Anatomy and Physiology:

The nasal passages are complex structures that serve several functions. These include the conduction, filtration, heating, humidification, and chemosensation of air. Filtration, heating and humidification are greatly aided by mucosal and bony infoldings of the lateral nasal walls: the turbinates. The middle and inferior turbinates are the most important structures for these functions. The inferior turbinate contains a separate bony structure that is attached to the inferior lateral nasal wall. Its meatus provides drainage for the nasolacrimal duct. It is about 50-60 mm long, 7.5 mm in height, and 3.8 mm wide. The inferior turbinate is the dominant structure of the inferior nose. Embryologically, it develops from an endonasal prominence called the maxilloturbinal prominence. The middle turbinate lies medial to several important sinus structures. These include the anterior ethmoid air cells, the maxillary sinus ostium, the nasofrontal duct, and the uncinate process. The mean length of the middle turbinate is 40 mm and its mean height is 14.5 mm anteriorly and 7 mm posteriorly. The superior turbinate provides drainage for posterior ethmoid air cells. The middle turbinate develops from the second ethmoturbinal, the superior turbinate develops from the third ethmoturbinal, and the supreme turbinate develops from the fourth and fifth ethmoturbinals. The turbinals are embryologic infoldings of the developing nasal cavities.

The mucosa of the turbinates consists of pseudostratified columnar ciliated respiratory epithelium. The respiratory epithelium contains goblet cells, which function to produce a mucus layer. The mucus, which contains numerous salts, glycoproteins, polysaccharides, and lysozymes, helps to trap bacteria, particulate matter, and toxins. The nasal submucosa contains a complex array of arteries, arteriovenous anastomoses, and unique muscular veins and venous sinusoids. Histologically, the inferior turbinate is composed of three layers: medial and lateral mucosal layers and a central osseous layer between them. The medial layer is considerably thicker than the lateral layer. This increased thickness is due to the increased size of the lamina propria, which extends from the basement membrane of the pseudostratified epithelium to the central osseous layer. It is in the lamina propria that venous sinusoids, lymphocytes and other
immunocompetent cells, and seromucous glands reside. The sinusoids can become engorged or constricted according to the extent of vasodilation or vasoconstriction in the veins and arteriovenous anastomoses.

Chemical or microbial irritation of this network can lead to a rapid inflammatory response, primarily by the activation of mast cells, basophils, and other leukocytes, which release histamine along with other inflammatory mediators that lead to swelling of the turbinates, primarily in the lamina propria, where the venous sinusoids reside.

The turbinate and other nasal mucosa may also undergo cyclic side-to-side engorgement referred to as the nasal cycle. The nasal cycle lasts from two to six hours, but does not normally affect the total nasal resistance since one side is relatively decongested. Recent studies suggest, however, that the nasal cycle may occur consistently in only 20-30% of the population (11).

The sympathetic and parasympathetic (vidian nerve) nervous systems also affect the level of engorgement of nasal mucosa and the production of mucus. The sympathetic system regulates blood flow to the nasal mucosa by regulating resistance vessels, while the parasympathetic nervous system regulates blood volume of the nasal mucosa by regulating capacitance vessels. Sympathetic stimulation results in increased resistance and thus less flow into the nasal mucosa, leading to decongestion. The sympathetic tone to the nasal vasculature is probably partially influenced by the partial pressure of carbon dioxide (pCO2) via the carotid and aortic chemoreceptors (11). Parasympathetic stimulation leads to relaxation of capacitance vessels, allowing congestion, and even edema formation in tissues. The vidian nerve carries parasympathetic fibers from the greater superficial petrosal nerve and sympathetic fibers from the deep petrosal nerve en route to innervation of the sinonasal mucosa.

Sensory receptors in the nose are responsible for sensation of air flow. These receptors are temperature-sensitive. This explains why menthol, which stimulates cold receptors is useful in treatment of symptomatic nasal obstruction.

