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Diseases of the Nose, Throat and Ear

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Diseases of the Nose, Throat and Ear

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The illustration on the cover is one of five tapestries entitled collectively "The Lady and the Unicorn." This example of the Lady and the Unicorn is traditionally thought to symbolize the sense of hearing. Other tapestries in the series represent taste, odor, touch and sight. They were woven between 1480 and 1500, but by whom and where is unknown. They now reside at the Musée de Cluny, Paris.

This tapestry depicts a Lady playing an organ while a young maidservant works at the bellows. Both the lion and the unicorn listen intently and function also as heraldic supporters. It may be that the tapestry was offered to Claude Le Viste, by Jean de Chabanne, as an engagement present.

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Preface

Continuing demand has afforded me the opportunity, which is a privilege and pleasure, to contribute, both as author and editor, to a new edition of *Diseases of the Nose, Throat and Ear*.

My desires for the 12th edition of this textbook are symbolized in the tapestry appearing on the cover. Though entitled *Hearing* it suggests the entire field of study of otorhinolaryngology. The text, it is hoped, is well woven and constructively and beautifully presented.

Personal investment in the 69-year history of this textbook has made it inevitable that I would make whatever sacrifices necessary to continue this tradition and to produce a work that was comprehensive, current, and accurate. I believe the present volume accomplishes this goal, and be it noted the weeks and months devoted to this end are untold and unregretted.

Having served in the dual capacity of contributing author myself, as well as the editor, I realize how indebted I am to the other twenty contributing authors who have

assisted me and thank them profusely for their excellent efforts. Of these contributors, twelve also wrote for the previous volume and eight are new to this one. Topics new to the 12th edition include cryosurgery, immunology and chemotherapy of head and neck neoplasms, and polytomography of the facial bones and paranasal sinuses. The subject matter of bronchoesophagology and reconstructive surgery of the head and neck has been completely rewritten. The entire book has been thoroughly revised.

I have been particularly pleased to note the wide distribution achieved by the 11th edition, produced in 1969, to Spanish speaking peoples through Editorial Jims of Barcelona; to India and England and other English speaking countries through Henry Kimpton of London; as well as to the United States and Canada through the admirable efforts of Lea & Febiger to whom I once again extend my gratitude. I have every hope that the present volume will be as well received and widely distributed.

Chicago, Illinois

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PART 1

THE NOSE AND ACCESSORY SINUSES

Chapter 1

The Clinical Anatomy and Physiology of the Nose and Accessory Sinuses

John J. Ballenger

The External Nose

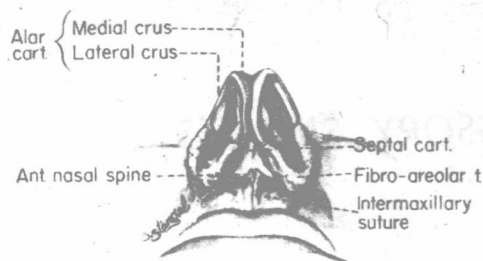
The more or less pointed tip of the nose is known as the apex. Extending superiorly and somewhat posteriorly from the apex is the dorsum, leading to the root of the nose where the dorsum merges with the forehead. The *membranous columella* extends from the apex posteriorly to the center of the lip and is located just distal to the cartilages of the nasal septum. The point where the columella strikes the lip is known as the base of the nose. The upper lip at this point bares a shallow, rounded trench, known as the *philtrum*, that stretches from above downward. On either side of the columella are the right and left anterior *nares* bounded laterosuperiorly by the *alae* of the nose and inferiorly by the floor.

The supporting framework of the external nose consists of the two nasal bones, the frontal process of the maxillary bones (*processus frontalis maxillae*), the upper lateral cartilage, the paired lower lateral (greater alar) cartilages, and the anterior (ventral) edge of the cartilaginous nasal septum (Fig. 1-1). The support of the nose is probably afforded primarily by the first four named structures. The upper lateral cartilages at their medial ends blend with the cartilaginous septum and at their cranial ends are firmly attached to the undersurface of the nasal bones and frontal processes.

