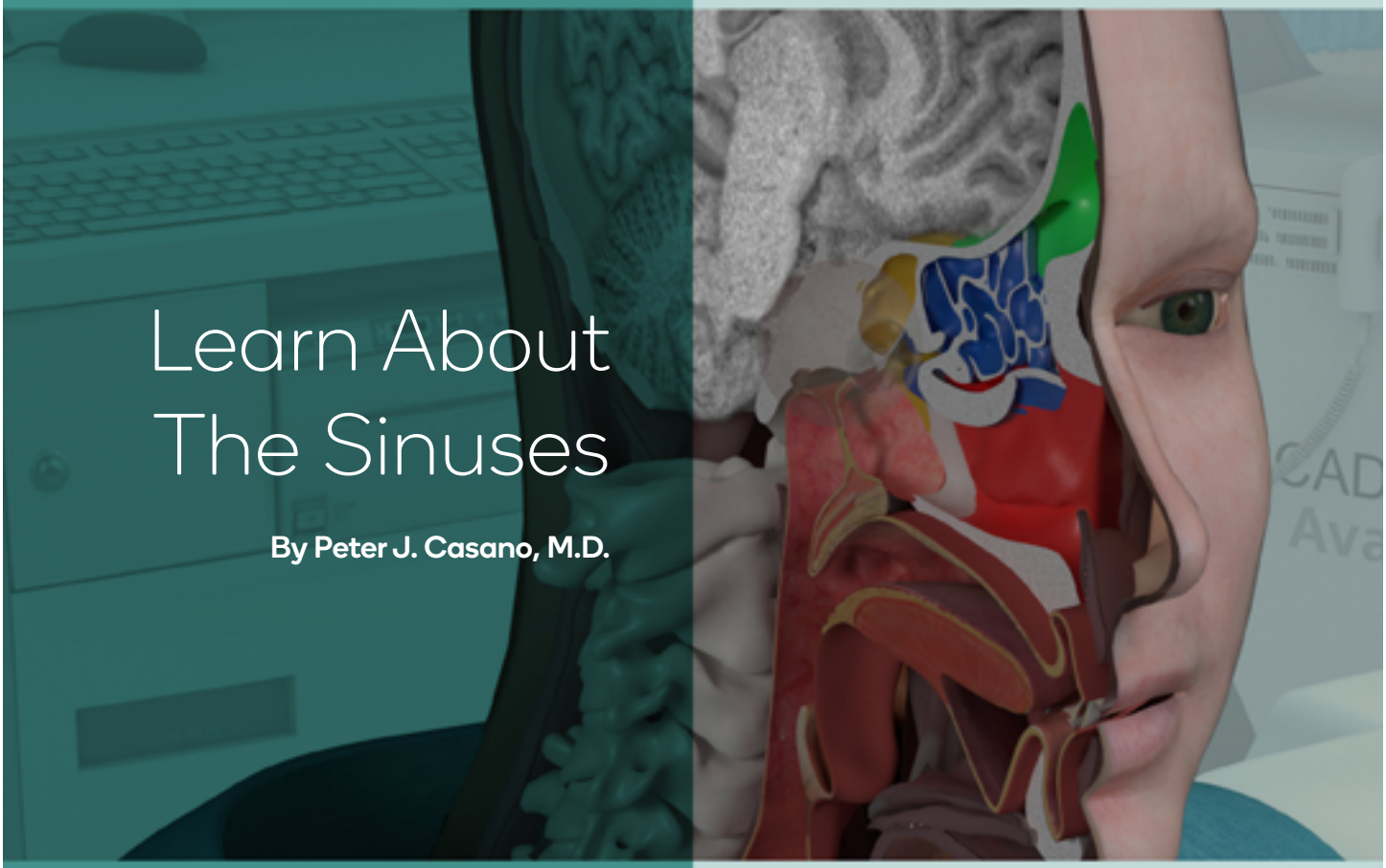
CME Companion Booklet



Learn About The Sinuses

By Peter J. Casano, M.D.

Contents:

CME: Sinus and Nasal Problems, Solutions, Anatomy, and Function

This booklet compliments Dr. Casano's three-part video series which explains the basics of sinus anatomy, nasal physiology, common problems that can arise, and solutions to those problems.

The series is best explored by watching the online videos. For an enhanced viewing experience, some type of stereoscopic (3D) display is recommended. You may also view in a standard fashion on a phone or PC.

Three ways to view the videos and begin the exercise:

1 To view on a PC or Mac, visit www.petercasano.com/CME

2 Scan the QR code at right with your phone or tablet

3 To view with 3D viewers, visit www.petercasano.com/3D

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Overview

Sinus and nasal problems are very common. Sinusitis is one of the 10 most common primary care diagnosis and accounts for over 10% of all outpatient antibiotic prescriptions. Despite this, the sinuses and nasal cavity and how exactly they function is poorly understood by many. The anatomy is complex and difficult to examine. Nasal symptoms are often similar for viral infections, bacterial infections, allergy, headache syndromes, and anatomic variations.

This course uses advanced graphics to explore nasal anatomy and demonstrate nasal function. Pathologic entities are examined and some of the most common surgical treatments are described.

Audience

The level of detail in this course is appropriate for primary care providers, dentists, nurses, health care student, and motivated patients.

Course Objective

This course is designed to help healthcare professionals and allied personnel understand the structure and function of the nasal cavity and sinuses. This knowledge can clarify how problems develop and some of the surgical methods that can be helpful. This knowledge can be helpful to improve patient care as we communication with ENT doctors and radiologists about these topics.

Faculty

Peter J. Casano, MD, received his Bachelor's degree in Biochemistry Tulane University in New Orleans, Louisiana and his Medical Degree from the University of Mississippi in Jackson Mississippi, He is Board Certified in Otolaryngology and has special interest in Rhinology. He currently practices Otolaryngology in Gulfport Mississippi.

Faculty Disclosure

Contributing faculty, Peter J. Casano, MD, has disclosed no relevant financial relationship with any product.

Technical Requirements

The videos are viewable on all up-to-date IOS devices and Android devices. Windows and MAC based desktop and laptop computers are compatible with the video formats. PDF viewers or browser extensions may need to be installed.

For viewing the material in stereoscopic 3D formats see http://petercasano.com/3D

References:

1. Stammberger HR, Kennedy DW. Paranasal Sinuses: Anatomic Terminology and Nomenclature. Annals of Otology, Rhinology & Laryngology. 1995;104(10_ suppl):7-16. doi:10.1177/000348949510410s01
2. Lund VJ, Stammberger H, Fokkens WJ, Beale T, Bernal-Sprekelsen M, Eloy P, Georgalas C, Gerstenberger C, Hellings PW, Herman P, Hosemann WG, Jankowski R, Jones N, Jorissen M, Leunig A, Onerci M, Rimmer J, Rombaux P, Simmen D,Tomazic PV, Tschabitscher M, Welge-Luessen A. European Position Paper on the Anatomical Terminology of the Internal Nose and Paranasal Sinuses. Rhinology. 2014, Suppl. 24: 1-34.

Learning Objectives

Upon completion of this course, you should be able to:

- Understand the basic location of the paranasal sinuses in the skull bone
- Articulate how the sinuses are named relative to the bones of the skull
- Identify structures that are around each of the sinuses
- Identify the larger sinuses on a coronal CT scan
- List the basic functions of the nasal airway
- Describe how the nasal structures achieve these functions
- Explain the basics of nasal airflow dynamics
- Be able to identify the key nasal structures and their role in nasal physiology
- Describe the basic pathways of mucous flow from the sinuses
- Understand the function of the three nasal turbinates and their location
- Understand the dynamic forces that create mucous flow from the sinuses
- Understand how the various sinus drainage pathways overlap
- Understand the role of mucous flow in the health of the nasal airway
- Be able to communicate the basic goals and methods of the most common and simple nasal and sinus procedures; septoplasty, opening an obstructed sinus, and turbinate reduction
- Be familiar with nasal packing in the context of sinus and nasal surgery

Chapter 1:

Basic Sinus Anatomy

The sinuses are important anatomic structures. Sinusitis is one of the 10 most common primary care diagnoses and sinusitis accounts for over 10% of all antibiotic prescriptions.

