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Nasal Anatomy and Evaluation

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The nose is a significant organ of respiration and the primary organ of olfaction. The nasal septum is a cartilaginous and bony structure that divides the nose into two chambers. The anatomy of the lateral nasal wall is formed by a series of folds and spaces known respectively as the nasal conchae and meati. The effect of these structures on the inspired air-stream sets the parameters for nasal breathing and the treatment of air before it is directed down into the lungs. The turbulent airflow caused by the conchae adds to the perceived resistance of nasal airflow and the sensation of adequate breathing. Turbulent airflow allows for the wafting of molecules to the sensory cells of the olfactory system and thus aids the senses of taste and smell.

The paranasal sinuses, immediately adjacent to the nasal cavity, are air-filled spaces lined with respiratory epithelium in continuity with the epithelium of the nasal cavity. Within the confines of the nose and paranasal sinuses courses the collecting portion and the lower drainage portion of the lacrimal system and the lacrimal sac and duct, respectively. The complex relationship between nasal anatomy and the lacrimal system requires that the ophthalmologist has a good understanding to successfully approach the lacrimal system while avoiding complications in the nasal cavity.[1–4]

Anatomy

The External Nose

The external projection of the nose approximates a pyramid. The superior attachment at the forehead is known as the root. The inferior angular portion is known as the tip. The dorsum nasi is the intervening ridge. The nares are the paired openings to the nasal cavity each bounded medially by the septum and laterally by the alae. Each ala is formed by a rounded lower lateral cartilage.

The nasal skeleton is partially cartilage, part bone, and part membranous. Two paired nasal bones articulate with the frontal bones and

rest firmly supported by the frontal process of the maxilla to support the bridge of the nose. The lower portion of the nasal pyramid is formed by several major and minor cartilages. The upper lateral cartilage is triangular in shape, extending from the paired nasal bones. The curved lower lateral cartilages overlie these and form the nasal opening. The medial portions of the lower cartilages sit anterior to the central septal cartilage.

The nasal cavity is divided into two nasal fossae. They are triangular in shape, opening anteriorly at the nares. The posterior openings into the pharynx are known as the choanae. The walls of the nasal cavity consist of the medial wall, formed by the septum; a lateral wall; and a floor. The most anterior portion of the nasal cavity is known as the vestibule. It is lined by squamous epithelium and has hairs, sweat glands, and sebaceous glands. The remainder of the nasal cavity is lined with respiratory epithelium, is highly vascular, and contains mucous and serous glands. The ciliated epithelium of the nasal cavity engages in active transport of mucous down into the nasopharynx.

The Nasal Septum

The nasal septum is formed by both bone and cartilage. The perpendicular plate of the ethmoid bone forms much of the posterior and superior portion of the nasal septum. The anterior portion is formed by the septal cartilage. Inferiorly lies the bony plate of the vomer, which rests on the nasal crests of the maxilla and the palatine bones. Variation in the anatomy, or deviation of the septum, can be attributed to the presence of bony protuberances, or septal spurs arising from the bony structures. The articulation of the septal cartilage can be angled from the nasal crest, causing a cartilaginous encroachment of the septum into the nasal cavity; clinically, this is known as a septal spur (Figure 3.1). The septal cartilage can also have a curved shape, causing narrowing of the nasal cavity, frequently referred to as septal deviation. These variations can be congenital in nature or acquired changes from nasal trauma.

The nerve supply of the nasal septum comes from the anterior ethmoidal and maxillary nerves with innervation coming via the sphenopalatine ganglion. Surgical treatment or trauma to the septum and resulting inflammation can lead to symptoms of numbness or pain of the upper incisors. The blood supply to the septum includes branches of the sphenopalatine artery, the ethmoidal artery, and the facial artery. The tissue is quite vascular and bleeding in surgery or from trauma can be quite brisk. Vasoconstrictive agents, topical and injected, are advisable when manipulation of the septum is necessary for surgical procedures.

The Lateral Nasal Wall

In contrast to the relatively simple medial wall, the lateral nasal wall in much more complex in both its anatomy and its involvement with the functions of respiration and drainage of the paranasal sinuses. It is the medial border of the paranasal sinuses and holds the projecting