The lower or caudal margins of the upper lateral cartilages lie under the upper or cranial margin of the lower lateral cartilages. On elevation of the lower lateral cartilage with a retractor, this margin, the *limen nasi*, of the upper lateral cartilage is visible. At times the opposing margins of the upper and lower lateral cartilages may not be adjacent at their medial extremities. In such a case, the support of the external nose is potentially less secure at this point. Between the upper and lower lateral cartilages laterally are found one or more sesamoid cartilages. The lower lateral cartilage has a horseshoe shape. The lateral crus of this is broad and strong and provides the framework of the ala of the nose. The medial portion is weak and extends partly along the free caudal edge of the cartilaginous septum and partly within the membranous columella.

In the bony skull the pear-shaped nasal opening is called the piriform aperture. The superior lateral margins are formed by the nasal bones and frontal processes of the maxilla. The base is formed by the alveolar process of the maxilla. In the midline of this last structure is a prominence called the anterior nasal spine.

The alar muscles consist of two sets, the dilators comprising the *dilator naris* (anterior and posterior), the *m. procerus*, and the *caput angulare* of the *quadratus labii*



Frontal process of max.
Nasal bone



FIG. 1-1. The external framework of the nose.

superioris; and the constrictors comprising the *m. nasalis* and the *depressor septi*.

The Nasal Septum

The septum divides the nose into two cavities or chambers, the right and the left. The septum (Fig. 1-2) is formed superiorly by the perpendicular plate of the ethmoid

bone; anteriorly by the septal (quadralateral) cartilage, premaxilla, and membranous columella; and inferiorly and posteriorly by the vomer, the maxillary crest, the palatine crest, and the sphenoidal crest.

The Nasal Chambers

The Floor. The floor of the nose is formed by the palatal process of the maxilla and the horizontal process of the palate bones.

The Roof. The roof from before backward is composed of the upper and lower lateral cartilages, the nasal bone, the nasal process of the frontal, the body of the ethmoid, and the body of the sphenoid bones. The lamina cribrosa or the cribriform plate of the ethmoid, which forms the major portion of the roof of the nose, transmits the filaments of the olfactory nerve as they descend from the undersurface of the olfactory bulb to their distribution in the mucous membrane covering the uppermost portion of the nasal septum down to and including the cranial surface of the superior turbinate.

The Lateral Wall. The lateral wall is formed by the inner surface of the frontal process of the maxilla, the lacrimal, the superior and middle nasal turbinates of the ethmoid bone, the inferior nasal turbinate, the perpendicular plate of the palate bone, and the medial pterygoid plate.

The Turbinates (Conchae). The nasal fossa is divided into three meatuses by the three turbinates (Fig. 1-3); the space situated between the inferior turbinate and the floor is called the inferior meatus, the space between the middle turbinate and the inferior turbinate is known as the middle meatus, and above the middle turbinate is the superior meatus. Occasionally a fourth turbinate (supreme turbinate) is observed. The supreme, superior, and middle turbinates originate from the lateral mass of the ethmoid bone. The inferior turbinate, a separate bone, is attached to the superior maxilla and to the palate.

The inferior turbinates are two elongated, shell-like laminae of bone, attached by their superior borders to the lateral wall of the nasal cavity on either side. They have curved borders separating a medial and a lateral

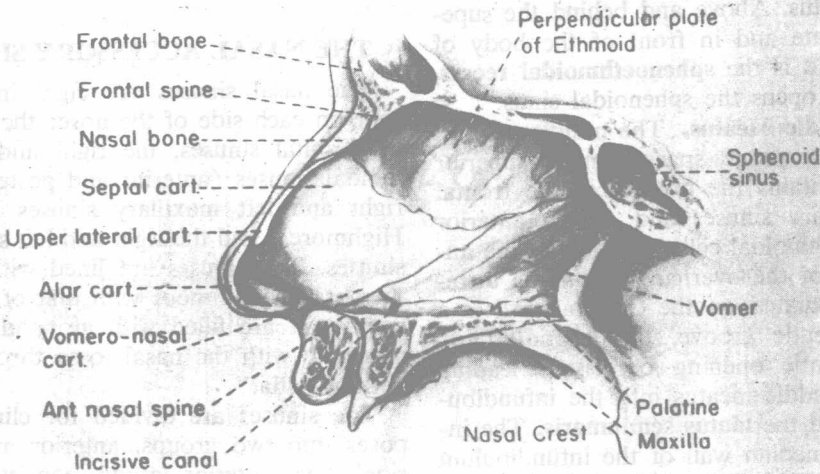


FIG. 1-2. The nasal septum denuded of its membrane.

