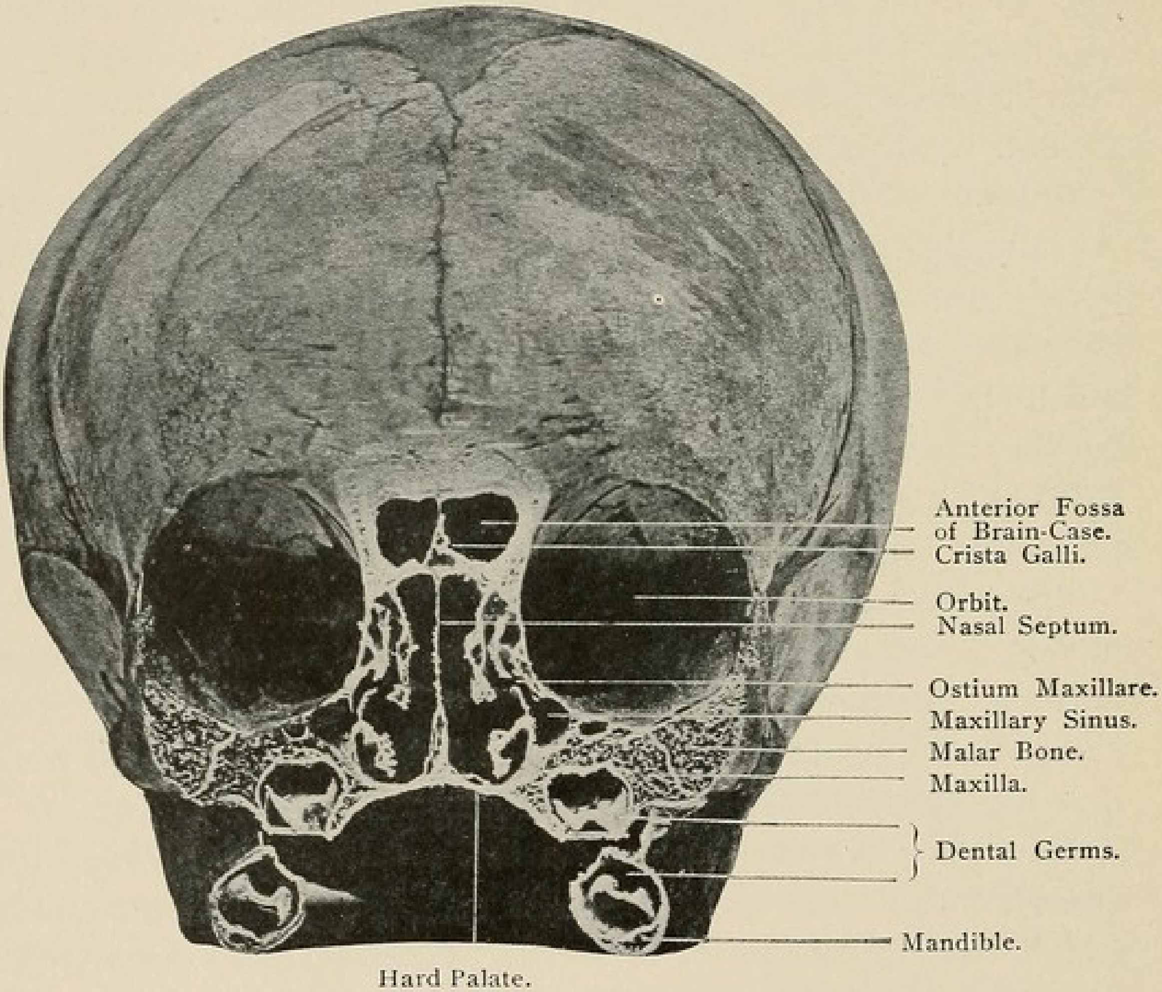
If an examination be made of a young child with a complete cleft, it will be noticed that the upper alveolar ridge is immediately over the alveolar ridge of the lower jaw, or it may be external to it; in the normal child or in the person of advanced age the upper alveolar ridge is in vertical line within that of the lower jaw, as is well illustrated in Figs. 25 and 149 and in B, Figs. 150 and 151.