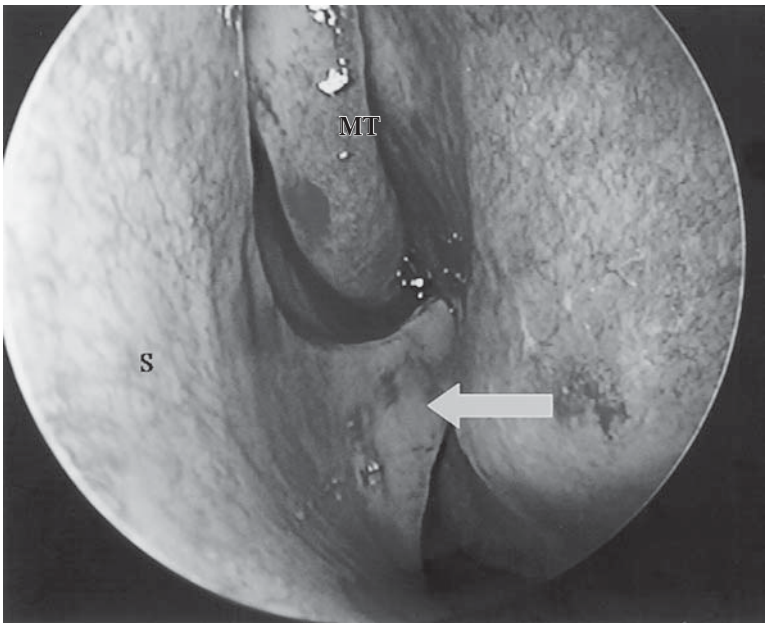

FIGURE 3.1. Septal spur. The arrow identifies a large septal spur. (S) identifies the nasal septum. (MT) identifies the middle turbinate.

ridges of bone known as the conchae or turbinates. These folds of respiratory mucosa over bone are named based on their relative position from below upward as the inferior, middle, and superior turbinate, respectively. In some cases, a fourth or supreme turbinate is present.

The inferior and middle turbinate are most important to discussions of the relationship between the lacrimal system and nasal anatomy. The spaces below the turbinates are known as meati and are named in accordance with the ridge to which they are related. The inferior meatus lies below the inferior turbinate, the middle meatus lies below the middle turbinate, and so on. The beginning of the space is at the anterior attachment or root of the turbinate.

The inferior turbinate consists of bone independent of the lateral wall (Figure 3.2). It is covered with a thick mucous membrane and contains a significant cavernous plexus which can be a source of brisk bleeding after surgical procedures. The inferior meatus, defined by the shape of the turbinate, is narrow anteriorly and posteriorly, and arched higher and wider in the center portion.

The structure of most importance in the inferior meatus is the opening of the nasolacrimal duct (Figure 3.3). Its shape is quite variable and has been described from rounded to more slit-like in appearance. The opening can be more raised from the surrounding tissue and papillae-like or can be more flattened and open into a deep groove or fossa. When the opening is more slit-like, it usually courses through a protective fold of mucous membrane known as the plica lacrimalis or

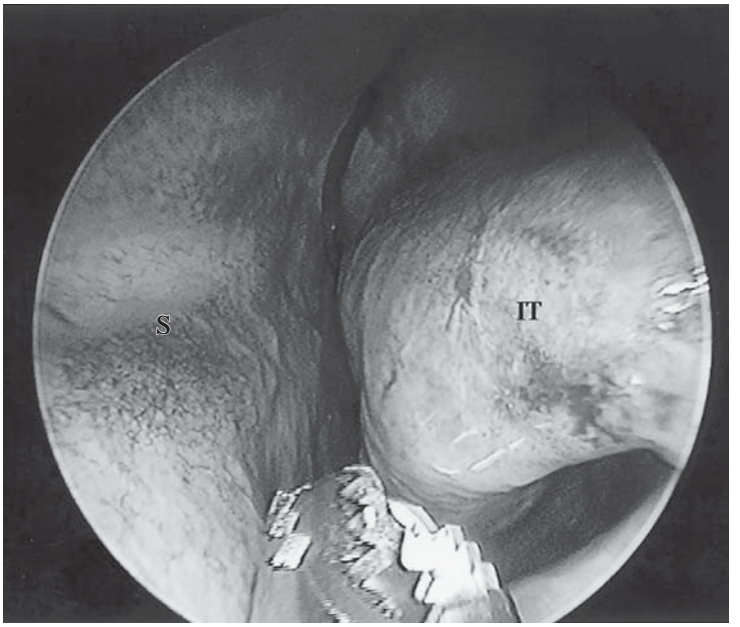

FIGURE 3.2. Inferior turbinate: (S) identifies the nasal septum. (IT) identifies the anterior portion of the inferior turbinate. A dissecting microdebrider blade is in the foreground.