surface. The inferior or free portion is curved from before backward and from above downward, with the convex surface facing the septum. The bone that forms the turbinate is deeply pitted and of somewhat cellular character, which gives a slightly rough and pitted appearance. The anterior and posterior extremities are somewhat pointed. The surface of the turbinate is per-

forated in numerous places by apertures through which the blood supply is transmitted. Longitudinal grooves or partial canals also help to distribute the large blood supply. The mucous membrane is thick, vascular, and adherent to the underlying perichondrium or periosteum.

Both the middle and inferior turbinates are covered with pseudostratified ciliated columnar epithelium, and the anterior tip of either the middle or the inferior turbinate in the adult may be replaced by low cuboidal or squamous cell epithelium. The stroma of the middle turbinate is characterized by the presence of many glands, whereas that of the inferior turbinate is characterized by many blood lakes. Glands, too, are found in the inferior concha but not to the extent they are in the middle. These blood lakes or venous plexuses constitute the erectile tissue of the nose and are distributed chiefly along the inferior border of the inferior turbinate and the posterior ends of both the middle and inferior turbinates.

The Superior Meatus. The superior meatus or ethmoid fissure is a narrow, slit-like space situated between the septum and the lateral mass of the ethmoid above the middle turbinate. The posterior group of

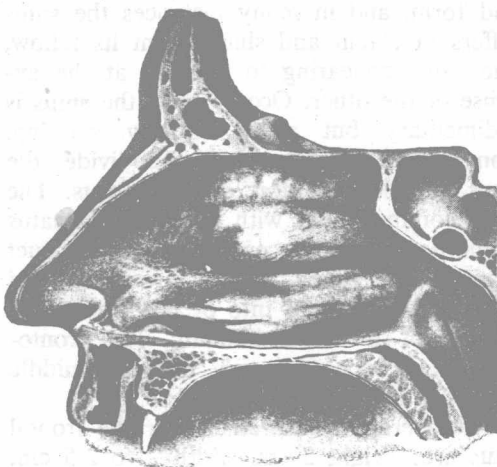


FIG. 1-3. The middle and inferior turbinates. The superior turbinate, which may be absent or rudimentary, is not shown.

ethmoidal cells drains by one or more orifices of variable size into the central portion of the meatus. Above and behind the superior turbinate and in front of the body of the sphenoid is the **sphenoethmoidal recess**, into which opens the sphenoidal sinus.

The Middle Meatus. The middle meatus, a much more roomy space than the superior meatus, contains the orifices of the frontal and maxillary sinuses and of the anterior group of ethmoidal cells. Hidden by the anterior half of the overhanging middle turbinate and situated on the external wall is a deep crescentic groove, the **infundibulum**. The crescentic opening or fissure leading from the middle meatus into the infundibulum is called the **hiatus semilunaris**. The inferior and median wall of the infundibulum forms a shelflike ledge known as the **uncinate process**. Above the infundibulum is a hemispherical prominence, the **ethmoid bulla**, formed by one of the ethmoidal cells.

The orifices of the frontal sinus, maxillary antrum, and anterior ethmoidal cells usually drain into the infundibulum. The frontal sinus and anterior ethmoidal cells usually drain into the anterior upper portion, and the maxillary sinus drains posteriorly to the frontal sinus. However, certain ethmoidal cells may have openings located above the ethmoid bulla, and the frontonasal duct sometimes has an independent orifice anterior to the infundibulum.

The Inferior Meatus. The inferior meatus, the largest of the three, contains the orifice of the nasolacrimal duct located on the lateral wall from 3 to 3.5 cm behind the posterior margin of the nostril.