The inferior portion of the nasal cavity, or that portion beneath the middle turbinate, accounts for well over 50% of the nasal airflow. The inferior turbinate, as the predominant structure in this part of the nose, therefore plays a central role in conditioning of nasal air and in nasal obstruction. The concept of the nasal valve is important because the nasal valves form areas of greatly increased resistance to nasal airflow. The nasal valve consists of external and internal nasal components. The external nasal valve is formed by the caudal edge of the lateral crus of the lower lateral cartilage, the soft-tissue alae, the membranous septum and the sill of the nostril. This area is occasionally a sight of nasal obstruction, especially in those who have undergone rhinoplasty in the past (e.g. a pinched ala deformity). The internal nasal valve is the region of the nasal airway bounded by the septum medially, the caudal end of the upper lateral cartilage laterally to the anterior end of the inferior turbinate infero-laterally. It is located approximately 1.3cm from the nares and is the narrowest segment of the nasal airway. The internal nasal valve accounts for 50% of total airways resistance. It is in this region that the inferior turbinate can exert its maximum role on nasal airway resistance.
Evaluation of the Nasal Airway and Turbinates:

Evaluation of the nasal airway and turbinates in most clinical practice is done by history and physical exam, including nasal endoscopy. Important symptoms to elicit are aggravating/relieving factors associated with nasal obstruction, rhinorrhea, sneezing, nasal itchiness. History elicits the nature of nasal/turbinate dysfunction and helps to stratify it into causes. Physical exam consists of a complete examination of the dynamic and static properties of the nasal airway. Septal deviation, enlarged, edematous turbinates and nasal polyps should be sought. It is important to remember though, that physical exam does not often correlate with history. For instance, a severely deviated septum may be asymptomatic if the patient does not have a nasal cycle leading to paradoxical obstruction (see below for an explanation of this phenomenon). A study by Saunders et al showed that in their retrospective patient population, MRI’s and physical exams showed poor correlation with patient symptoms of obstruction. Physical exam should be performed before and after decongestion. Failure of swollen turbinate mucosa to shrink after application of decongestant suggests the possibility that the patient may have bony hypertrophy of the inferior turbinate, chronic unresponsive soft tissue hypertrophy, or drug induced rhinitis. CT scan is indicated in the evaluation of nasal obstruction when a cause cannot be identified on physical exam with endoscopy or when evaluating tumors or polyps.

Rhinomanometry is a technique for measuring nasal airway resistance. Resistance can be described by Ohms Law: \( R \) (resistance) = \( P \) (pressure)/ \( V \) (flow). This relationship applies to systems with laminar flow. The inferior and middle turbinates usually provides turbulence that alters this relationship, so that at extremes of pressure this correlation breaks down. Anterior rhinometry utilizes the placement of a pressure sensor in one nostril and detects the flow of air in the other nostril. In this fashion, the resistance of each nasal cavity can be calculated separately (in parallel). Posterior rhinomanometry places a pressure sensor at the mouth, which allows direct calculation of total nasal airway resistance. Most healthy adults have a nasal resistance ranging from 0.15 to 0.3 Pa/cm\(^3\) (1). A total nasal resistance of greater than 0.3 Pa/cm\(^3\) is usually symptomatic. However, even lesser resistances may lead to symptoms in some individuals - so rhinomanometry findings are not always predictive of patient’s symptoms. Measurements are performed with and without nasal decongestion to determine the relative influence of structural (e.g. bony) influences vs. mucosal influences on nasal obstruction. Also nasal valve collapse is easily demonstrated on acoustic rhinometry because the increased resistance is seen only on inspiration, and expiration is normal.

Acoustic Rhinometry uses a reflected acoustic pulse to determine the cross-sectional area of the nasal cavity. The test plots cross-sectional area of the nasal cavity vs. distance from the nasal aperture. The validity of acoustic rhinometry has been confirmed by studies using acrylic models and by comparison with MRIs that scan in a plane perpendicular to the direction of the acoustic waves (10). In the normal adult, acoustic rhinometry confirms that the internal nasal valve is the area of greatest narrowing, or minimal cross sectional area. Nasal obstruction is consistently rated as severe by patients when the minimal cross-sectional area is 0.3cm\(^2\) or less (1). However, controversy exists at to how to rate gradations of narrowing in correlation to obstructive symptoms. As in rhinomanometry, measurements are taken before and after decongestion to determine mucosal versus structural abnormalities.
Other tests exist for evaluation of nasal function but are not widely used. Objective tests of olfaction can be useful in determining whether inferior or middle turbinate disease is affecting the sense of smell. In academic medicine, various techniques exist to measure nasal humidity and temperature (2) and mucociliary function. The nasal smear is a method in which a swab is run along the inferior border of either the middle or inferior turbinate. The pattern of cells seen on nasal smear can indicate the severity and type of nasal disease.

