IV.

THE SUPERIOR MAXILLA—A DISCUSSION OF ITS PROPER DEVELOPMENT.*

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In preparing a paper on this subject at this time an apology is hardly necessary for reiteration of matter frequently before you in the current literature, because it is one of great importance, not only to those devoting their time to special work, but to the general practitioner, and, from certain points of view, to him rather more particularly.

It goes without saying, almost, that the configuration and development of these bones have features of import as great, if not greater, than any other of the bones of the body, because upon their proper evolution are dependent proper respiration, primarily, and, secondarily, nutrition, through digestion. It will not, then, if this be true, be much loss of time to recall to mind the anatomy of these bones and the functional purposes with which they are in relation.

Gray states that the superior maxillæ are the most important bones of the face on account of some of the diseases to which their parts are liable, and that "they are the largest bones of the face, except the inferior maxilla as a whole."

Each bone assists in the formation of three cavities: the roof of the mouth, the floor and outer wall of the nose, and the floor of the orbit; and also enters into the formation of two fossæ: the zygomatic and sphenomaxillary.

The body of the bone, hollowed in its interior, forming the antrum of Highmore, presents four surfaces, each of which contains certain structures of more or less interest to the purpose of this paper:

The external or facial surface shows: Eminences corre-

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sponding to the position of the teeth. Various fossæ, giving points of origin to facial muscles. Infraorbital foramen, the terminus of infraorbital canal.

The posterior or zygomatic surface presents: Several apertures leading to the posterior dental canals. A groove running obliquely downward and backward, forming, when articulated with the palate bone, a part of the posterior palatine canal.

The superior or orbital surface forms part of the floor of the orbit. Along the middle line of the orbital surface is a deep groove, the infraorbital, for the passage of the infraorbital vessels and nerve. This groove is sometimes covered so as to form a canal in its entire length. This canal subdivides into two branches, one of which terminates in the infraorbital foramen; the other, which is smaller, runs downward in the substance of the anterior wall of the antrum; it is the anterior dental canal and transmits the anterior dental vessels and nerves to the front teeth of the upper jaw. From the back part of the infraorbital canal a second small canal is sometimes given off which runs to the outer wall of the antrum and conveys the middle dental nerve to the bicuspid.

The internal surface. Behind the aperture leading into the maxillary antrum is a rough surface articulating with the perpendicular plate of the palate bone; it is traversed by a groove which, commencing near the middle of the posterior border, runs downward and forward, and when articulated with the palate bone forms the posterior palatine canal.

As the purpose of this paper is concerned chiefly in the effects of faulty development of the superior maxillæ, many points in the anatomic description have been omitted, attention being directed to the canals present therein. These are, to repeat:

Infraorbital vessels and nerve.

Infraorbital canal, terminating in the infraorbital foramen.

Canal for the middle superior dental nerve.

Canal for the anterior superior dental nerve.

Canal for the posterior dental nerves.

The posterior palatine canals, one large and several accessory.

The anterior palatine canals.

The nerves transmitted by these canals are:

The infraorbital canal transmits the superior maxillary division of the fifth nerve; in the canal, the middle and anterior superior dental branches are given off, which, as we have seen, traverse special canals in the substance of the bone to reach their points of distribution.

The middle superior dental branch is given off in the back part of the infraorbital canal and runs downward and forward in a special canal in the outer wall of the antrum to supply the bicuspid teeth. It communicates with the posterior and anterior dental branches, and at points of communication are thickenings, ganglionic in character.

The anterior superior dental nerve, of large size, is given off just before the exit of the nerve from the infraorbital foramen. It enters a special canal in the anterior wall of the antrum and divides into a series of branches, which supply the incisor and canine teeth; and a nasal branch which, passing through a minute canal, enters the nasal fossæ, supplying the mucous membrane of the forepart of the inferior meatus and floor of this cavity, communicating with the nasal branches from Meckel's ganglion.

The posterior superior dental branches arise from the trunk of the nerve just as it is about to enter the infraorbital canal, pass downward and enter the posterior dental canals on the zygomatic surface of the maxilla, communicating with the middle dental nerve and giving off branches to the lining membrane of the antrum and to each of the molar teeth.

The posterior palatine canals, for there is one large and several smaller, accessory canals, transmit the descending or palatine branches of distribution of the sphenopalatine ganglion. These branches are:

The anterior, or large palatine nerve, supplying the gums, mucous membrane and glands of the hard palate, the inferior turbinates and the middle and inferior meatus of both surfaces of the soft palate.