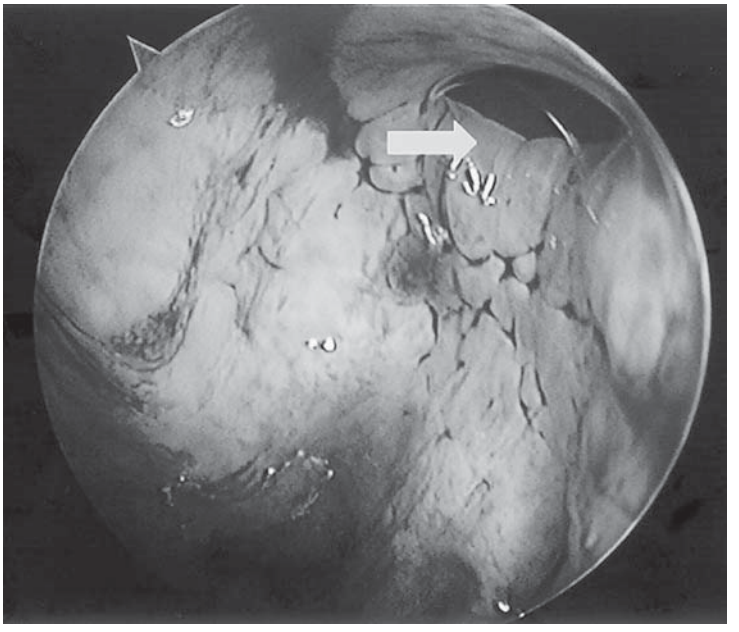

FIGURE 3.3. Opening of the nasolacrimal duct into the inferior meatus. The arrow identifies the opening of the nasolacrimal duct.

the valve of Hasner. The location of the nasolacrimal ostium is usually in the anterior portion of the inferior meatus at the lateral wall. It has also been described as high as the attachment of the turbinate.

The middle turbinate is a projection of the ethmoid bone that overhangs the complex anatomy of the middle meatus (Figure 3.4). This space is of vital importance in the drainage of the paranasal sinuses. The anterior attachment of the middle turbinate runs almost vertically and then bends to horizontal through the posterior portion. Under the high anterior portion is the highest part of the middle meatus known as the frontal recess. The frontal recess receives drainage from the frontal sinus superiorly. From the frontal recess, the middle meatus runs inferiorly and posteriorly. It is bordered by the face of the ethmoid sinus and the ethmoid bulla posteriorly. On the lateral wall, the uncinate process is a fold that projects posteriorly into the middle meatus. The natural ostium of the maxillary sinus lies below the inferior portion of the uncinate process. Scarring in the area of the middle meatus can be an iatrogenic cause of chronic sinus disease if the drainage pathways are blocked after manipulation and subsequent narrowing. This is particularly true for the frontal recess and chronic frontal sinusitis.

The most anterior part of the middle meatus corresponds to the location of the medial wall of the lacrimal sac. The sac can be fairly reliably

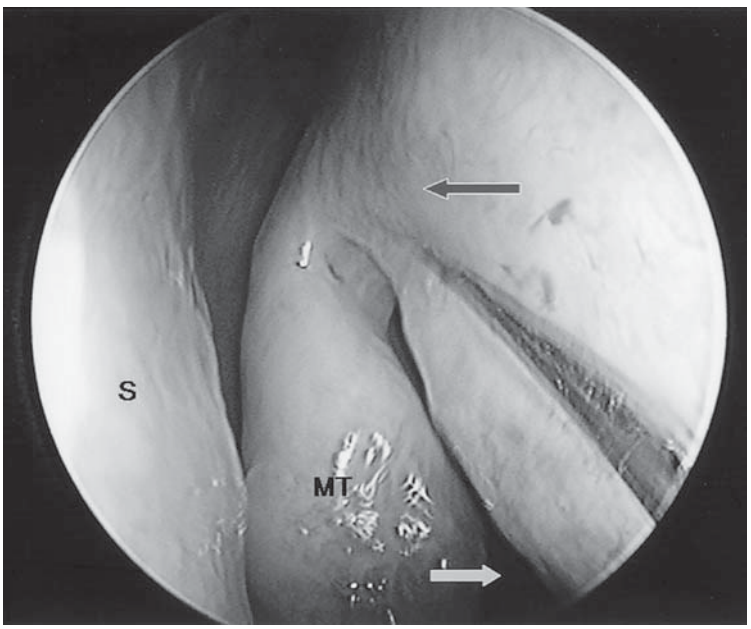

FIGURE 3.4. The middle meatus, injection of local anesthesia. The yellow arrow identifies the middle meatus. (MT) identifies the middle turbinate. The red arrow identifies the attachment of the middle turbinate, near the location of the lacrimal sac. (S) identifies the nasal septum.

located just anterior and inferior to the anterior attachment of the middle turbinate. The nasolacrimal duct courses within the bony nasolacrimal canal which runs inferiorly and slightly posteriorly and laterally between the lateral nasal wall and the maxillary sinus. The nasolacrimal duct can continue as the same diameter as the lacrimal sac, but generally narrows as it runs inferiorly. Whereas the nasolacrimal duct is intimately attached to the surrounding periosteum, the lacrimal sac is more loosely associated with its surrounding periosteum. As previously described, the nasolacrimal duct drains into the inferior meatus via its ostium.