Manner of Drinking. Individuals having cleft palate, especially those with double cleft, have not the power to drink when the anterior portion of the mouth is on a lower level than the posterior portion. They are compelled to raise the head, thus throwing the fluid back into the pharynx, similar to the manner in which a chicken drinks. This mode of drinking is normal with the chicken, as it has naturally a cleft palate, and has not the power of suction as performed in man by his palato-glossus muscles. A child with a complete cleft has no power of suction with the lips. If the artificial nipple be long and large, in order that the child may seize it with the palatal muscles, it will have the power of sucking or of drawing the fluid through the nipple.

Mold upon which the Maxilla is Formed. It is generally accepted that the lower jaw acts as a matrix or mold upon which the upper jaw is formed. It certainly to an extent becomes the mold upon which the inferior border of the upper jaw is formed, as the latter comes in contact with its inner edges. This action also influences the general contour and shape of the superior alveolar ridge and roof of the mouth.

Fig. 148 is a picture taken from the skull of a fully developed fetus. The skull has been cut vertically and transversely in the region of the developing deciduous teeth of both jaws, showing the jaws in transverse section. The skull is quite symmetrical. It is plainly to be seen that the width of the upper jaw is much less than that of the lower.* As a further evidence of this fact, if vertical lines are drawn through the centers of the tooth-germs and the alveolar process of each jaw, it will be found that the lines of the upper jaw are on the inner side of those of the lower jaw, the extent of the difference being about one-half of the thickness of the lower jaw.

FIG. 148.



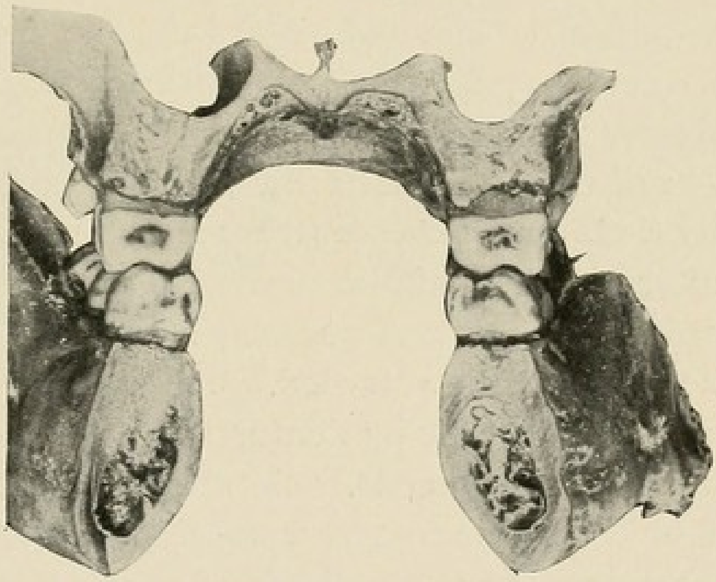
Vertical transverse section through the orbits, the nasal chamber, and the premolar teeth.

Fig. 149 is taken from an adult jaw. If the lines be drawn through the axes of the upper and the lower teeth, it will be found that those through the upper teeth, as they extend toward the coronal surfaces, pass a little outward, while those passing up through the lower teeth incline inward. This is

*For description of other features shown in this illustration, see Fig. 40.

evidence that the relation found in the fetus has been continued, and that all through the period of growth of the lower jaw and development of its alveolar process, the latter has been directed inward, while the upper alveolar process has extended outwardly, so that the cusps of the upper permanent teeth, when fully developed normally, bite over the outer cusps of the lower teeth occluding with them. If the teeth and alveolar process be excluded, it will be observed, as in the fetal skull, that the upper jaw is much smaller than the lower. The same characteristics will be found more markedly shown in Fig. 25.

FIG. 149.



Anterior view of a vertical transverse section through the lower jaw and the lower portion of the upper jaw.