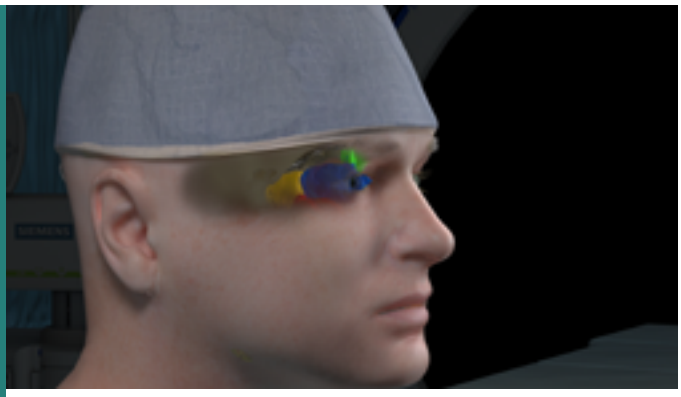
Sinus problems are extremely common yet it is an anatomic region that is poorly understood by many.

The paired maxillary sinuses are the most known over the eyes and are shown in red.

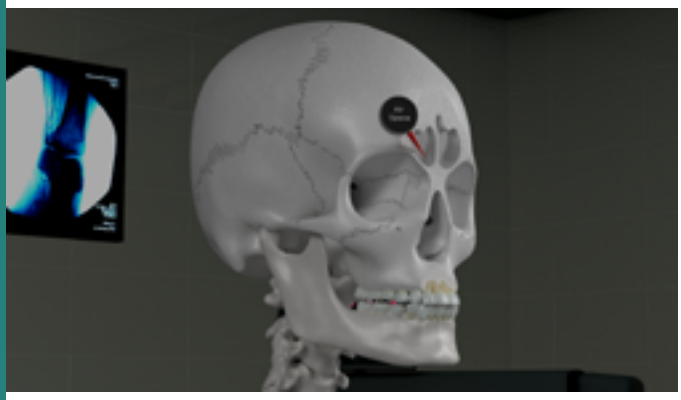
The frontal sinuses are behind the forehead and over the eyes and are shown in green.

Between the eyes is a honeycomb of small sinuses called the ethmoid sinuses. They are shown in blue.

Farthest back are the relatively large sphenoid sinuses, shown in yellow.



Sinuses are simply air spaces in bone that form during development and expand into early adulthood. They are like small caves inside several of the bones of the skull. The air space over your forehead, in the frontal bone, is called the frontal sinus.



The airspace over your teeth is the maxillary sinus.

The human skull is composed of 22 different bones. The junction between adjacent bones is called a “suture” and it forms solid unions in adults.

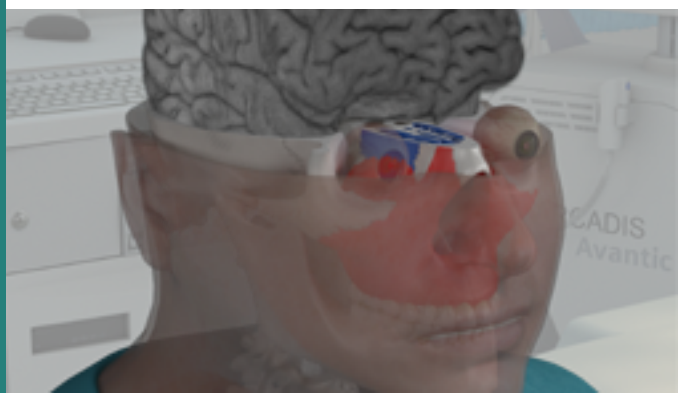
Each sinus is named after the specific skull bone that contains it.

The maxillary sinuses are within the paired maxillary bones shown in red.

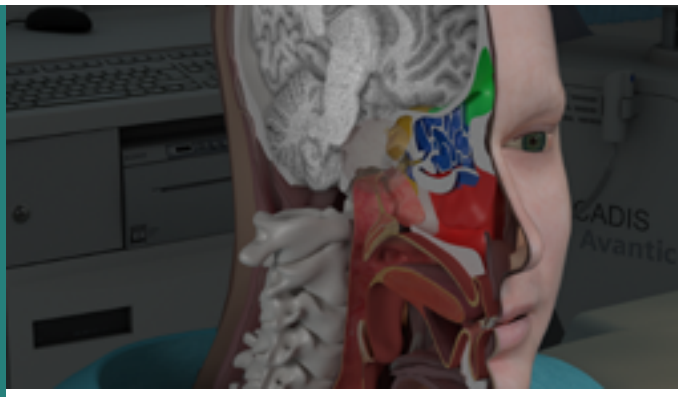
The frontal sinuses are within the frontal bone in green.

The ethmoid bone is shown in blue.

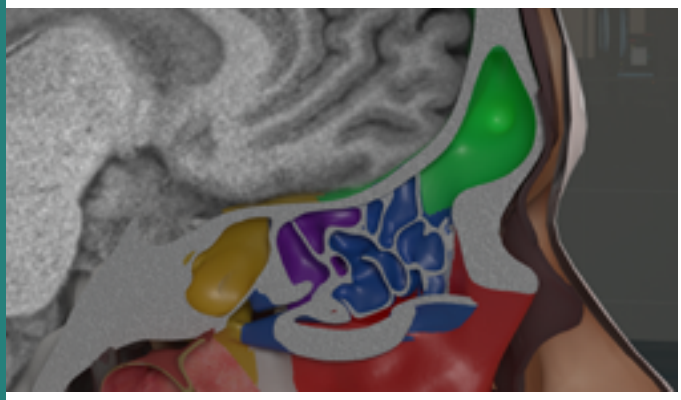
The ethmoid sinuses are that part of the ethmoid bone that is like a honeycomb of small air cells; they are the most complicated group of sinuses and occupy that critical space between the eyes and just below the brain.



When viewed in this saggital plane, you can see how the ethmoid sinuses occupy the upper parts of the nasal cavity from the front to the back. The sphenoid is seen in yellow and is behind the nasal passage.

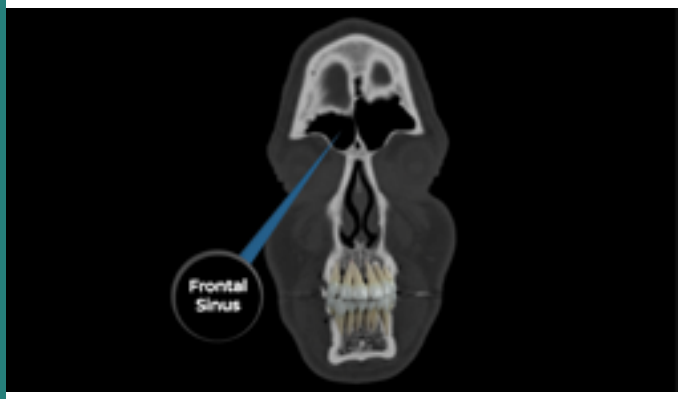


The ethmoid sinuses, shown in blue, are further divided into the anterior ethmoid sinuses, and the posterior ethmoid sinuses. The posterior ethmoid sinuses are shown in purple. These two subdivisions of the ethmoid sinuses have distinct drainage pathways.

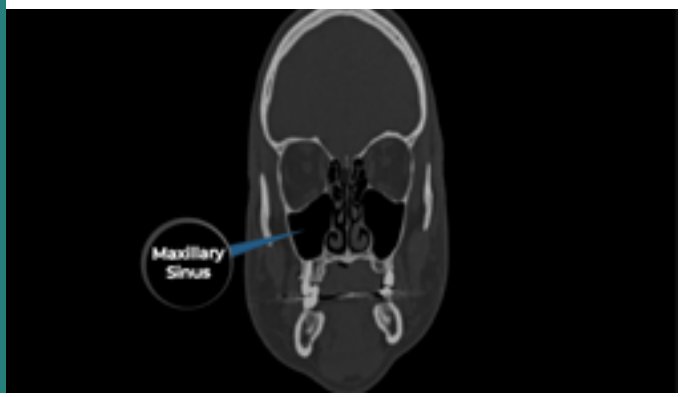


CT scans and other X-Rays compliment the physical exam when evaluating patients with sinus and nasal problems. The most common type of X-Ray used is the coronal CT scan.

The anterior slice shows the frontal sinus and the incisors.