The Nares. The posterior nares or choanae through which the nasal fossae and the nasopharynx communicate are oval-shaped apertures located one on each side of the nasal septum. Each opening is formed inferiorly by the horizontal plate of the palate bone, internally by the vomer, superiorly by the vaginal process of the sphenoid and the ala of the vomer, and externally by the medial pterygoid plate of the sphenoid.

The anterior nares provide communication of the nasal cavity with the outside. They are considerably smaller than the posterior nares or choanae, the latter being

about 2.5 cm in height and 1.25 cm in width.

THE NASAL ACCESSORY SINUSES

The nasal sinuses are eight in number, four on each side of the nose: the right and left frontal sinuses, the right and left ethmoidal sinuses (anterior and posterior), the right and left maxillary sinuses (antra of Highmore), and the right and left sphenoidal sinuses. The sinuses are lined with mucous membrane continuous with that of the nasal cavity; all are filled with air, and all communicate with the nasal fossa through their various ostia.

The sinuses are divided for clinical purposes into two groups, anterior and posterior. The anterior group consists of the frontal and maxillary sinuses and the anterior ethmoidal cells of the ethmoidal sinus. The posterior group is made up of the posterior ethmoidal cells and the sphenoidal sinus. The line of attachment of the middle turbinate to the lateral wall of the nose marks the division between the two. The anterior group drains below the middle turbinate into or near the infundibulum and the posterior group at several locations above the middle turbinate.

The Frontal Sinus

The frontal sinus varies greatly in size and form, and in many instances the sinus differs in extent and shape from its fellow, one sinus appearing to develop at the expense of the other. Occasionally the sinus is rudimentary but never entirely wanting. Bony septa may partially subdivide the sinus into one or more compartments. The sinus communicates with the middle meatus of the nose by means of the frontonasal duct (Fig. 1-4), which passes downward and backward and opens into or near the upper portion of the infundibulum. The frontonasal canal opens directly into the middle meatus in some instances.

The average measurements of the frontal sinus are: height 3 cm, width 2 to 2.5 cm, depth 1.5 to 2 cm, and average capacity 6 to 7 ml.

The anterior plate of the frontal sinus is almost always diploetic, especially in the re-

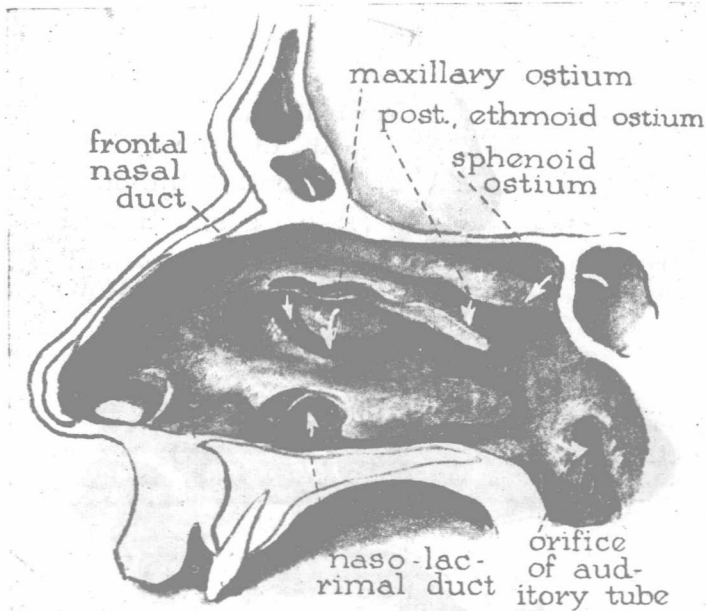


FIG. 1-4. Sagittal section through the nose. Portions of the middle and inferior turbinates have been removed to show various structures.

gions of the external or inferolateral angle and the superior sulcus where the anterior and posterior plates fuse.

The Ethmoidal Cells

The ethmoidal cells or labyrinth lies on either side just lateral to the superior one half or one third of the nasal cavity and medial to the bony orbit (Figs. 1-5 to 1-7). The ethmoid bone has a horizontal plate and a vertical plate that are at right angles to each other. The vertical plate has a superior portion called the *crista galli* and an inferior portion called the *perpendicular plate of the ethmoid*, a part of the nasal septum. The horizontal plate is comprised of a medial portion, the thin perforated *cribriform plate*, and a more lateral, thicker portion that forms the roof of the ethmoidal cells.