The blood supply to the lateral nasal cavity posteriorly is largely from the sphenopalatine branch of the internal maxillary artery. The anterior and posterior ethmoid arteries from the internal carotid circulation supply more anterior and superior portions of the nasal cavity. The vestibule is largely supplied by branches of the facial nerve from the external carotid circulation.

Evaluation of the Nasal Cavity

Anterior Rhinoscopy

The most anterior portion of the nose, the nasal vestibule, can be easily evaluated with a light and direct vision. A nasal speculum will facilitate the examination by allowing the lateral retraction of the nasal ala. Alternatively, this can be accomplished with a handheld otoscope. In evaluation of the anterior nasal cavity, the physician should look for epistaxis, polyps, granulomas, skin malignancies, or benign lesions. A benign granuloma or hemangioma can bleed as easily as a malignancy. Consider biopsy or referral for biopsy for any suspicious lesion.

Nasal Endoscopy

Fiberoptic nasal endoscopes are valued tools in the evaluation of the nasal cavity. Both rigid and flexible endoscopes provide for thorough evaluation. The experienced examiner can proceed gently without the aid of a topical anesthetic, such as 4% lidocaine. The use of a topical decongestant, however, is advisable to aid in visualization and patient comfort.

With nasal endoscopy, the examiner can identify the presence of benign and malignant tumors, nasal polyps (Figure 3.5), septal deviation, and turbinate hypertrophy. Indeed, the completion of an endoscopic examination in the office is a good practice run for the use of a scope in the operating room and can help increase the comfort of the surgeon with the instrument as well as familiarize the surgeon with the anatomy.

Frequently, a 0°, 2.7-mm, rigid nasal endoscope is used. A wider, 4-mm endoscope will resist damage but will be more difficult to use in the nasal cavity. A flexible fiberoptic nasopharyngoscope may be more easily directed to the posterior nasal cavity; however, it cannot be used with one hand to allow manipulation of suction or forceps to remove

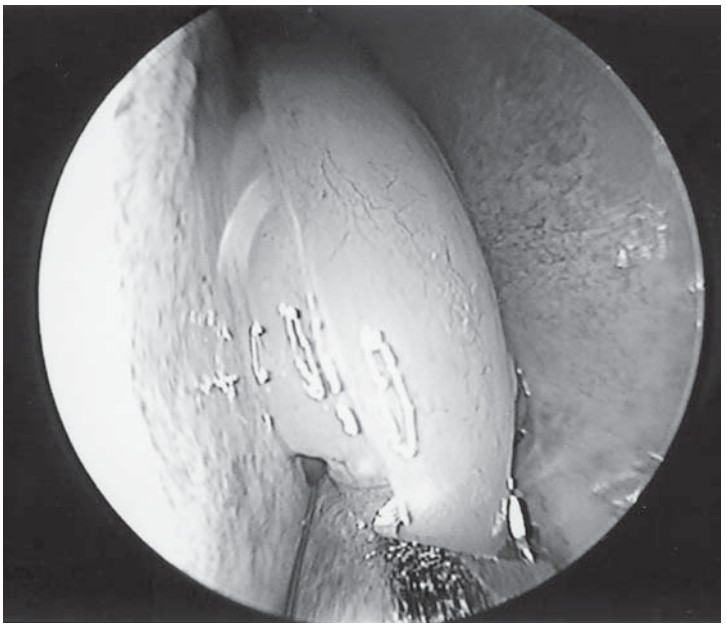

FIGURE 3.5. Benign nasal polyps: extensive nasal polyps in the nasal cavity.

debris. Caution must be used in the care and examination with nasal endoscopes. The optical fibers can break easily if the endoscope is dropped, and repairs and replacement are costly. Multiple articles describe the care and cleaning of endoscopic equipment and suppliers of these technologies are quite helpful in teaching about their upkeep.

Imaging Studies

Computer tomography in the coronal plane is an excellent modality in evaluation of the nasal cavity. Septal deformity, turbinate hypertrophy, and masses can all be evaluated. Computer-aided imaging systems used in neurosurgery, skull base surgery, and sinus surgery can be of assistance. The systems allow for real-time correlation of patient anatomy to computed tomography anatomy in the operating room. They can, however, increase operative time and may not be of much additional help for routine cases. Their utility may lie more in cases of severely abnormal anatomy, such as revision cases or in the setting of an anatomy-altering mass.

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