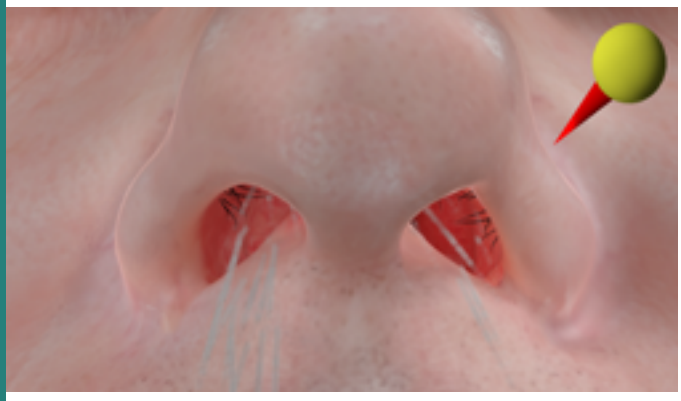
The middle slice includes the maxillary sinus, the ethmoid sinuses, the nasal septum, and the relationship of these structures to the dentition, brain, and orbital contents.



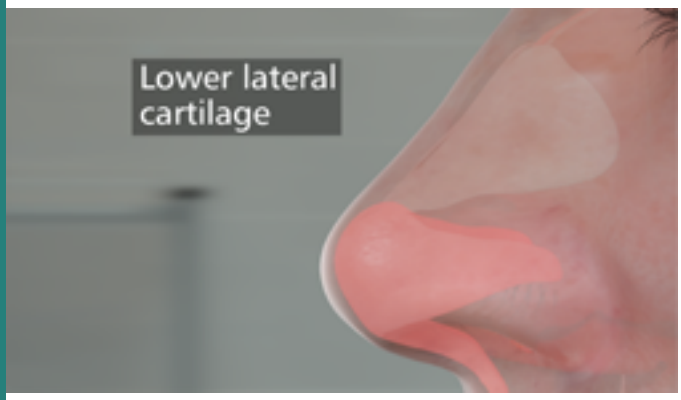
Chapter 2:

Nasal Anatomy And Function

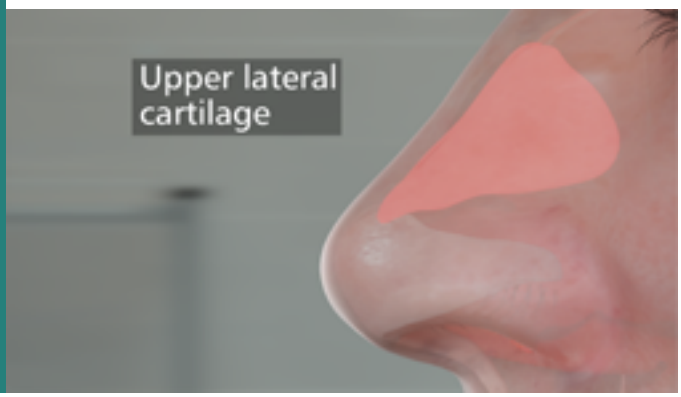
The nasal cavity contains the nasal septum, the turbinates, and is the space that air flows through as it is headed towards the lungs. It is the space that collects mucous drainage from the sinuses and that contains the olfactory nerves. These structures and functions are explored below.



The nasal hairs, called vibrissae, are the first line of defense against large particles and debris. The external part of the nose has to be somewhat flexible to bounce back from trauma yet rigid enough to maintain an opening.
As air flows into the nostrils the flow creates an inward force that tends to collapse the nostril.

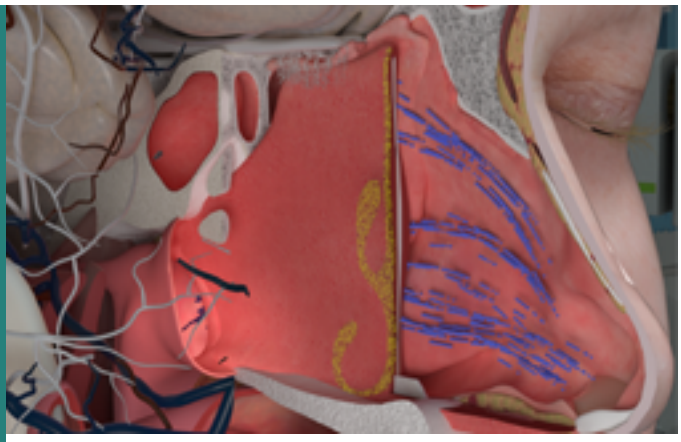


Flexible cartilage under the nasal skin provide support to resist this force. The paired lower lateral cartilages and upper lateral cartilages are in bedded in the nasal skin and provide this support.

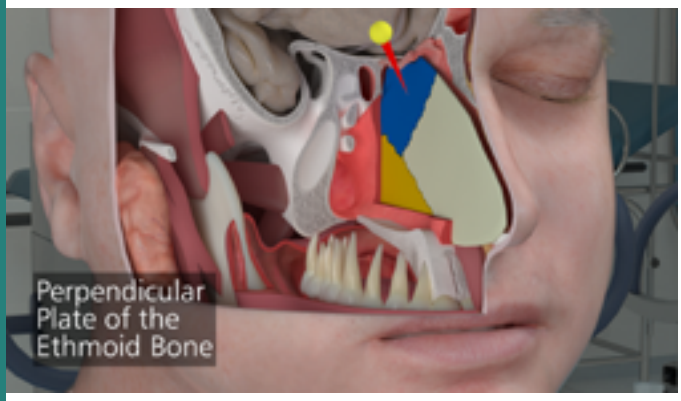


The upper lateral cartilages are fused to the cartilaginous nasal septum and the nasal bones.

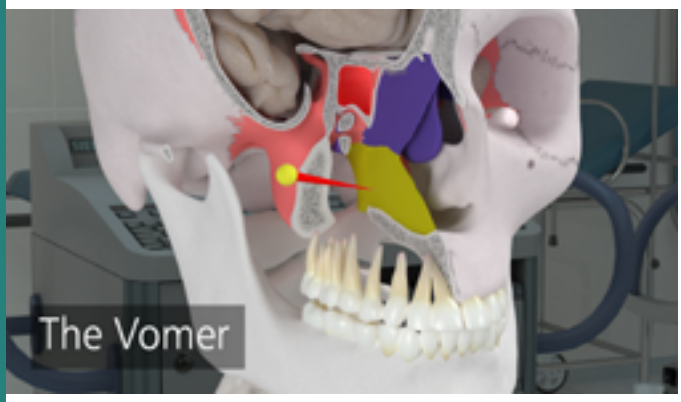
Once air enters the nose it is divided into left and right by the nasal septum. The septum extends from the nostrils to the nasopharynx. The septum provides additional surface area for air to come in contact with mucous membranes. The septum changes the airway into a narrow passage on each side, as the yellow cross section demonstrates.



The anterior portion of the septum is composed of cartilage that can flex and move without breaking (ivory color). The superior septum is comprised of thin bone which is a component of the ethmoid bone (blue color).

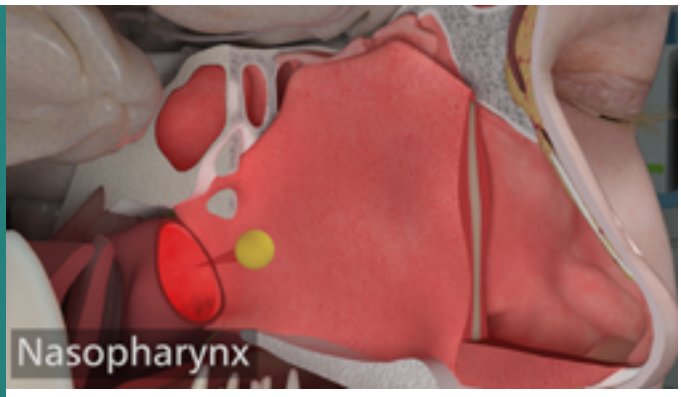


The inferior and posterior part of the nasal septum is the thick vomer bone (yellow color), a distinct bone that abuts the skull base at the sphenoid bone.