The cribriform plate is not covered by the ethmoidal cells but is freely exposed in the attic of the nose. While the bone is dense and not easily fractured by ordinary force exerted during an operation, its numerous openings render it a possible atrium for the conveyance of infection to the meninges, especially if the ethmoid is operated upon in

the presence of an acute upper respiratory infection. The outer wall of the ethmoidal sinus is the *os planum*, or *lamina papyracea*, of the ethmoid and the lacrimal bones. These plates of bone are extremely thin and form the inner wall of the orbital cavity. Should this plate of bone be perforated, orbital cellulitis, with protrusion of the eyeball, might result.

The ethmoidal cells, first seen in the fourth month of fetal life, are present in the newborn, developing in size with advancing years until puberty. In the adult the sinus is a series of pneumatic cells of variable size and number. Anterior ethmoidal cells not uncommonly encroach upon and narrow the nasofrontal duct. The volume of the two sinuses together is about 14 ml but may vary considerably from this figure. Two groups of cells may be differentiated: an anterior group, which drains into the middle meatus, and a posterior group, which drains into the superior meatus.

The anterior cells are separated from the posterior cells by a thin, transverse, bony partition. The attachment of the middle turbinate to the lateral wall of the nose also marks the line of division between the ante-

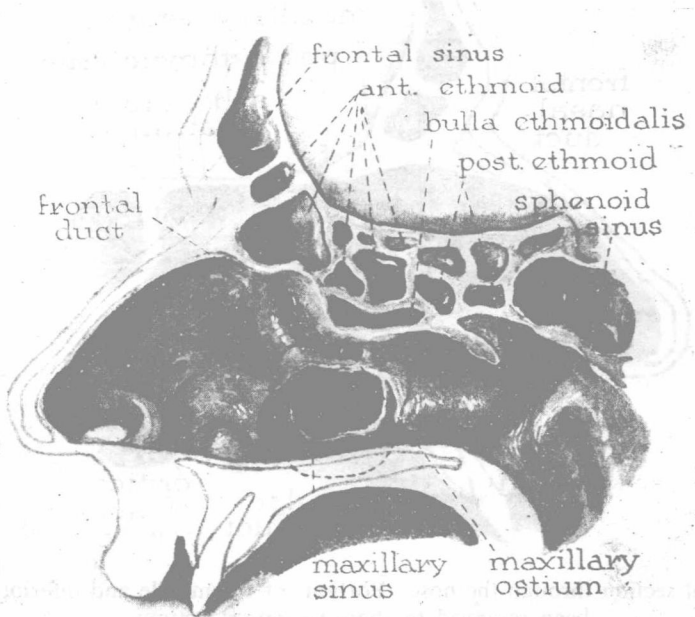


FIG. 1-5. Sagittal section through the ethmoidal labyrinth.

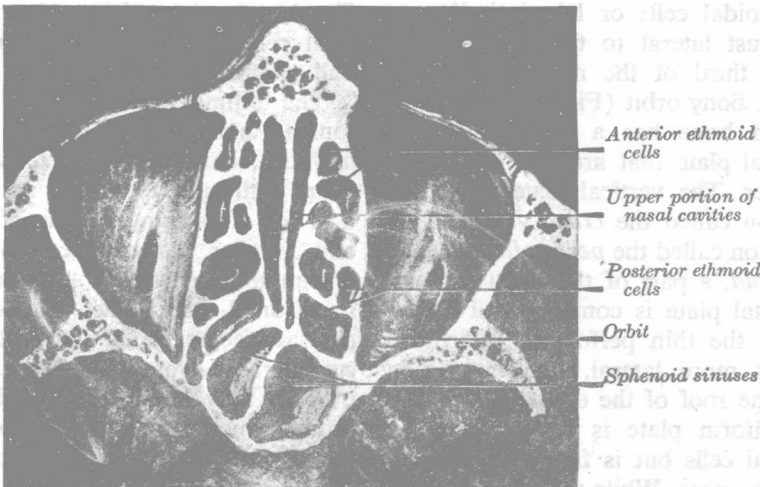


FIG. 1-6. Horizontal section through the ethmoidal labyrinth.

