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On the Vomer in Man and the Mammalia, and on the Sphenoidal Spongy Bones. By JOHN CLELAND, M.D., Demonstrator of Anatomy in the University of Edinburgh.

The remarks which I am about to make will be confined as much as possible to matters of observation. I shall resist the temptation to enter on the question of the constitution of the vomerine segment of the skull, although it is one on which the statements to be made have an important bearing; I shall content myself with exhibiting the relations of this bone in different mammalia, and, founding upon these and on development, shall show how the vomer in man corresponds in its relations to those of other animals, and what is the nature of the sphenoidal spongy bones.

Last autumn, while disarticulating the skull of a lamb, it came prominently under my notice that the central plate of the sphenoid bone adhered without marks of separation to the presphenoid, while the lateral masses of the ethmoid and the vomer formed one other single piece. On further examination I found that in mammalian skulls the formation of one piece by the vomer and lateral masses of the ethmoid was the general rule, and their separation a rare exception. This is a circumstance so easily seen that one would think it could hardly escape the notice of any one in the habit of disarticulating mammalian skulls, yet I can find no description of it by authorities on human and comparative anatomy. It is, however, as we shall see, the most important of all the connections of the vomer, and throws some valuable light on human anatomy. With respect to the other articulations of the vomer, we shall see, that that with the central plate of the ethmoid is by no means a primary one, and that the most constant of those of its inferior margin is that with the intermaxillary bones.

In the *ruminantia* it is a well-developed elongated bone. Let us take that of the lamb as an example. It consists principally of two laminæ united inferiorly so as to form a groove; deepest posteriorly where the laminæ are most developed, and shallowing away to a scooped extremity in front. In this groove lies the cartilaginous septum of the nose, which is continuous behind with the presphenoid bone. The posterior extremity of the vomer is bifid and slightly dilated, as it is in man, and in front of the dilatation the lines of margin begin to approach, and seem as if they would pass directly forwards; but they are almost immediately lost as fissures in two lateral expansions, which, springing from the vomerine laminæ, pass outwards to the outer and back part of the ethmoid, and are continuous with the principal arches of the framework of that bone. On the upper aspect there is a sharp angle between the laminæ that lie against the cartilaginous septum and their lateral expansions, and the former are prolonged in many animals beyond the angle. Where the ethmoid is joined by the ethmo-vomerine lamina—for so we shall call the expansion just described—it forms the upper part of the nasal foramen of the palate bone, in human anatomy called the spheno-palatine foramen. In the lamb there is not much development of the vomer as a mesial plate below the level of the groove. It articulates inferiorly by a rough sutured edge with the superior maxillary bones, and in front of that its scooped anterior extremity lies for about an eighth of an inch or so on the groove formed by the mesial processes of the intermaxillary bones—the universal method of articulation of the mammalian vomer with the intermaxillary bones (fig. 1).

The vomer of the *cat* is proportionally less elongated than that of the sheep, but like it has little development of the mesial plate beneath the vomerine groove. It articulates by a rough surface with the superior maxillary and palate bones, but with the intermaxillary bones by an elongation forward upon them of the laminæ which bound the groove. These laminæ are connected towards their back part with the lateral masses of the ethmoid, exactly as is the case in the sheep; and at the point where the vomer passes into the ethmoid, the latter presents a minute orbital surface, which lies between

the two ascending processes of the palate bone, and completes by a point in its inferior margin the almost perfect nasal foramen of that bone. The sphenoid process of the palate-bone lies between the ethmo-vomerine laminæ and the pterygoid bone. The central plate of the ethmoid does not at all touch the vomer in early life, but the cartilaginous septum of the nose passes back beneath it to the presphenoid bone.

It may be mentioned at once that the nasal foramen of the palate bone is completed by the ethmoid in all the animals examined.

The relations of the vomer in the *fox* and the *pig* are the same as in the cat. In the case of the *hedgehog*, as in the sheep, it does not articulate with the palate bones. In the *horse* also it does not articulate with the palate bones. But the superior connections of the vomer in the horse are peculiar, inasmuch as the inferior surface of the leaflets of the ethmoid, instead of lying in contact, as is usual, with the ethmo-vomerine lamina for a considerable extent, is completely floored in by the upper part of the palate bone, which is expanded for that purpose. Even in the horse, however, a slender lamina, immediately in front of the palate bone, and in contact with its nasal foramen, passes downwards and inwards on each side from the framework of the ethmoidal turbinations to the margin of the vomer; but the vomer and it are not anchylosed until other sutures also have begun to be obliterated.

The vomer in the *rodentia* is remarkable in having very little tendency to come in contact with the superior maxillaries. As far as I have observed, it is always continuous with the lateral masses of the ethmoid.