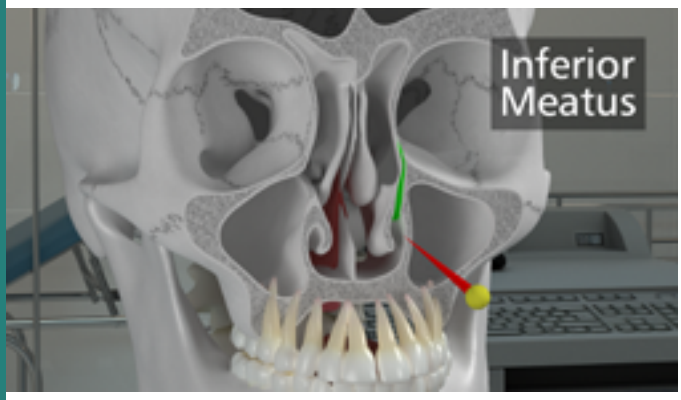


The inferior turbinate is a large and important part of the nasal airway. It runs from the front of the nose to the back. The inferior turbinate is a discreet skull bone and attaches to the maxillary bone, the bony portion is covered by a highly vascular mucosa and can change size to regulate airflow. It has a large surface area to humidify and warm the air.

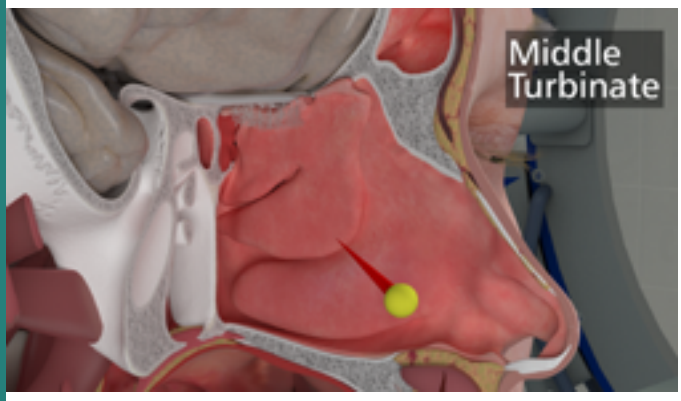
The farthest back portion of the nasal airway does not have a partition. The nasopharynx is this common space and represents the back of the nasal airway and the top of the pharynx.



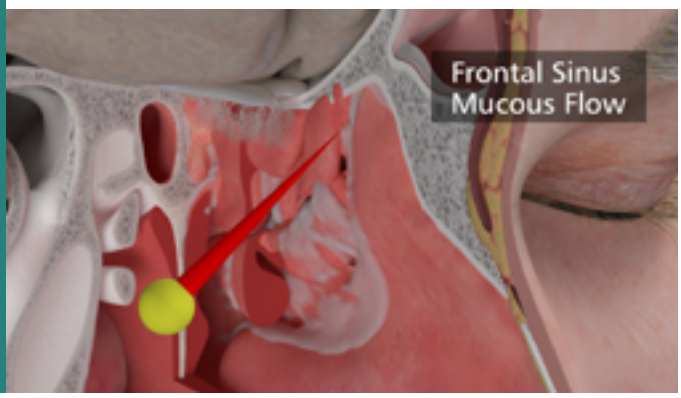
The space under the inferior turbinate is called the inferior meatus. Another discrete bone, the lacrimal bone - shown in green, helps form the tear duct which drains into the inferior meatus.



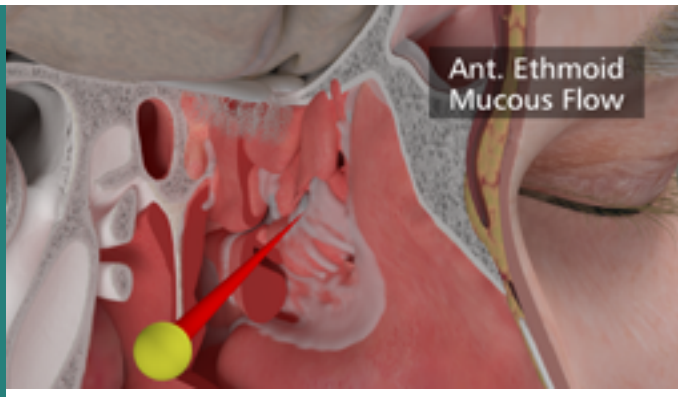
The middle turbinate acts as an awning for the sinus drainage from the frontal sinus, the anterior ethmoid sinuses, and the maxillary sinus.



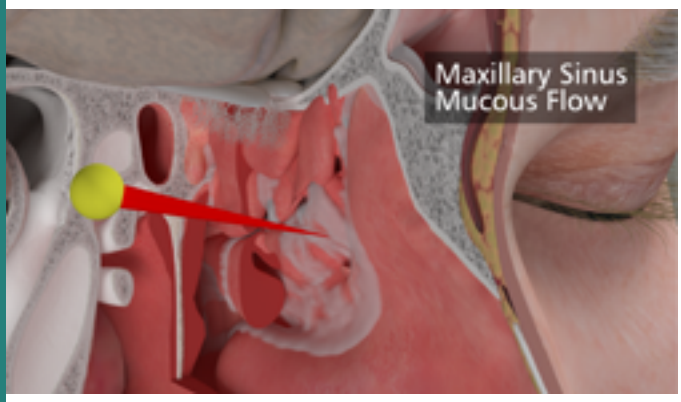
With the middle turbinate removed, the frontal sinus drainage can be seen coursing over and around the anterior ethmoid sinus cells.



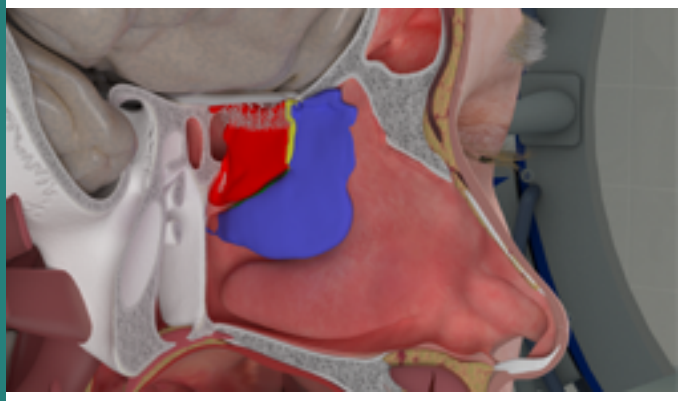
The anterior ethmoid cells also make mucous which mixes with the frontal sinus drainage and courses over the uncinate process as shown.



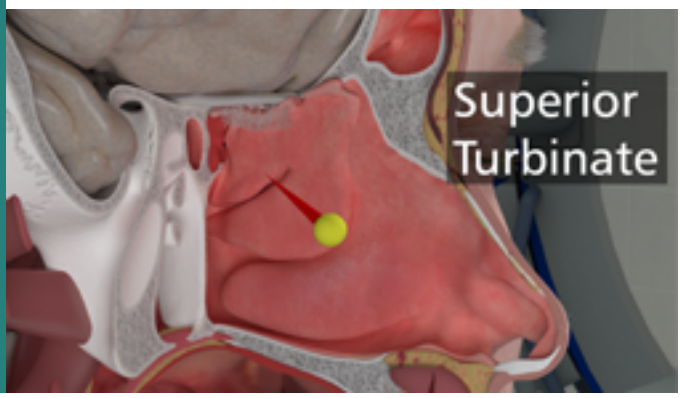
The large maxillary sinus makes a larger amount of mucous which also mixes in and courses over the uncinate process and eventually down the nasopharynx to be swallowed.



The middle turbinate is often divided into 3 sections: The vertical portion (blue), the basal lamella (yellow), and the horizontal portion (green - hard to see here). The basal lamella (yellow) divides the anterior ethmoid sinuses from the posterior ethmoid sinuses. The Superior Turbinate is shown in red.

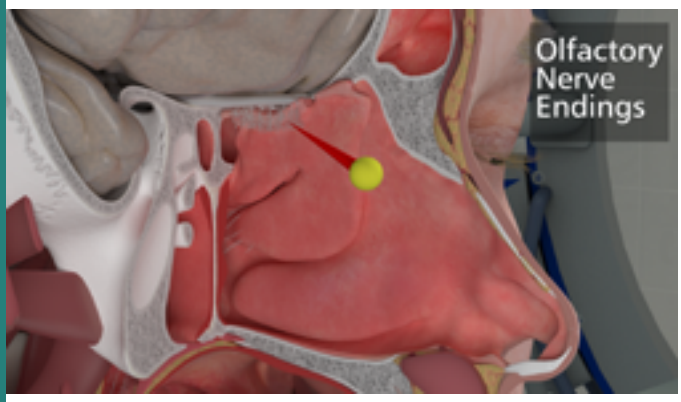


The superior turbnate is the "awining" for drainage from the posterior ethmoid sinus cells. They drain through a distinct pathway from the anterior ethmoid sinuses.