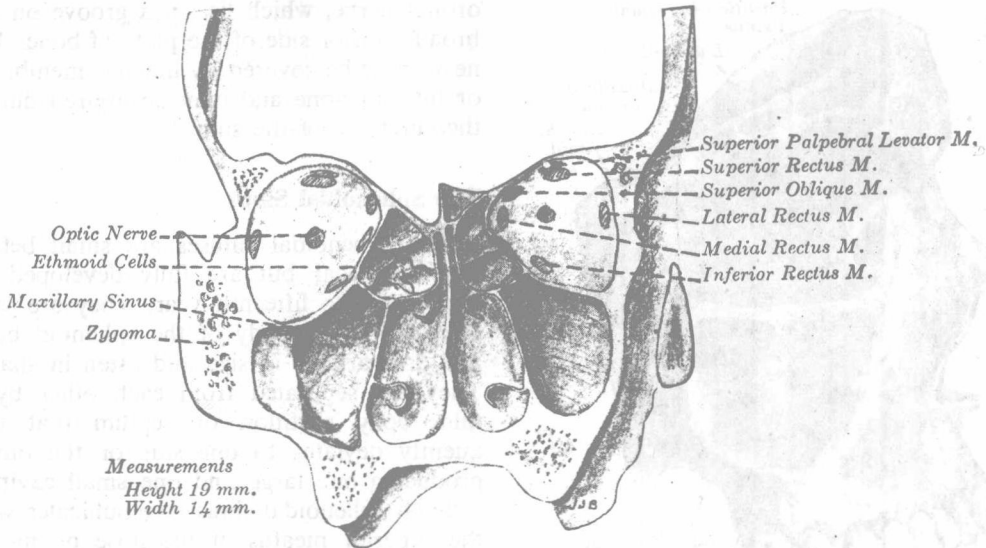


FIG. 1-7. Coronal section through the ethmoidal labyrinth.

rior and posterior groups of cells. The anterior cells lie in front of and below it, while the posterior cells lie above and behind it.

The two groups may be found to differ greatly in size when specimens are examined, but usually the posterior ethmoidal cells are fewer in number and larger in size than the anterior cells.

It is not uncommon to find cells beyond the confines of the ethmoidal sinus proper. The middle turbinate frequently is the site of a posterior ethmoidal cell, *concha bullosa*, whereas the anterior group frequently extends into the agger nasi and the uncinate process. Frontoethmoidal cells may encroach on the lumen of the frontal sinus, in which case they are termed the frontal bulla, or they may extend above the sinus to form supraorbital cells. Occasionally the body of the maxilla is the site of ethmoidal cells. Ethmoidal cells may also be found on the body of the sphenoid bone, with encroachment on the sphenoidal sinus.

The Maxillary Sinus

At birth the maxillary antrum occupies a small space to the inner side of the orbit. At first its floor is above the nasal floor, descending continually, until at 8 years it is on the same level. The subsequent develop-

ment is downward, its full shape being assumed after eruption of the permanent teeth. Maximum development is attained between the fifteenth and eighteenth years. The maxillary sinus, or the *antrum* of *Highmore*, the largest of the nasal accessory sinuses, is an irregularly shaped pyramid with its base presenting to the nasal fossa and its apex corresponding to the zygomatic process of the maxilla. Morris's Human Anatomy gives the following average dimensions for the newborn— $7-8 \times 4-6$ mm—and for the individual of 15 years— $31-32 \times 18-20 \times 19-20$ mm. In the adult the capacity of the sinus is approximately 15 ml.

The median wall or base of the antrum is formed by the vertical plate of the palate bone, the uncinate process of the ethmoid, the maxillary process of the inferior turbinate, and a small portion of the lacrimal bone (Fig. 1-8). The upper wall separates the cavity from the orbit. The posterior-inferior wall or floor is normally the thickest and is formed by the alveolar portion of the superior maxilla and by the outer part of the hard palate. The anterior wall corresponds with the canine fossa.