The Resorption of the Alveolar Processes. As the alveolar process belongs to the teeth and is developed with them, and its function is that of holding them in position, it disappears to a greater or less extent after the teeth are lost. The manner of its resorption differs in the two jaws. In the upper the external plate disappears more rapidly than the internal, which persists for a considerably longer period, though in extreme old age the entire process is lost, leaving a very narrow jaw and a small roof to the mouth. (See B, Figs. 150 and 151.)

In the lower jaw the resorption of the two plates takes place more evenly. Usually they are resorbed in such a manner that a slight ridge is left between the places which they formerly occupied.

The Relations in Extreme Old Age. As a result, we find a twofold effect upon the relation of the jaws. As the resorption of the alveolar process goes on, the vertical distance between the body of the lower jaw and that of the upper is lessened, while the natural difference in their width is increased. The area of the upper jaw becomes smaller in proportion to that of the lower, the axes of the mandible extending further outward. In the endeavor to close the jaws under these circumstances, the lower is projected further forward as it rises to meet the upper, until, in extreme cases, it may pass absolutely outside of the upper. This is a frequent characteristic of the edentulous jaw in old age.

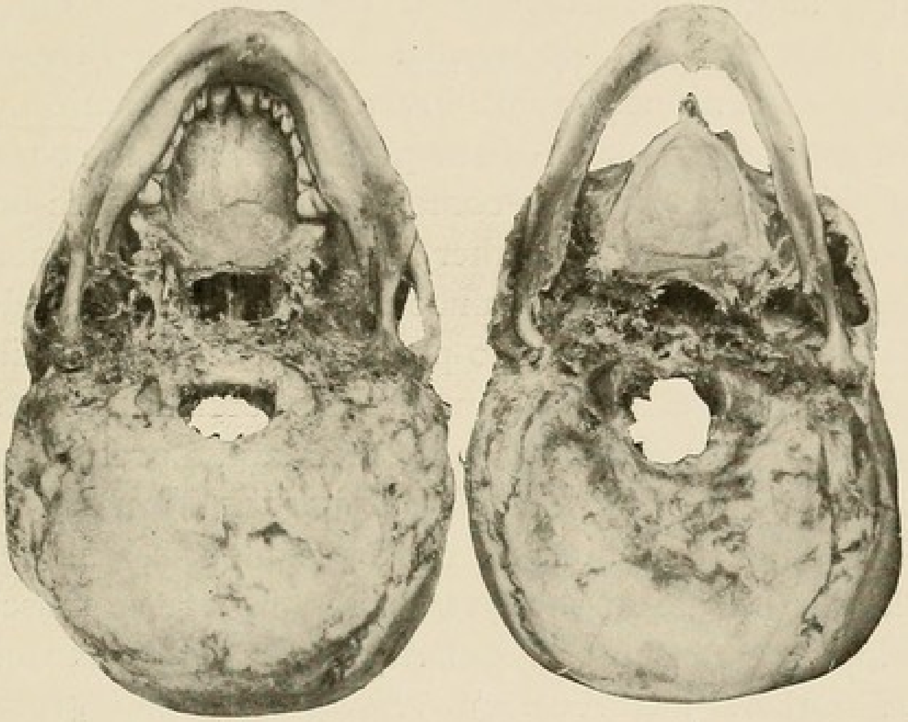
If properly fitting artificial dentures are placed in the mouth promptly after the loss of the natural teeth, the resorption of the alveolar process, and particularly the change in the angle of the jaw, will be retarded. Thus, if these teeth are replaced from time to time by dentures adjusted to the conditions as the processes recede, this characteristic change of old age will be overcome to a very considerable extent.

Fig. 150 is taken from two skulls of about the same shape and size. A is from an adult of about twenty-five years, having a full set of normally occluded teeth. The direction of the upper and lower teeth can be observed as described. B is from a person of seventy-five years or more, where all the teeth were lost and the alveolar process resorbed long before death, showing the upper and lower jaws in their normal shape and relations.

Fig. 151 is a side view of the same skulls shown in Fig. 150. It seems evident from these skulls, which are typical and not exceptional, that if the teeth be lost and the alveolar process resorbed after middle life, the upper and lower jaws cannot be again brought into occlusion through their alveolar borders.