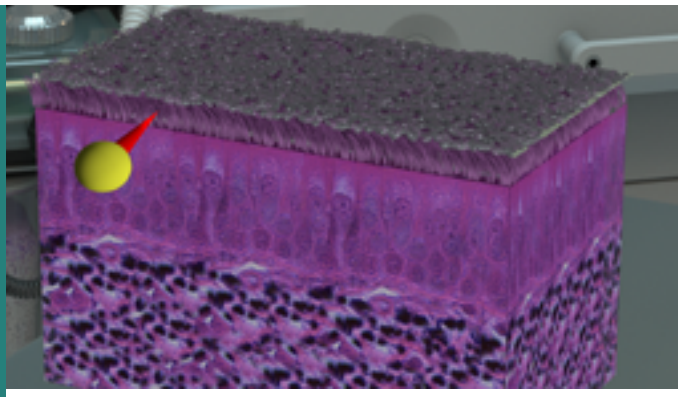
A recently recognized anatomic region called the "Nasal Swell" functions to regulate airflow in the mid portion of the nasal airway. This region of mucosal covering of the nasal septum has an enhanced ability to shrink and swell to regulate nasal air flow, much like the inferior turbinate does for the lower portion.

High in the nasal cavity are the olfactory nerve endings. This highest region of the nasal airway is extremely narrow and provides slow moving humidified air to the delicate nerve endings where the sense of smell begins.



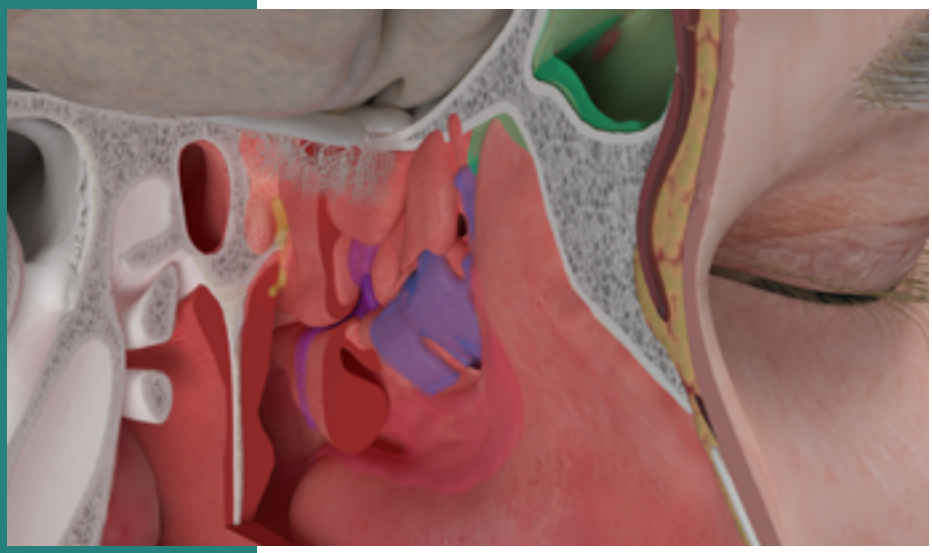
The uncinate process is a component of the ethmoid bone. There are several different configurations of the uncinate. The uncinate process provides a gutter to direct drainage from the maxillary sinus. Depending on the exact shape, it can also channel drainage from the frontal sinuses and some of the anterior ethmoid sinuses. The uncinate process helps to protect the maxillary sinus opening from direct airflow and possible contamination.

Mucous flow from the maxillary sinus is seen. The flow travels to the top and medial aspect of the sinus and drains through a small hole and then over the uncinate process. This drainage mixes with the drainage from the Anterior ethmoid sinuses and frontal sinus and then proceeds to the nasopharynx to eventually be swallowed.



A cross section of cilliated mucous membrane is shown. The mucous membranes have hair like cilia on their surface which provides the pumping action that makes active mucous flow possible. Particles stick in the viscous mucous and are moved along by the coordinated action of the cells. The arrow points to the hair cells and the mucous layer is on the top surface.

Particles stick in the viscous mucous and are moved along by the coordinated action of the cells that line the sinuses much like a crowd surfer is moved at a concert.



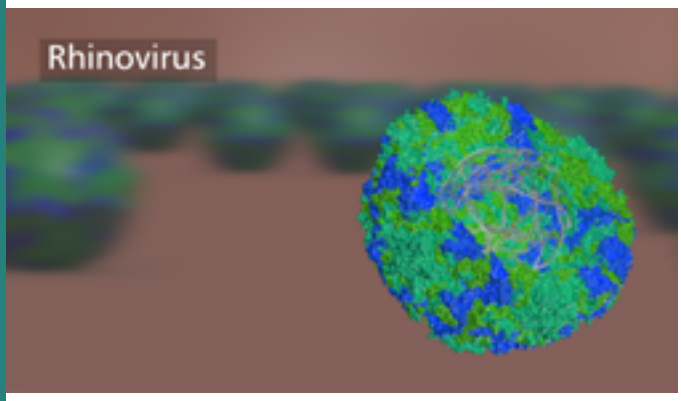
The drainage from the anterior sinus cavities mix together in the ostiomeatal region. The frontal sinus drainage is shown in green. it mixes with the maxillary sinus drainage as it passes over the uncinate process. The anterior ethmoid sinus drainage is shown in blue. the combination of these three drainage sources is shown in red. the posterior ethmoid sinus drainage is shown in purple. and the sphenoid sinus drainage is shown in yellow.

Chapter 3:

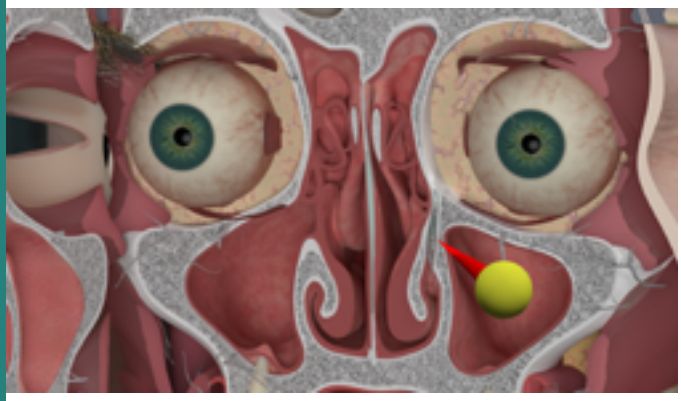
Nasal Problems and Solutions

Your nose is primarily an air passage, but in order to be successful, the airway must remain clean, humidify and warm the air, and it must also handle undesirable particles such as dust, pollen, bacteria, and viruses. It should come as no surprise that problems can arise.

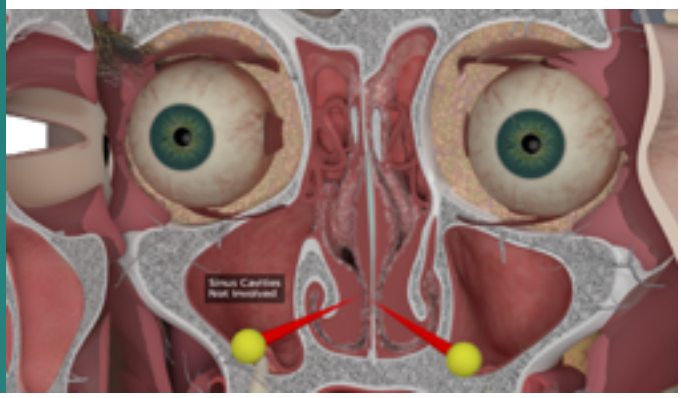
One of the most common problems is the common cold. The average adult gets 2 colds per year and children in day-care can have 10 or more viral infections per year. The rhinovirus is a single stranded rna virus as is the coronavirus. A common event that can lead to catching a cold begins with unwashed hands...