Causes of Turbinate-Related Nasal Obstruction:

Allergic rhinitis (AR) is characterized by seasonal or perennial nasal obstruction with itchy nose, sneezing, and rhinorrhea. Physical exam demonstrates pale, edematous mucosa, and nasal smear demonstrates eosinophilia. Histopathologically, the turbinates of individuals with allergic rhinitis demonstrate mast cell abundance in the lamina propria, and in chronic stages, seromucous gland proliferation, and interstitial fibrosis. Nasal smear demonstrates eosinophils.

Acute rhinosinusitis, usually cause by viral infection, is characterized by clear rhinorrhea, fever, sneezing, and nasal obstruction with or without pain. Nasal exam is similar to that in allergic rhinitis, but nasal smear findings may demonstrate lymphocytes and neutrophils.

Vasomotor rhinitis is characterized by congestion and rhinorrhea without sneezing, pruritis, or eosinophilia on nasal smear. Drug induced rhinitis is characterized by a history of topical decongestant use, with refractory mucosal edema and often erythematous, fragile mucosa. Chronic rhinosinusitis is characterized by a long duration of symptoms similar to those in the acute form, often associated with long-standing changes (e.g. submucosal fibrosis) in the nasal mucosa, especially at the middle meatus, but also in the inferior turbinate.

Nasal polyposis is a disease that, interestingly, rarely involves the inferior turbinate. Most nasal polyps arise from the thin mucosa of the osteo-meatal complex, and so, when severe, can be considered a middle turbinate related cause of nasal obstruction. The reason that the inferior turbinates, while most exposed to environmental insult, are so resistant to polyposis is unclear. One theory is that the thin mucosa of the osteomeatal complex is sparsely innervated, which leaves it under less control of autonomic regulation inhibiting vascular extravasation of fluids. When the poorly innervated areas meet with environmental insults, they may be more susceptible to polyp formation, as edema fluid slowly causes the polyp to grow. Inflammatory cells (e.g. mast cells) are found in greater numbers in polyps, which supports the notion of inflammation contributing to polyp formation (12). However, inflammatory conditions such as allergic rhinitis have not been definitively shown to cause polyposis. Nasal polyposis is related to conditions such as aspirin sensitivity, asthma, cystic fibrosis, and Kartagener’s syndrome, and it is often idiopathic.

Atrophic rhinitis, while not a cause of nasal obstruction, is a disease that deserves mention, because it has been associated with overaggressive turbinectomy procedures, although this issue remains debated. This rare condition is characterized by progressive, slow atrophy of the nasal mucosa with crusting and foul drainage (ozena), typically beginning at puberty. Several organisms have been grown from patients having this condition, but their exact role in the pathogenesis is unclear.
Anatomic causes of nasal obstruction include problems with the inferior turbinate, the septum, and the nasal valve. Septal deviation can lead to obstruction of one nasal airway with compensatory hypertrophy of the contralateral inferior turbinate. The reason for this hypertrophy is not entirely clear, but it can lead to nasal obstruction when the nasal cycle causes engorgement of the enlarged turbinate. A histologic study by Berger et al showed that the most commonly enlarged component of the contralateral inferior turbinate in septal deviation is the bony turbinate (13). This suggests that mucosal swelling is not solely responsible for nasal obstruction in these patients.