In the skull of the *rabbit* there is only one great anterior palatine foramen; for, although the mesial processes of the intermaxillaries project well backwards, the palate plates of the superior maxillaries do not come far enough forwards to meet them. The vomer does not at all approach the superior maxillaries; its posterior margin terminates inferiorly in a thickened angle, which articulates with the intermaxillaries in such a manner as to make their inferior aspect continuous with the posterior margin of the vomer. In front of this, the laminæ bounding its groove are prolonged on the upper

surface of the intermaxillaries, as we have seen in other animals (fig. 4).

In the *porcupine* and *squirrel* the vomer is not in contact with the superior maxillary bones; in the *rat* and the *beaver* it is.

In the *quadrumana* the mesial process of the intermaxillaries is so slightly developed that the anterior extremity of the vomer frequently falls short of it by a slight interval. In monkeys the vomer and orbital plates of the ethmoid are continuous; but in the skull of a young *Chimpanzee* in the University Museum, the arch of bone which unites them is separated at one extremity from the ethmoid by a suture, and at the other only touches the vomer. This piece of bone has all the essential characters of the sphenoidal spongy bones of the human subject.

The vomer and sphenoidal spongy bones in man.—Having found the vomer and lateral masses of the ethmoid so universally connected, we naturally inquire how they are related in man. They are not in contact. Their only connection is that the expanded portion of the vomer which grasps the rostrum lies beneath the sphenoidal spongy bones, and that these articulate with the lateral masses of the ethmoid. Now, seeing that the sphenoidal spongy bones are recognised as ossifications distinct from the sphenoid, I think we have already sufficient evidence to prove that they represent the ethmo-vomerine laminæ, by aid of what we have noticed in the Chimpanzee's skull; for it is impossible to doubt either that the distinct bone which lies between the orbital plates of the ethmoid and the vomer in that skull corresponds to the ethmo-vomerine lamina of other monkeys; or, on the other hand, that it corresponds to the sphenoidal spongy bone in man. But the correspondence becomes much more distinct when we study the early condition of the sphenoidal spongy bones. The most interesting condition of these bones is when, in the skulls of young children, they can be got completely ossified and not yet destroyed by amalgamation with the neighbouring bones. In this state the sphenoidal spongy bone is somewhat of the shape of a hollow pyramid with the apex directed backwards, its inner aspect parallel to its fellow,

and its cavity (the first form of the sphenoidal sinus) opening at its base into the nasal cavity in front (fig. 2). This pyramid is constructed by the union of at least three distinct pieces of bone. Firstly, there is an orbital piece, forming a portion of the wall of the orbit between the ethmoid and sphenoid, an element, I believe, in the formation of the orbital wall not hitherto observed. It articulates with the orbital process of the palate bone, and, together with the inferior piece, completes the nasal foramen of the palate-bone, namely, the foramen called spheno-palatine, but which we have seen to be invariably ethmo-palatine in other animals. The superior piece bounds the sphenoidal sinus above and on the inside, and ultimately becomes incorporated with the sphenoid bone. The inferior piece is the largest of the three; it forms the floor of the sphenoidal sinus, and the under half of its opening in front, and includes the greater part of what has hitherto been recognised, and described under the various names, sphenoidal spongy bone, sphenoidal cornu, and bone of Bertin. Its inner margin is joined by the superior piece at an acute angle, and is prolonged downwards and forwards so as to lie edge to edge with the corresponding lamina of the vomer, immediately in front of the thick dilated part of that bone. Beneath and behind is the sphenoidal process of the palate-bone, and behind that is the internal pterygoid process. In man, therefore, as in other mammalia, we find three processes in succession from behind forwards, viz., the pterygoid bone, the sphenoidal process of the palate-bone, and an arch passing from the ethmoid to the vomer, adapted to it edge to edge; and moreover, this arch completes the foramen which divides the ascending part of the palate-bone. It in every respect, therefore, corresponds with the ethmo-vomerine lamina. The reason why the arch formed by the vomer and ethmoid is broken up in the human subject into so many separate pieces is to be sought in the characteristic peculiarities of the human subject, particularly in the very slight development of the organ of smell, and the rapid curvature of the cranio-facial arch. But on this subject I hope to speak more fully on some future opportunity. The inferior edges of the sphenoidal spongy bones, which in childhood lie edge to edge with the

vomer, are in the adult state smoothed down to a mere ridge, and considerably separated from the middle line by the expansion of the sphenoidal sinuses.