The middle palatine, supplying the uvula, tonsil and soft palate.

The posterior palatine, supplying the uvula, tonsil and soft palate, also, probably, the levator palati and azygos uvulæ muscles.

The nerves transmitted by these canals possess varying functions. Coming as they do from the Gasserian and Meck-

el's ganglions, they exercise sensory, vasomotor and trophic control, and, possibly through communication with the Vidian nerve, motor control.

Through one of the roots of the fifth nerve come the secretory nerves of the mucous glands of the entire nasal mucous membrane, as is proven by stimulating the trigeminus and producing secretion, while section diminishes it with consequent atrophic degeneration of the mucous membrane.

The vasomotor effects, so prominent in the symptomatology of diseases of the nasal mucosa, are derived through fibers coming to the Gasserian and Meckel's ganglia from the carotid plexus. The sensory function through the trigeminus proper and from the Vidian nerve, motor function to the levator palati and azygos uvulæ.

Let us now turn to the development of the maxilla and consider its ratio of development in relation to the other facial bones. Piersol states, concerning the superior maxilla, that "All the bones of the face except the lower jaw and the hyoid touch the superior maxilla. It has been described as the key to the architecture of the face. The palate bone both completes the palate and lies between this bone and the pterygoids, closing the posterior part of the opening into the antrum. The malar, joining the process of that name, makes the prominence of the cheek and helps to bound the orbit. The lacrimals and ethmoid touch the inner side of the orbital plate, and the ethmoid the inner surface of the nasal process. The frontal rests on the nasal process, and the inferior turbinate rests on the inner surface of the maxilla, and the vomer on the crest made by the union of the palate processes."

With such a relational situation it can be at once seen that the development of this bone is of the greatest importance. Its rapidity of growth in fetal life is far greater than the surrounding structures. It develops from four centers, which are deposited in membrane:

1. One which forms that part of the bone lying internal to the infraorbital canal, and includes the floor of the orbit, the outer wall of the nasal fossæ and the nasal process.
2. One which forms that portion lying external to the infraorbital canal and the malar process.
3. One which forms the palatal process posterior to Stenson's canal, and the adjoining nasal wall.

4. One which forms the front part of the alveolus and corresponds to the premaxilla of lower animals.

Of these, the third, forming the palatine process, is the largest and most important, producing as it does the major portion of the bone, and is directly concerned in the formation of the nasal chambers.

In a recent article by Hartz on the physiology and development of the nose, he states that the head and face grow more rapidly in two periods. The first is from birth to the eighth year. The second begins at puberty, when the head and face develop in all directions alike, and is completed about the age of twenty-one.

In the child the development occupies several stages. In intrauterine life the development of the head is far in excess of the face; during the first year the development of both head and face is nearly alike, though the face gains distinctively, especially in the lower portion of the nasal chambers. This is due to a downward and outward growth of the superior maxilla. From the second to the fifth year there is a distinctive gain in rapidity of the face over the head; the face becomes wider and the upper jaw more prominent. From the fifth to the seventh year there is further increase in facial development, the face becoming longer. With this development there are consequent alterations in the size and shape of the nasal cavities. At birth a line projected backward from the palatal process of the maxilla would intersect the junction of the sphenoid with the basilar process of the occipital. At three years this point of intersection would be about the middle of the basilar process, and at seven it would be about level with the edge of the foramen magnum. With this lengthening of the nasal chamber there is an accompanying lateral growth.

It is seen that these changes are a part of the early life of the child; that this stage of life is probably of greater importance than any other, because, unfortunately, there arise in this period causes which retard or arrest this development and thereby materially alter the shape, and, necessarily, the relational position, of the maxilla.

In making this latter statement it must be borne in mind that there are many who believe that deformities or retardation of development of the superior maxilla are due to the

peculiar type of skull. Siebenmann, Fraenkel, Haag and other German writers have expressed the opinion that the high arched and V-shaped type of alveolar arches depend on the type of the skull. The normal type is broad, with wide nasal cavities and dome shaped palate. The abnormal type has a high, narrow face, narrow nasal cavities and V-shaped alveolar arch.

It is not the purpose of this paper to discuss this question. Much can be said pro and con. Personally, I am of the opinion that nature never intended to promote a type which would so develop as to cause restriction of respiration, the most vital of all functions. I believe there is but one normal type, as above referred to, the wide nasal cavity, broad alveolar arch and dome shaped palate.