Another anatomic cause of nasal obstruction can be the concha bullosa. The concha bullosa refers to pneumatization of the middle turbinate. The concha bullosa is divided into three groups according to the degree and localization of pneumatization: 1) lamellar type (localized in the vertical lamella), 2) bulbous type (localized in the inferior portion), and 3) extensive (large) type (localized in both the vertical lamella and inferior portion). The degree of pneumatization defines the severity of symptoms. The first two types usually do not manifest any symptoms, but the extensive type does. The indications for surgical intervention can be categorized into four groups. The first is to remove the pathologic contents of concha-like infection and diseased mucosa. The second is to alleviate the nasal obstruction in extremely large cases. The third is to facilitate visualization of the ostiomeatal complex during endoscopic surgery. The fourth is to treat the so-called “middle meatus obstructive syndrome,” which results in neuralgia and pressure sensation.

Paradoxical curvature of the middle turbinate is seen in 11%-29% of patients. It refers to a convex curvature on the lateral, rather than medial side of the turbinate. The disorder may predispose the patient to unilateral sinusitis.

Dynamic collapse of the nasal airway is due to incompetence of the upper lateral cartilages, which aid in maintaining nasal patency. Often patients with this problem have a prior history of nasal surgery that has weakened the cartilages.

Anatomic abnormalities of the inferior and middle turbinates also include polypoid changes, and synechiae. These changes are especially important at the middle turbinate, where they can lead to blockage of the ostiomeatal complex and to sinusitis.

Medical Management of Turbinate Dysfunction:

Turbinate-related causes of nasal obstruction are generally an extension of whole sinonasal pathology. Therefore, the broad pathologic condition must be treated. Treatment is directed toward the specific etiology. In allergic rhinitis, treatment is directed toward the inflammatory response. Avoidance of allergens is counseled, but medication is usually needed for better control. This entails the use of topical and systemic antihistamines along with topical steroid sprays. Systemic decongestants are also used. Occasionally, systemic steroids can be given. Allergy desensitization is used typically when other medical means have failed.

Nasal polyposis, especially when related to asthma and aspirin sensitivity is often responsive to treatment with systemic steroids. Topical nasal steroids have shown some efficacy in nasal polyposis. Polyposis related to chronic rhinosinusitis is less responsive to corticosteroid
therapy and often requires functional sinus surgery for correction. Even this surgery, however is associated with a high rate of recurrence.

Drug induced rhinitis is treated with cessation of the offending agent with use of a steroid spray. Acute and chronic sinusitis are treated with short and long courses of antibiotics (respectively) when appropriate along with nasal irrigations and short courses of topical decongestants.

Surgical Management of Turbinate Dysfunction:

Symptoms of nasal obstruction may persist despite maximal medical management. In many patients who continue to complain of nasal obstruction, inferior turbinate hypertrophy can be confirmed by physical exam and rhinometry, though the latter is infrequently performed in clinical settings. It has been shown that inferior turbinate enlargement can prevent adequate medical management by preventing the transmission of topical steroids and topical antihistamines to the superior nasal cavity (4). So surgical procedures that reduce the size of the inferior turbinate can not only improve symptoms, but can also potentiate medical management of rhinitis. Numerous procedures exist for this purpose, and controversy abounds as to which is the best. There are very few randomized studies comparing different procedures to each other, and those that exist are generally not long-term studies. Procedures can be classified as those that address bony causes of nasal obstruction, and those that address mucous and submucous swelling.

The classically performed procedure for inferior turbinate hypertrophy was total turbinate resection. This procedure involves clamping the inferior turbinate at its base to achieve hemostasis, followed by the use of nasal scissors or endoscopic instruments to resect the entire turbinate along its base. This procedure definitively widens the nasal airway and has been shown to be one of the most effective procedures in achieving long-term nasal patency, with a retrospective study by Ophir et al showing that 80% of 150 patients had subjectively improved nasal breathing and 91% had widely patent nasal airways at an average follow-up time of 2.5 years (range 1 to 7). The most common complication of total inferior turbinectomy appears to be hemorrhage. The procedure often requires nasal packing after completion. Also, nasal crusting, synechiae, and discomfort are frequent occurrences for several months afterward because of exposed bone at the lateral nasal wall. A 1985 retrospective study by Moore et al condemned total inferior turbinectomy, reporting that 66 percent of their 18 patients had ozena, or advanced atrophic rhinitis characterized by chronic crusting and dysosmia even leading to anosmia due to destruction of olfactory cells. Others, such as Ophir, have refuted this notion and report that atrophic rhinitis is a rare and even insignificant complication of total turbinectomy. However, many otolaryngologists today have abandoned this procedure.