We have now seen that the relations of the vomer to the lateral masses of the ethmoid in the human subject are essentially the same as in the mammalia generally. In early life the human vomer resembles those of other mammals in form likewise, and seems to be connected in the same manner with the intermaxillary bones. In the skulls of fœtuses and young children the vomer mainly consists of two laminæ extending upwards on the sides of the cartilaginous septum of the nose. The inferior edge exhibits a flat surface with a raphe in the middle line, which articulates with the superior maxillaries proper, *i. e.*, with the part behind the anterior palatine foramen; and which narrows to an edge behind, where it comes in contact with the palate-bones. But this surface ceases abruptly in front, and only the lamina bounding the groove for the cartilage is prolonged on the intermaxillary part of the palate (fig. 3). In the adult state both the scooped projection lying on the intermaxillaries, and the remains of the surface for articulation with the superior maxillaries, can be seen, when the vomer still admits of being accurately disarticulated. But this is not often, as it soon becomes anchylosed with the neighbouring bones; and even when this has not happened, it requires that portions of the other bones be sacrificed for the sake of removing it entire. As the face elongates, the upper part of the vomer undergoes much alteration; not only is there a considerable development of lamina in the mesial plane beneath the groove, but usually the laminæ bounding the groove deviate from the mesial line, and one of them becomes more developed than the other, and is more extensively anchylosed with the central plate of the ethmoid, which, growing downwards, replaces the cartilage between them. In consequence of these changes taking place at a comparatively early period, the specimens which are sold with disarticulated skulls, and from which the descriptions in text-books are drawn up, are seldom complete, and have most frequently more or less of the central plate of the ethmoid adherent to them. Thus the vomer is described as exhibiting at its upper and back part a cul-de-sac for the

rostrum. Such a cul-de-sac is often seen, but the central plate of the ethmoid invariably enters into its formation, for it is only the ethmoid, and never the vomer in the slightest degree, which replaces the cartilaginous septum.

Explanation of Plate V.

Fig. 1. The vomer and lateral masses of the ethmoid of a lamb, seen from below. *a*, The inferior margin of the vomer, rough posteriorly, for articulation with the maxillaries, and smooth in front, where it comes in contact with the intermaxillaries; *b b*, the grooves which complete the nasal foraminæ of the palate bones. The spaces between the grooves and the margins of the vomer represent the ethmo-vomerine laminæ, and on the outer aspects of the grooves are the small orbital surfaces of the ethmoid.

Fig. 2. The vomer, ethmoid, sphenoidal spongy bones, and left palate and maxillary bones, from the skull of an infant; seen from behind (slightly enlarged). *a*, Orbital plate of the ethmoid; *b*, posterior extremity of the vomer; *c*, sphenoidal process of the palate bone; *d*, orbital surface of the palate bone, and immediately above it is the orbital portion of the sphenoidal spongy bone. Between the two processes of the palate bone is the spheno-palatine foramen, completed above by the inferior portion of the sphenoidal spongy bone. *e*, The superior portion of the sphenoidal spongy bone.

Fig. 3. Another view taken from the same specimen: *a*, *b*, *c*, The parts of the inferior margin of the vomer for articulation with the palate, maxillary, and intermaxillary bones respectively; *d*, inferior aspect of the sphenoidal spongy bone; *e*, orbital plate of the ethmoid seen in perspective; *f*, inferior turbinated process of the ethmoid.

Fig. 4. Illustrates the articulations of the vomer in the rabbit. Above are the vomer and ethmoid forming one bone. Beneath are the bones of the upper jaw of the left side, and a portion of the intermaxillary bone of the right side adhering to it. *a*, Anterior extremity of the vomer, grooved for the cartilaginous septum of the nose; *b*, the part of the vomer which articulates with *c*, the extremity of the expanded mesial processes of the intermaxillary bones, forming turbinations in connection with Jacobson's organ.

Fig. 1.

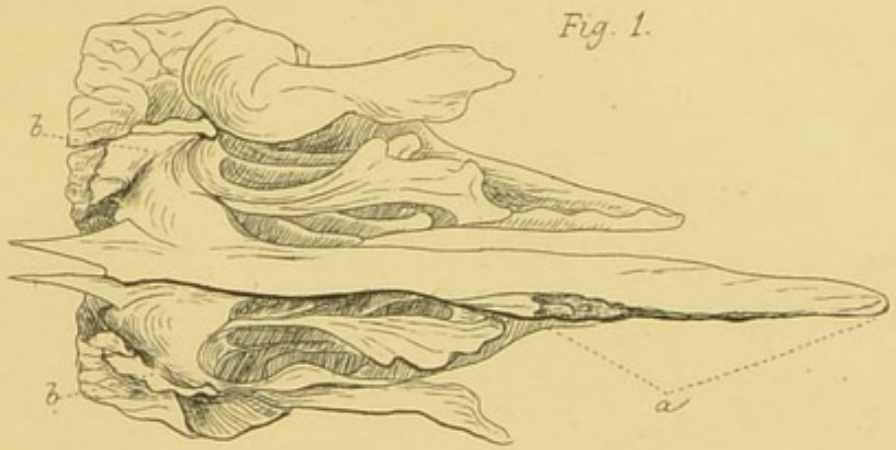

Fig. 2

Fig. 3.

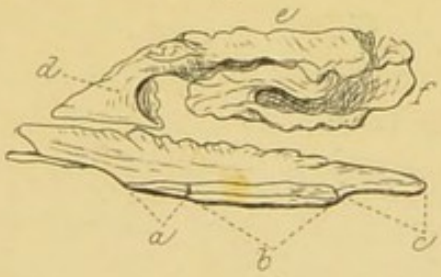

Fig. 4.