In studying a series of casts of the infantile pharynx, Braislin states that "In the newborn, shallowness of the nasopharynx is due to the undeveloped state of the bones of the cranium, face, and cervical vertebræ, chiefly the pterygoid processes of the sphenoid, the palate bones, the palate processes of the superior maxilla and of the vomer. * * * As age advances the growth of the bones of the cranium and face is very rapid, the vault of the nasopharynx becoming higher."

In considering the relationship of the maxillæ to surrounding structures it can be seen that certain forces might operate to retard the growth of the maxillæ while not affecting the bones with which they are united. I refer to the action of the facial muscles and of the tongue. We can see the possibility, therefore, of asymmetrical development, both as regards the maxillæ to their neighbors and to each other.

Cryer has made a great many dissections of skulls and studied the internal anatomy of the face, and his work has been of great value to rhinology. In reference to asymmetry he makes the following statement:

"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 lacrimal, 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."

With these facts in mind the importance of closely watching the growing child cannot be overestimated. Every factor tending to restrict development should be met and removed. Hypertrophied adenoids and tonsils are the chief factors for which our services are asked. Unfortunately it is the rule, at least in my experience, that the children brought to us for correction are, in the great majority of cases, from five years upwards. The children operated under this age are certainly fewer. It is still the impression among the laity, and with a great many general practitioners, that the child will outgrow these causes for his obstructed respiration. Possibly this is so, but in the meantime what is the result? These very imperfections of development which we all have seen and do see day after day.

It has been stated before that the most rapid period of growth is from birth to the fifth year. At this time development goes on with great rapidity, and it is during this time that any restriction of growth in one portion of the growing maxilla can produce effects which so alter the shape of the bone as to materially affect its relations and functions. Respiration, through narrowing of the nasal chambers, and mastication, through malocclusion of the teeth, are so interfered with as to cause serious impairment of the general health, and it is because of these effects that these cases are brought to us. There is another feature, however, not so generally recognized or considered, to which it is desired to bring attention.

In discussing the anatomy of the maxilla, particular mention was made of the canals, transmitting nerves, which passed through the substance of the bone or were formed by apposition with a contiguous bone. In normal development it is fair to presume that the lumen of these canals is free and unobstructed. In faulty development, however, variation in the course and size of the canal presumably occurs, with the possibility of stenosis and pressure upon the contents.

The hypersensitive nasal mucosa is almost the rule rather than the exception. We remove spurs, resect septa, reduce or remove turbinates and do various operative and treatment work on this region, in the great majority of cases, with ben-

eft; in some, however, with failure to relieve symptoms, and when failure does occur, is it not the experience of each of you that it is in the narrow type of nasal chamber that our usual procedures do not help?

We see many children in which widening of the face has not taken place because of failure of development of the palatal processes of the maxilla. As a rule, these children present the usual history of being weak physically, and frequently so mentally, and preeminently nervous and irritable. They are poor sleepers and show all the signs of irritable nervous systems. Repeated examinations may fail to show any particular cause. Adenoids may have been present and removed and the improvement that was expected has not taken place. Is it not logical to assume that this nervous irritability may be a reflex from a crowded nerve in a stenosed canal? Crowding of a nerve in a restricted or stenosed canal certainly should alter or impair its function, or by irritation lead to reflex phenomena. In an article on the effect of maxillary readjustment, Brown of Milwaukee says:

"Especially among growing children treated by this method has there been marked physical improvement, tendency to growth in height as well as general development and increase in weight. Many of these had been unable to attend school regularly because of tendency to nose, throat and bronchial affections. Nervousness was almost invariably greatly relieved, and this, it is believed, for two reasons: First, the well understood results from the improvement in breathing apparatus, with general healthfulness to be expected from better aeration and freedom from diseased nasal secretions, and, second, the relief from that condition to which Kiernan has called attention, caused by crowding together of the dental arches, with tendency to nerve irritation. This condition quite frequently manifests itself, not only in increased nervousness of a general character, but also in the development of neurotic tendencies leading to chorea, epilepsy and other similar affections, which, in some instances at least, might perhaps have been averted if these patients could have been tided over critical periods in their development."

Also, in a report of the Murray Hill School, a very interesting case is cited wherein the extraction of teeth, permitting readjustment and relieving irritation by crowding, produced

a remarkable change in the mental and physical condition of the subject. It is of such interest that I quote it in full.