Partial turbinectomy is a procedure developed to remove the anterior part of the inferior turbinate. It is directed at relieving obstruction at the nasal valve, while leaving a portion of the turbinate to continue its function of air conditioning. Nasal patency rates show great subjective improvement immediately after surgery, with one retrospective study suggesting that 70 of 76 patients reporting improvement at about 8 years (6). However, other studies have suggested decreased effectiveness with time (7), similar to non-resection procedures. Complications are
similar to those for total turbinectomy, though the crusting is usually less severe, as is the risk of hemorrhage. Atrophic Rhinitis with this procedure is rare.

Submucous resection of the inferior turbinate is a procedure that attempts to preserve the mucosa of the turbinate in order to improve the side effect profile and to maintain the mucociliary clearance and air conditioning function of the inferior turbinate. An incision is made along the inferior border of an in-fractured inferior turbinate and medial and lateral submucosal flaps are elevated. The anterior 2/3 bone of the inferior turbinate is partially resected under the flaps. The flaps are trimmed to re-drape the remaining bone. This procedure is technically more difficult than the previously discussed procedures. However, it is generally associated with a decreased complication rate, with significantly less crusting and hemorrhage. Though immediate relief of symptoms is generally very good with a good side-effect profile, the long-term improvement is poorer. Also, symptoms of rhinorrhea often persist because the procedure leaves a large amount of mucus-producing tissue.

Electrocautery has been used successfully in the ablation of inferior turbinates. Two forms of the procedure exist – submucosal diathermy, and mucosal cautery. Both procedures can be performed in the office under local anesthesia. Mucosal cautery, as the name implies, utilizes the electrocautery device to burn from posterior to anterior along the inferior turbinate. This causes more pain and greater risk of hemorrhage. It also damages mucosa with subsequent increase in mucosal transport time. Submucosal diathermy avoids those risks. It involves inserting a bipolar cautery to cause a submucosal lesion along the inferior border of the inferior turbinate. The device frequently has two sharp points that are used to pierce the inferior portion of the inferior turbinate. Efficacy with these procedures, while excellent immediately, is poor in the long term, with as few as 41 percent reporting improved in symptoms with submucosal diathermy at 1 year (7). But these procedures can be repeated in the office.

The successful use of many different kinds lasers to reduce hyperplastic nasal turbinates has been reported in clinical studies. These include the CO₂, the YAG, the Argon and the KTP lasers. Lasers produce a beam of coherent light that is absorbed by the tissues; the extent of absorption and therefore the depth of the lesion depends on the wavelength. Most laser surgery is performed with a pulsed beam, creating anterior-to-posterior horizontal lesions along the inferior turbinate’s medial wall (8 – see slide diagram). Some protocols with some lasers require burning of the entire medial surface of the inferior turbinate. The advantages of laser surgery include ability to perform the procedure under local anesthesia, reduced frequency of hemorrhage, and reduced discomfort. Though short term improvement in symptoms is good, significant damage to the mucosa is shown by significantly increased mucociliary transport time in one study (9) at twelve weeks. The mucosa often regenerates though, and the procedure must often be performed again.

Cryosurgery reduction is similar to laser surgery in that it also can be done in the clinic under local anesthesia. However, the side effects are more pronounced and include more risk of hemorrhage, delayed mucosal sloughing, and risk of damage to the external nose on entry. Like laser surgery, short term effects are good, but long term efficacy is not as good.

Radiofrequency devices are increasingly used as means of inferior turbinate ablation. A bipolar or unipolar radiation-producing probe is used. The probe injected into the mucosa at the
head of the inferior turbinate and advanced to its hub or to the posterior portion of the turbinate. At a power setting of 10-12 watts, the probe is withdrawn slowly at a rate of about .5cm/second to deliver total tissue energy of about 500 Joules. The probe causes thermal injury by the use of high power electromagnetic radiation. Like the other forms of non-resection, immediate results are good. Long-term studies at one year appear to show continued improvement, but longer studies are not currently available. A prospective one year study by Back, et al. on twenty patients showed improvement in nasal cross-sectional area by acoustic rhinometry, and improvement in Visual Analog Scale patient symptom ratings (18) at one year. Unfortunately, the literature is sparse with studies involving randomized comparison to other methods of turbinate reduction.