The antrum communicates with the infundibulum in the middle meatus by means of a small opening, the maxillary ostium, located in the upper and anterior part of the

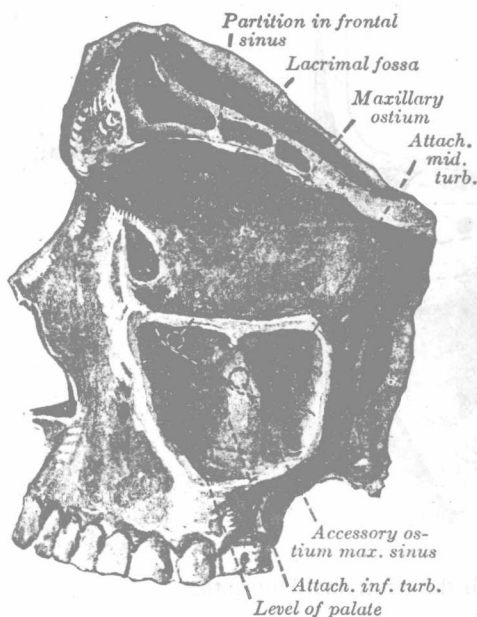


FIG. 1-8. Medial antral wall showing the relationship of the intranasal structures.

median sinus wall. The ostium is usually membranous. Thus the bony ostium is larger than the actual orifice, a fact that provides the rhinologist with an area of easy access for purposes of irrigation of the sinus. In a small percentage (10%) of cases, an additional opening (accessory ostium) is present, lying posterior to the major opening. In the majority of cases, the ostium is a canal of 3 mm or more in length. The accessory ostium is in almost all instances an orifice or true ostium. Most nerves and blood vessels enter the sinus by way of the ostium or the membranous portion of the nasoantral wall.

The second bicuspid and the first and second molar teeth are in close relation to the floor of the sinus. Indeed, they sometimes project into the bony cavity, being covered at times by mucous membrane only. A suppurative process around the root of either of these teeth might affect the mucous membrane of the sinus through the lymphatics and blood vessels, and removal of these teeth may create an opening into the sinus with resultant sinusitis.

The superior wall or roof of the sinus is crossed in its central portion by the infra-

orbital nerve, which lies in a groove on the broad inferior side of the plate of bone. The nerve may be covered by mucous membrane or by thin bone and may be injured during the curettage of the sinus.

The Sphenoidal Sinus

The sphenoidal sinuses are small before the third year but are fully developed by the twelfth to fifteenth year. They are situated within the body of the sphenoid bone and are variable in size and often in shape. They are separated from each other by a thin, bony partition or septum that frequently deviates to one side or the other, producing one large and one small cavity.

Each sphenoidal sinus communicates with the superior meatus of the nose by means of a small aperture that empties into the sphenoethmoidal recess. The size of the ostium of the sphenoid varies from 0.5 to 4 mm and is located usually 10 to 20 mm above the sinus floor, thus being disadvantageously placed for gravity drainage. The dimensions of the sinus are approximately as follows: at 1 year $2.5 \times 2.5 \times 1.5$, and at 9 years $15 \times 12 \times 10.5$ mm. The average capacity is about 7.5 ml (0.05 to 30 ml).

The ostium is practically always membranous, its bony circumference being considerably larger than its actual orifice. It is near the septum of the nose and is hidden from view by the approximation of the middle turbinate to the septum. If there is marked atrophy of the turbinate, or if the septum deviates to the opposite side, it may be seen by anterior rhinoscopy. The purulent secretion flowing from the ostium drains either directly through the posterior choana into the nasopharynx or onto the posterior end of the middle turbinate.

The optic nerves and the hypophysis lie above the sinus, and the pons lies posteriorly. External and lateral to the sinus are found the cavernous sinus, the internal carotid artery, the superior orbital fissure, and related cranial nerves. The sphenoidal sinus may present a bony dehiscence so that the mucous membrane lies in direct contact with the subjacent structures. Thus curetting of the sinus must be done with great care. The