Causes of Malformation of the Jaws. The normal action and reaction between the two jaws has been spoken of as pro-

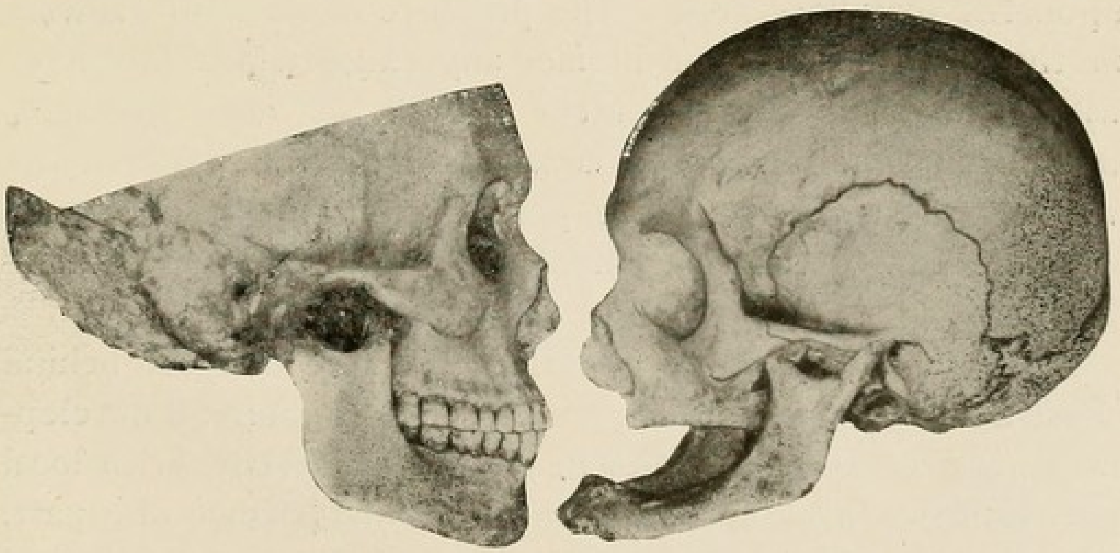
FIG. 150.



A B

Under view of two adult skulls. A from a subject about twenty years old, B from one well advanced in years.

FIG. 151.



A B

Side view of the two skulls shown in Fig. 150.

ducing irregularities in the shape of the arches, of the roof of the mouth, and in the position of the teeth. In general, it may be said that any cause which prevents the normal occlusion of the jaws, during either rest, speech, or mastication, will bring about malformation of these parts. Among the causes which prevent the normal bringing together of the jaws may be mentioned mouth-breathing, inflammation of the bone, of its periosteum or of the pericementum, or conditions causing pain when the teeth come in contact. Mouth-breathing should be corrected, whether it is caused by bony obstruction, hypertrophy of the mucous membrane, or adenoid growths in or about the naso-pharyngeal space. While the jaws are kept asunder the muscles in connection with the orbicularis oris are somewhat tightened, and a pressure which has a tendency to force the teeth inward is brought to bear upon the non-occluding teeth, causing malocclusion.

While this feature of the lateral pressure of the muscles of expression as a cause of irregularity in the upper dentures of mouth-breathers has received very general acceptance, it is, in the opinion of the writer, merely an incidental factor, and of far less etiological importance than the loss of the developing and molding influence which directly results from the percussive force of occlusion exerted by the mandible upon the maxillary arch. The presence of adenoid growths in the naso-pharynx, or in fact any cause which interferes with the normal closing of the mouth, at once interferes with occlusion, which, in view of more recent studies, the writer regards as the most potent factor in the normal development of the relation of the upper to the lower dentures.

It is, of course, to be understood that the factor behind these anatomical variations, leading to asymmetrical development, is necessarily nutritional. Some interference with local nutrition has brought about functional disturbance of a part, and this, in turn, a corresponding modification of anatomical form.

The writer trusts that the data which are embodied in this work will not be regarded as exhaustive of the subject, but rather as an indication of the magnitude of the field to be studied, and more particularly as suggestive of the rational method by which the subject should be studied,—viz., by actual dissection of anatomical specimens.

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