Submucous resection can also be performed with the microdebrider, using specialized attachments. The procedure for using these devices is simple. The turbinate blade is inserted into the anterior face of the inferior turbinate just medial to the mucocutaneous junction under direct visualization with a headlight. The blade is firmly pushed towards the turbinate bone until it pierces the mucosa. Next, a sub-mucosal pocket is dissected by tunneling the elevator tip in an anterior to posterior and superior to inferior sweeping motion. The correct plane of dissection is sub-mucosal and not sub-periosteal. Once an adequate pocket has been created, resection of stromal tissue is begun with the microdebrider. The blade is positioned with its cutting edge facing laterally and is moved back and forth in a sweeping fashion in a manner analogous to liposuction. The intact mucosal layer is seen collapsing toward the blade and the process is continued until adequate volume reduction has been achieved. More aggressive resection may be accomplished by turning the cutting edge towards the mucosal surface but care must be taken to minimize perforation of the mucosa. The length of the blade is adequate to reach the posterior aspect of the turbinate in order to treat the posterior portion of the inferior turbinate. Alternatively, a second, more posterior entry point may be created to better access the posterior area. In areas where the mucosa is more tightly adherent to the bone, injectable saline may be infiltrated to hydro-dissect the turbinate tissue. Once turbinoplasty has been completed, the turbinate is routinely outfractured using standard techniques.

Corticosteroid injection into the inferior turbinates has been used for many years. The procedure is often performed using triamcinolone acetonide slowly injected intramucosally into the head of the inferior turbinate with a 27 gauge needle and a tuberculin syringe, forming a bleb. Maximum benefit from the procedure is seen by 1 week and effects usually subside by 6 weeks. The injection of corticosteroids into the nose has been associated with rare reports of blindness, possibly as a result of accidental injection into a vascular structure and particulate occlusion of the optic blood supply versus retinal vasospasm. The choice of anesthetic varies. The incidence of this complication has been estimated to be .006 percent (15).

Vidian Neurectomy is another procedure that has been performed to achieve turbinate reduction. The vidian nerve provides parasympathetic input to the nasal cavity and thus contributes to significant rhinorrhea. Vidian neurectomy can be performed by transantral, transseptal, and transpalatal approaches. It requires general anesthesia and has been shown to be effective for turbinate hypertrophy associated with non-allergic and vasomotor rhinitis (7).

The middle turbinate is a structure that straddles the osteomeatal complex. Pathology in the middle turbinate can lead to disease in the maxillary, frontal, and ethmoid sinuses. For
instance, a pneumatized middle turbinate or a concha bullosa can lead to sinusitis by obstructing the drainage complex. Polypoid disease on the turbinate can cause the same problem. Polypoid disease is resected with standard endoscopic technique. It is often argued that conservative resection is appropriate in these cases, with preservation of normal anatomy.

Concha bullosa, when felt to be contributing to nasal obstruction or to sinusitis, can be treated in many ways. One method is described by Dogru et al. A vertical incision is made with a sickle knife along the anterior face of the middle turbinate. After entering the bullous cavity, the entire inner mucosa is curetted endoscopically. To abut the lamella to each other, the concha is split superiorly and inferiorly from the anterior to posterior direction. Then the turbinate is then squeezed from the superior attachment to the inferior and then posteriorly with a special forceps that avoided the outer mucosal injury.

It remains controversial whether resection of a seemingly normal middle turbinate in functional sinus surgery is beneficial. Many otolaryngologists feel the same as Willam and Mousel (17), who agreed that the nose should be left in its normal physiologic position whenever possible, including the middle turbinate. One prospective randomized study of over 1000 patients from Australia in 2000 (9) reports that routine partial resection of the normal middle turbinate (anterior inferior third) is beneficial. The study reports the need for significantly fewer revision cases in the middle turbinate resection group (7.1% for resection vs. 15.6% for preservation). The control group in this study that needed revision tended to exhibit synechiae from the middle turbinate to the maxilla, frontal sinus area and ethmoids. Complication rate of resection (e.g. hemorrhage) was not higher than in the control group. Many authors still feel, however, that preservation of normal structures and mucosa is important in reducing postoperative crusting and in increasing long term satisfaction.