Report of Miss Rowley, Murray Hill School, February 8, 1911:

In 1909 Carrie Mangino, 12 years old, a pupil of the Murray Hill school, was classed special four grade. She wore glasses to correct crosseyedness. Her manner in school was that of a nervous child. Her work and progress were hindered by some great strain. But there were glimpses of hope to tell the teacher that the girl had a good quality of mind, and that she could advance if some physical relief were given. October 18, 1910, Dr. Barnes examined her teeth. For six weeks thereafter her teeth were treated, and finally four teeth were extracted to relieve the impacted teeth. The week following December 17th, the time of extraction, a change in the girl's appearance is noticeable. Her eyes are straightened. In her own words, "I can now see things straight in front." Her nervous manner is gone. January 10th, she seems to be let down from some great strain or tension. January 17th, improvement in her lessons begins to show. She writes better. Her reasoning power is stronger. She has never read well enough to grasp the thought of a story; she does it now readily. Last year she was a poor, little, backward child to teach. This year the physical relief has made her a bright, animated, hopeful girl."

I also wish to cite a case of my own which has a like application to the point of view herein presented.

J. H., male, age five years, was brought to me for examination. He was a mouth breather, with all the attending symptoms, was excessively nervous, under size and poorly nourished. The lower border of the septum was partially deflected into the right nasal chamber, almost sufficiently so to obstruct respiration. His nasopharynx was filled with adenoids and the tonsils enlarged. There was marked arrest of development of the superior maxilla, as shown by the alveolar arch, the teeth being crowded and the bite very imperfect. I have a photograph showing this, kindly loaned me by Dr. C. A. Hawley, orthodontist, to whom he was referred.

The adenoids and tonsils were removed with some improvement in respiration, but not up to the normal standard. After a period of several months he was sent to Dr. C. A. Hawley, orthodontist, for readjustment. About two months later I

saw him again and the change was most marked; almost one-fourth of an inch space had been made between the central incisors. The respiration was wholly nasal, the nervous symptoms had disappeared and he had gained in weight and general appearance much improved. The septal deflection had disappeared.

In this instance the improvement in nasal respiration, so marked after adenectomy when there is more complete lateral growth of the maxilla, was not sufficient to give the relief which is usually looked for. The septal deflection, coupled with a narrow nasal chamber, still caused restricted nasal breathing. After a widening appliance had been used there was a very appreciable increase in the intranasal space with normal nasal respiration. But even with this the marked change in the nervousness was more than could be attributed to the respiratory improvement. With this there was, of course, improvement in the dental occlusion, which showed its effect by improvement in digestion. And yet, in spite of all this, I am of the belief that there was relief from reflex nervous irritability and that it was brought about by bringing to a more normal condition the paths through which the nerves of the nasal mucosa reach their region of distribution.

An hypothesis of this character would answer certain questions. We have seen at times, for instance, certain cases of atrophic rhinitis for which no adequate explanation as to cause could be given, except, possibly, heredity through some degenerate ancestor. It is more logical, however, to assume that if the trophic fibers which regulate the nourishment of the mucous membrane are inhibited in their function, we have thereby a cause rather than an indefinite empiricism which, by following its own law of practice, gives us no results.

This proposition also answers certain questions relative to cases of excessive irritability of the nasal mucous membrane that apparently resist those methods of treatment that in most cases materially benefit the patient; for it is also logical to assume that partial pressure upon a nerve may keep it in a state of chronic irritation.

When we look into the importance of the proper development of the maxillæ, however, when we realize that by reason of improper development so much harm may be done, it seems to me that the lesson of greatest importance to be learned is that of watchfulness of the growing child, to see that these

imperfections do not arise, and that if they should appear, to take immediate steps for their correction. It has been often pointed out that hypertrophy of the lymphatic ring around the nasopharynx is the chief factor that retards development; it must be especially impressed upon you that these causes should be removed in the early life of the child; the greatest mistake occurs in saying that these causes will disappear as the child grows older. It is true that they may, but it is also just as true that the damage has been done, and done to structures that are much more difficult to restore than the offending cause is to remove.

In the study of the maxillæ from this viewpoint, the following conclusions are reached:

1. That normal nasal respiration is only attained through proper lateral development of the maxillæ, i. e., the palatal processes.

2. That this development is materially retarded by those factors which prevent nasal respiration.

3. That in this abnormal development the shape of these bones may be materially altered, thus affecting their relations to contiguous structures.

4. That in this changed relation and altered shape we have factors for changing the direction and the lumen of the nerve canals traversing these bones, thereby making pressure upon their contents and causing alteration of function or, from irritability, reflex phenomena.

5. That no child is too young from which to remove causes for restricted nasal respiration.

6. That when abnormal development has occurred, readjustment of the maxillæ probably offers the best results that we can look for.

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