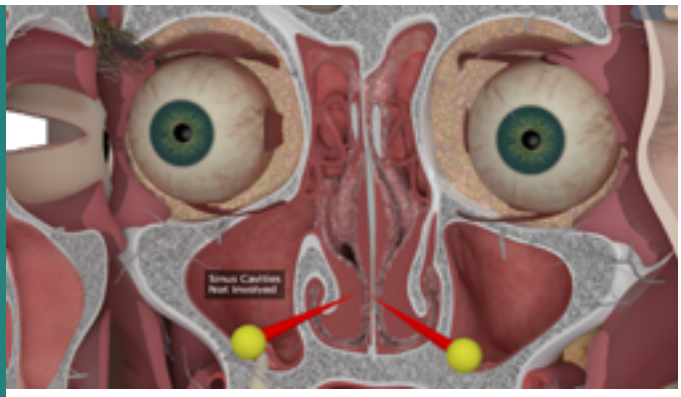
Often times, a person touches a contaminated surface, rubs their eye, and introduces viral particles to the mucous membrane at the corner of the eye. The virus travels with tears, down the lacrimal duct, and into the nasal cavity where viral replication begins. This causes swelling and increased nasal secretions. The lacrimal duct is shown, it is an underappreciated way that viruses get into your nasal cavity.



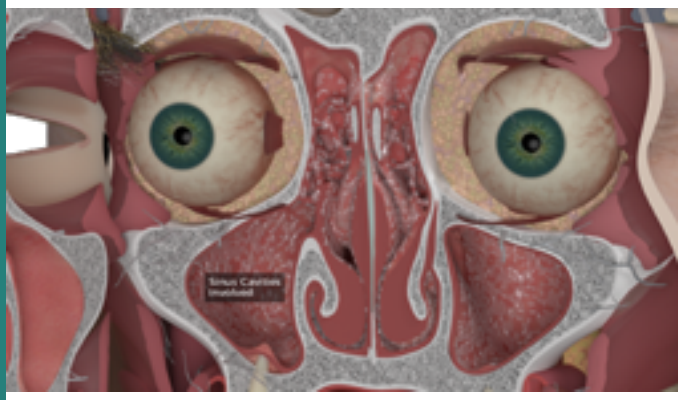
In some rhinovirus infections only the nasal cavity is involved. The septum, turbinates, and other surfaces become inflamed and swollen. Secretions increase. The space between the structures narrows causing cong are spared in mild rhinovirus infections.



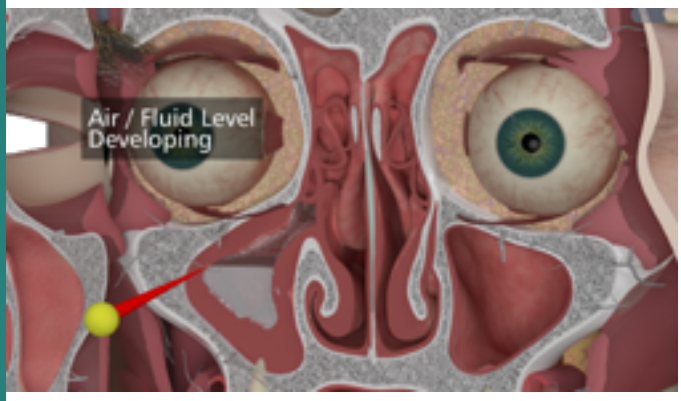
In some rhinovirus infections only the nasal cavity is involved. The septum, turbinates, and other surfaces become inflamed and swollen. Secretions increase. The space between the structures narrows causing congestion. The sinus cavities are spared in mild rhinovirus infections.



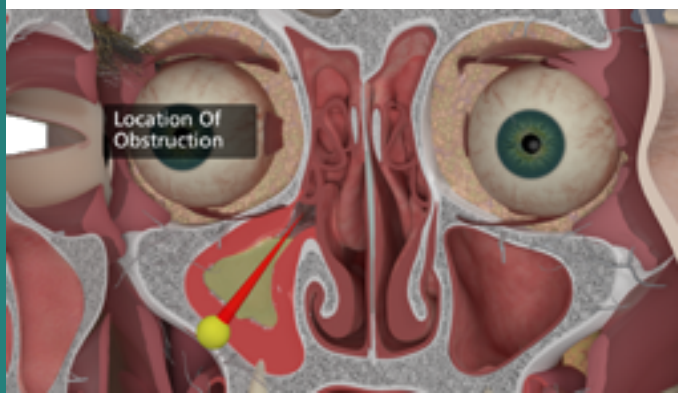
In most viral infections the swelling, increased secretions, and inflammation extends into one or more of the sinus cavities. Viral infections that involve the sinus cavities are the most common type of sinusitis. When health care professionals use the term "sinusitis", however, they are generally implying a bacterial infection.



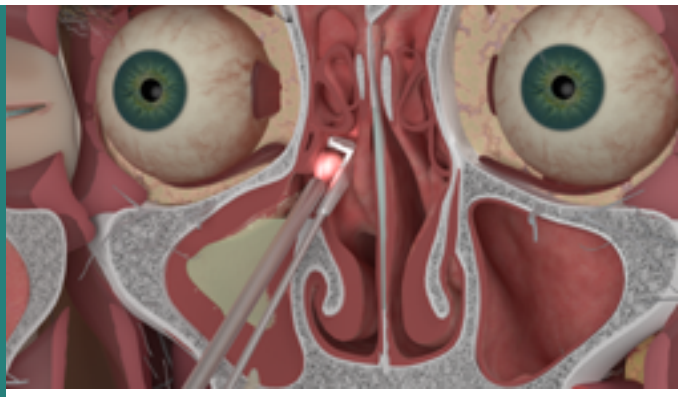
When the sinus cavities become inflamed, even as the viral infection begins to clear, it is possible for one or more of the cavities to become obstructed and fill with a puddle of liquid, often referred to as an air fluid level. In a small percentage of rhinovirus infections, the pooled secretions provide an environment for bacteria to gain a foothold. An acute bacterial sinusitis has developed.



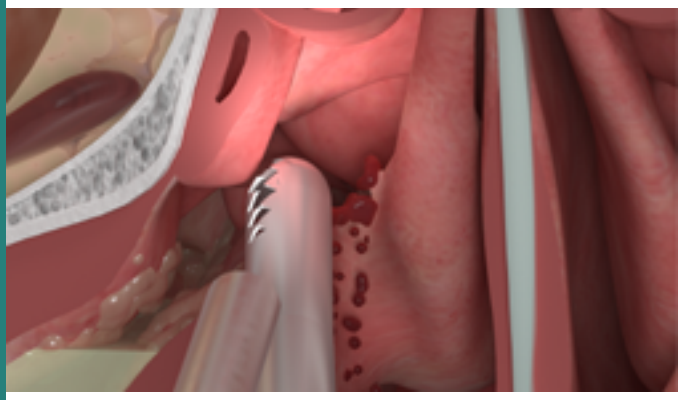
Persisting bacterial infection can lead to the simplest form of chronic sinusitis, chronic bacterial sinusitis. When inflammation and swelling block the drainage pathway of one sinus and the infected mucous cannot escape the sinus cavity, a chronic sinusitis has developed.



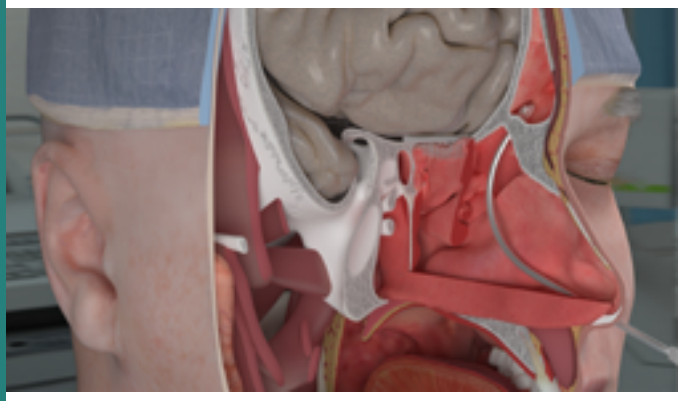
At some point it becomes clear that medications will not resolve the infection... surgically opening the sinus may become necessary. Here we see a common endoscopic sinus surgery procedure. An endoscope is used to examine the site of the obstruction, in this case the right maxillary sinus.



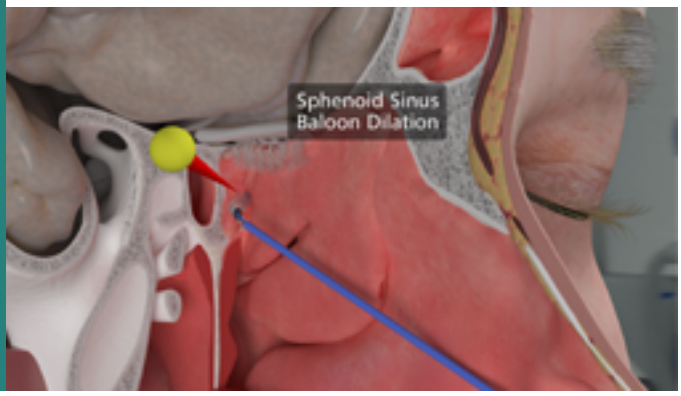
The instrument above is called a backbiter and is often used to begin removal of the uncinate process. Here we see a closeup of a powered instrument called a micro debrider that is used to remove tissue. The debrider snips small pieces of obstructing tissue and sucks them down the hollow tube.



One of the more technically difficult sinuses to open surgically is the frontal sinus. Chronic frontal sinus obstruction is dealt with by removing the obstructing ethmoid cells in the frontal recess. Once the pathway is clear, the mucosal swelling and fluid collections will often resolve. There are specific instruments that are used to open each of the different sinuses.

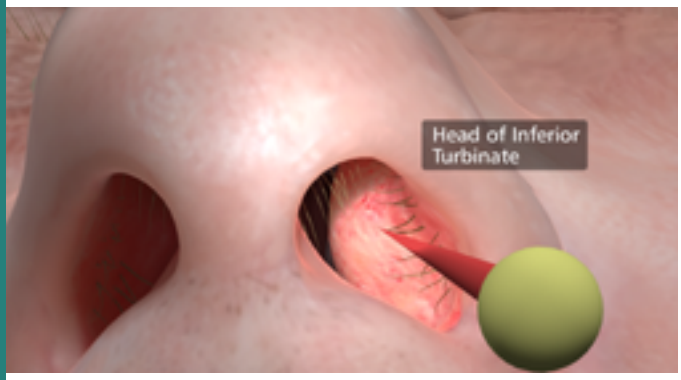


In addition to traditional sinus surgery with removal of obstructing and diseased tissue, some surgeons utilize balloon systems to stretch narrow openings and to crush obstructing sinus cells creating more room for drainage. The balloon systems are a less invasive technique, but most experienced sinus surgeons prefer removal of obstructing tissue.

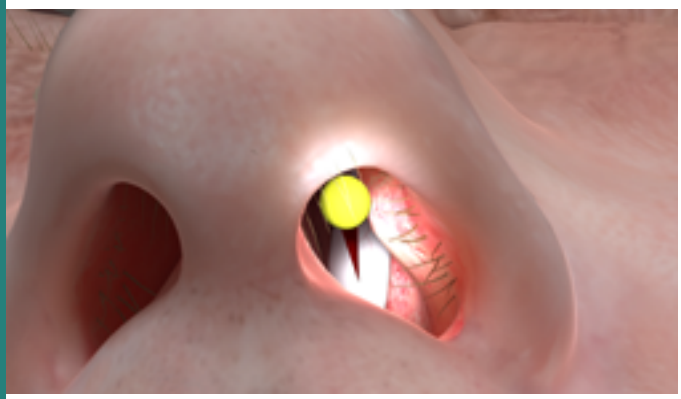


In some patients, the mucous membranes respond to inflammation by forming nasal polyps. Nasal polyps are benign inflammatory growths that represent focal swelling of the mucous membrane. Usually, they are multiple and represent exaggerated focal swelling of mucous membranes. In their most dramatic form, they can be seen protruding from the nostril.

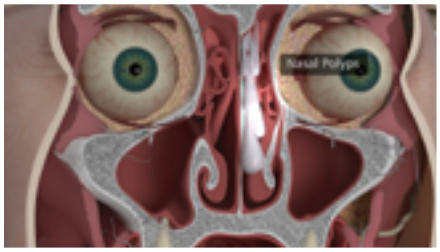
During a standard nasal exam, if the head of the inferior or middle turbinate is enlarged, it can be mistaken for a polyp.

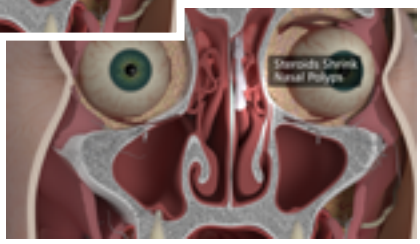


Unlike polys, enlarged turbinates are usually redish in color whereas inflammatory polyps are more often pale grey in color.



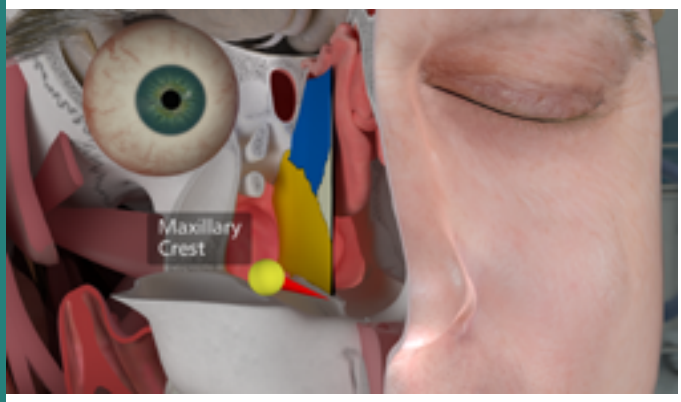
Polyps can obstruct airflow, they can block sinus drainage, and they can interfere with the sense of smell. Steroids usually shrink nasal polyps and can provide some relief. Oral steroids are most effective but steroid sprays are helpful.



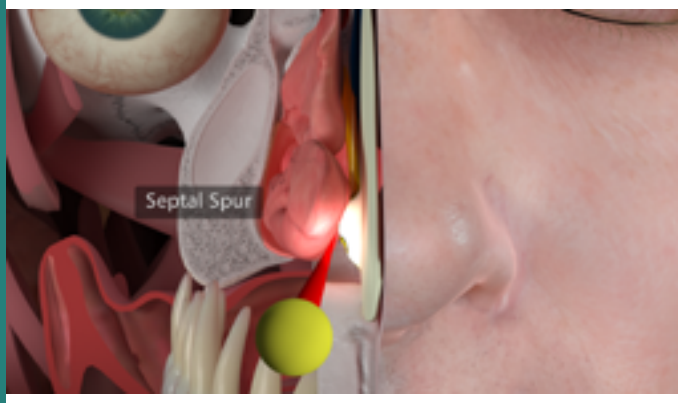


Nasal septal deviations are often attributed to injuries but many times there is no clear history of an injury. When the nose is impacted, such as in a sports injury, fight, or simply birth trauma, the impact occurs to the front of the cartilage but the force is transmitted farther back, often causing deviations well away from the actual impact.

The nasal septum sits in a trough of bone called the maxillary crest. Imperfections in the alignment of the septum here are common and can cause problems. The septum can be off of the midline, or the trough of bone itself can be off of the midline, or they are often deviated together. Each of these configurations can cause airway obstructions

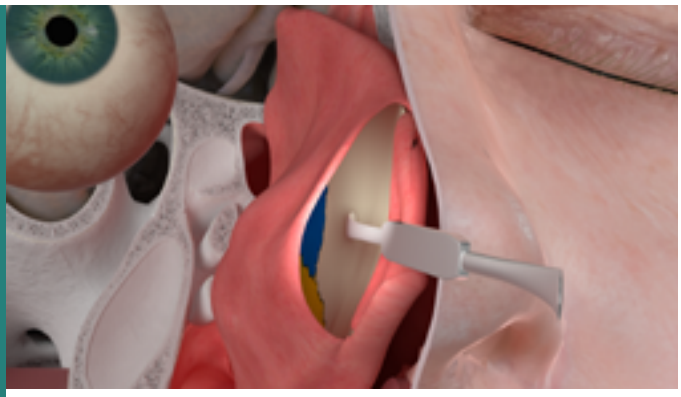


Another common abnormality is an isolated ridge of bone called a septal spur. Septal spurs can cause airway obstruction, but they can also cause referred pain if they indent the inferior turbinate

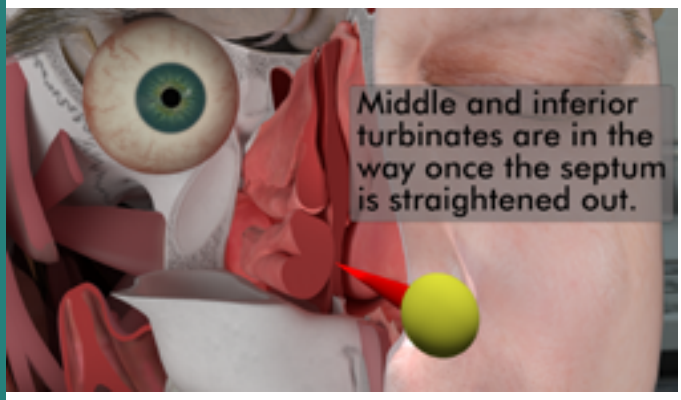


Repairing a deviation usually begins by making an incision in the mucous membrane and carefully elevating it off of the bone and cartilage.

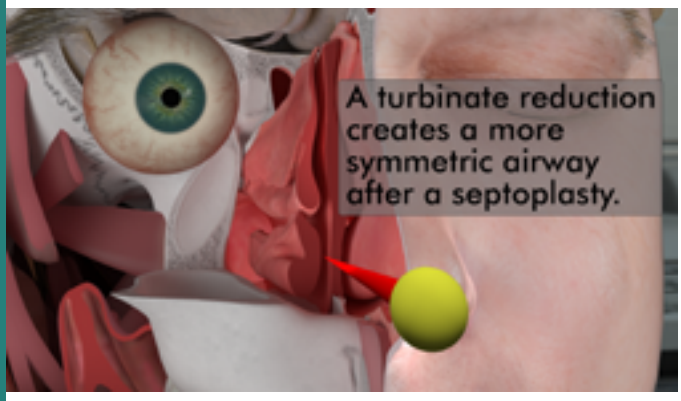
Once the deviated bone and cartilage is accessible, the off center portions of bone are removed or re-positioned. Cartilage is straightened using various techniques.



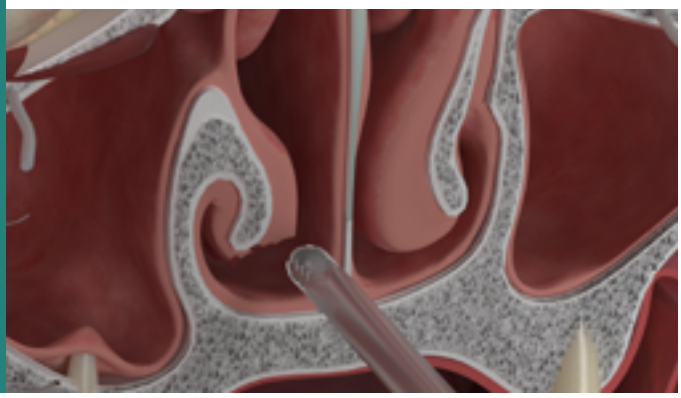
The Inferior turbinates tend to change size over time to fit the available space. They often fill the concavity of a deviation. When a deviated septum is restored to the mid-line, the previously more opened side can become obstructed because of the size or position of the middle and inferior turbinates.



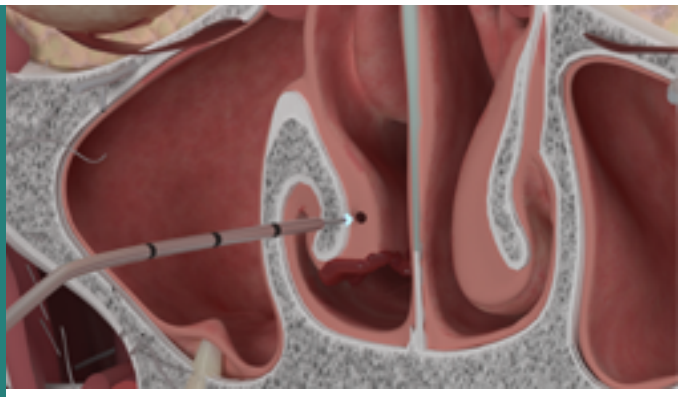
A turbinate reduction is often performed in conjunction with a septoplasty to create a symmetric airway.



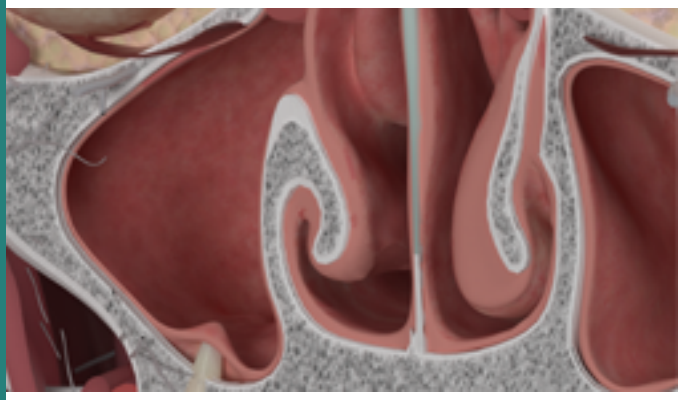
Turbinate size can be reduced using several techniques. A turbinate reduction can be helpful to improve the nasal airway in several situations and is often done as a stand-alone procedure. Here a micro debrider is removing tissue from the bottom of the inferior turbinate.



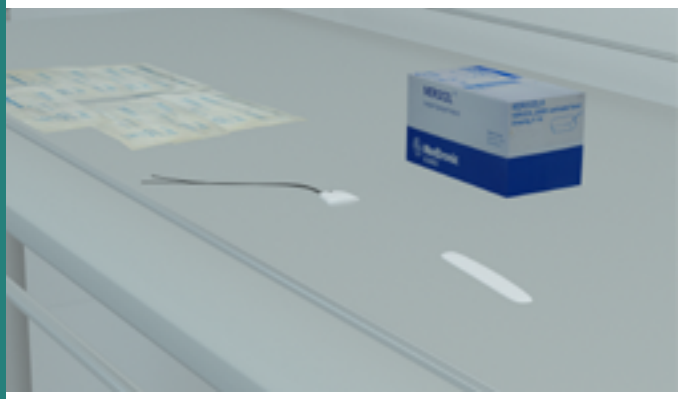
Once the excessive tissue is removed from the bottom of the turbinate, the remaing portion is treated with a plasma wand or in some cases a laser. There are several methods for reducing the inferior turbinate.



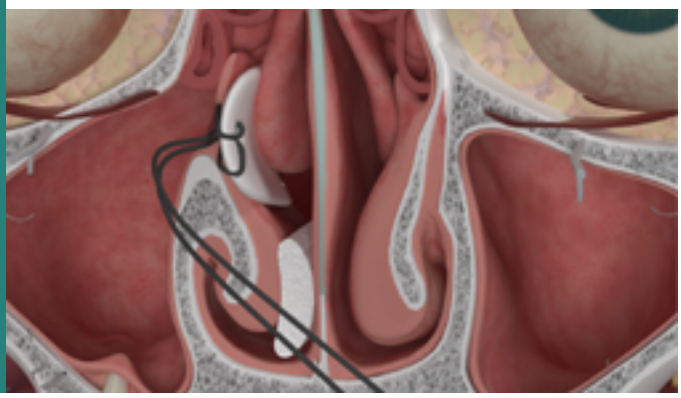
As the turbinate heals after a reduction, it recontours into a smooth surface. It is important not to remove too much tissue. The inferior turbinate serves the important function of humidifying the air and regulating airflow.



There are several different types of material that are used as packing. One of the most common is a sponge made from cellulose. This type of packing starts out firm and narrow. Once it is inserted, it is wetted with saline, Afrin, or blood the sponge expands, becomes soft, and applies gentle pressure to surrounding structures.



Packing against the inferior turbinate is often placed after a turbinate reduction or septoplasty and packing under the middle turbinate is placed for sinus surgery.



About The Author

In the interest of giving back to the medical community, Dr. Casano is providing this educational resource to anyone who might find it helpful. He is also working on advanced topics in head and neck anatomy that benefit from the unique perspective that 3D and stereoscopic animations can provide.

Dr. Casano practices in Bay Saint Louis and Diamondhead, MS as a general Otolaryngologist seeing children and adults. He has a special interest in difficult sinus and nasal problems. His practice philosophy revolves around using evidenced-based medicine to diagnose and treat sinus and nasal problems, always with a cost-conscious perspective. When surgery is a helpful option, Dr. Casano's intimate knowledge of sinus anatomy and his surgical experience ensures a well thought out and cautious approach tailored to the patient's specific situation.