Techniques exist to medialize the middle turbinate to lessen the chances of synechiae formation after endoscopic sinus surgery. One is described by Dr. Thornton (16). A 4-0 Vicryl suture on a straightened P-3 needle is passed through the middle turbinate from lateral to medial, traversing the nasal septum to the contralateral side, picked up and continued through the middle turbinate from medial to lateral, and brought out through the nose. It is then passed in the opposite direction through the same structures and tied, thus securing the middle turbinates tightly against the septum. His study shows that the middle turbinates were effectively medialized in 30 of 31 patients. The effectiveness of medialization in preventing synechiae formation cannot be concluded, however, because this study includes no control group.

Diseases of the inferior turbinates frequently lead to obstruction of the nasal airway. Diseases of the middle turbinates frequently lead to sinonasal pathology. Both of these areas can be treated in a wide variety of medical and surgical fashions. The literature regarding the efficacy of different treatment modalities is suffers from a lack of controlled prospective studies. However, most are probably effective, at least in the short term, and are generally so with a favorable side effect profile.
Discussion by Roy Goodman, MD

I enjoyed the Grand Rounds about the turbinates, but I have two comments that I'd like to pass along to you and to the resident who prepared the material.

The Grand Rounds cites a paper giving the incidence of visual loss after intranasal steroid injection as .006 percent. That's 1/16,000, which is orders of magnitude greater than the estimate that I thought was the accepted one--1/1,000,000, as reported by Mabry years ago. Even that may be too high because 1) some of Mabry's cases were actually temporary visual loss and 2) at the time he wrote the paper, everybody was using steroids with a fairly large particle size, and I think he's converted us all to triamcinalone acetonide, which has a small particle size.

I direct the residents' attention to the letter: Goodman LF, Goodman RS, Steroid Injections, Am J Rhinology 16:287, 2002. We wrote this in response to an article about injecting a mixture of steroid and triamcinalone acetonide into the frontal recess--probably a really lousy idea, if not for clinical reasons then definitely for medicolegal ones. In the research for this letter my daughter and I discovered that virtually any substance, injected virtually anywhere above the clavicle, has been reported to cause visual damage. This was going to be an article "Injections and Infarctions in Otolaryngology" but then I discovered that McCleve and Goldstein had written more or less the same thing in about 1995. I think that this might be an eye-opening topic for a Grand Rounds* and if one of your residents wants a lead on the material please have him or her get in touch with me. One of the goals would be to produce a publishable paper with my daughter (Ohio State University School of Medicine class of '05) as a coauthor.

Inferior turbinate surgery for nasal obstruction produces a high rate of relief, but it's certainly not the only approach and I'm not at all convinced that it's the best. Donald Leopold states that we feel air moving when it flows through our middle meati, and that inferior turbinate reduction can actually shunt air away from the middle meati, creating a sensation of obstruction even when air is moving well. I've been using anterior ethmoidectomy as my usual adjunct procedure since about 1995 or 1996--right about the time I had a patient with obstructive symptoms following an objectively successful septoplasty and turbinate reduction--and I'm convinced that my results are better and my patients are more comfortable during the immediate post-op period. Leopold has written very little about this, but you can find it in Current Therapy In Otolaryngology.

I'm very interested in the differing approaches to nasal obstruction. I know my results improved vastly when I added an adjunct procedure to septoplasty (first turbinate reduction, then anterior ethmoidectomy) and I think it accounts for my very low rate of septal perforation (2 in 21 years, both asymptomatic.) I'm not asking my septoplasty to do all the work, so I can afford to be conservative. At the other end of the scale are those who think you can relieve most obstruction with a septoplasty alone, and then you have Donald Lanza looking first at the nasal valve. I'd love to see a good debate among proponents of the different approaches.
Bibliography: