Task force report

Nasal and sinus endoscopy for medical management of resistant rhinosinusitis, including postsurgical patients

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Nasal endoscopy has been practiced by allergists since the early 1980s; however, allergists in general have not embraced endoscopic evaluation of patients with sinus disease, either before or after surgery. Allergists are in a unique position to render medical (as opposed to surgical) care of patients with sinusitis. There has been a growing realization that endoscopy is a valuable procedure for the evaluation and medical treatment of patients with difficult sinusitis. This has resulted in the need for a resource to allow allergists to understand the nature of endoscopic findings in patients with sinusitis, either preoperatively or postoperatively. This article introduces the findings at endoscopy that are common in patients with sinusitis, including those that may be seen after surgery. The findings include perforation of the septum, retained secretions, small surgical ostium caused by postoperative ostial stenosis, previous Caldwell Luc procedure, recirculation of mucus, hyperplastic nasal disease, synechiae, recurrent disease in previously unaffected sinuses, empty nose syndrome, frontal sinus disease, dental disease, and other, more complicated entities.
(J Allergy Clin Immunol 2008;121:917-27.)

Key words: *Sinusitis, rhinosinusitis, endoscopy, sinus, nasal, surgery, FESS, maxillary, ethmoid, culture*

Practice parameters and practical descriptions for performance of nasal endoscopy have been written previously but have not been recently updated.[1,2] This article focuses on the use of nasal and sinus endoscopy for chronic rhinosinusitis in both presurgical and postsurgical patients. The article does not focus on normal anatomy and diagnostic aspects of normal endoscopy, because these subjects have been reviewed previously.[3]

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Disclosure of potential conflict of interest: W. S. Tichenor has consulting arrangements with Sinucare and Accentia Pharmaceuticals. D. L. Hamilos has consulting arrangements with Sinexus, Genentech, ISIS, Dey LP, Schering-Plough, Novartis, and Accentia; has received grant support from Flight Attendants Medical Research Institute and Merck; and is on the speakers' bureau for Merck, Genentech, and Novartis. The rest of the authors have declared that they have no conflict of interest.

Received for publication July 6, 2007; revised August 8, 2007; accepted for publication August 14, 2007.

Available online November 5, 2007.

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0091-6749/$34.00

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doi:10.1016/j.jaci.2007.08.065

HISTORY AND PHILOSOPHY

Allergists began performing flexible nasal and sinus endoscopy (hereafter referred to simply as "endoscopy") in the early 1980s.[4] Around the same time, functional endoscopic sinus surgery (FESS) began gaining popularity and has since become the primary surgical technique for treatment of patients with chronic rhinosinusitis that has proven refractory to medical treatment.[5-7] Endoscopy is a useful technique that affords the allergist the ability to assess and localize sinus pathology with far greater precision than a routine nasal examination. Use of endoscopy can also improve diagnostic accuracy and thereby reduce costly and unnecessary medication use (eg, antibiotics).

It is highly desirable that all specialists treating nasal and sinus disease be able to perform a complete endoscopic evaluation of the nose and sinuses, especially for evaluation of inflammatory disease.[8] Endoscopy should be viewed as part of a complete examination of the nose and sinuses. Allergists are in a unique position to treat the entire "unified airway."[9] For these reasons, it is highly desirable for allergists to be skilled in nasal endoscopy and in the preoperative and postoperative treatment of patients with rhinosinusitis.[6,10-12] A strong argument can be made for incorporating endoscopy in the routine care of any patient with chronic rhinosinusitis.

According to the otolaryngology (ENT) literature, sinus surgery affords benefit in the vast majority of cases selected for surgery.[6,10-12] Still, relapses after surgery are not infrequent and are usually best managed medically provided that the initial sinus surgery was technically adequate and resulted in an acceptable outcome. The list of conditions amenable to medical management in postsurgical patients is long and includes (1) allergic or nonallergic chronic inflammation, (2) chronic infection, (3) fungal colonization, (4) hyperplastic mucosa, (5) nasal or sinus polyposis, and (6) aspirin hypersensitivity. With experience, it is also possible to recognize anatomic abnormalities that may contribute to persistent disease after surgery.[13] Competence in endoscopy merely enhances the already important role of the allergist in recognizing and treating all diseases of the nose and sinuses and in recognizing other important contributing conditions, such as gastroesophageal reflux disease (GERD), aspirin sensitivity, immunodeficiencies, and less common diseases such as cystic fibrosis, sarcoidosis, Wegener granulomatosis, and ciliary dyskinesia or tumors. Wegener typically may have constitutional symptoms associated with nasal blockage, crusting, epistaxis with facial pain, septal perforation, and nasal collapse. Tumors most commonly arise in the maxillary sinus. They tend to be unilateral, with nasal obstruction, hyposmia, and epistaxis. Orbital symptoms are common. If any suspicion of malignancy occurs, the patient should be referred for biopsy.

It has been shown that patients with chronic rhinosinusitis and allergic rhinitis fare better after endoscopic sinus surgery if their allergies are managed optimally.[14] Although some allergists have expressed concern about performing nasal endoscopy, nasal endoscopy is generally considered part of normal procedures for allergists by both malpractice and health insurance companies and is usually included in malpractice insurance. In addition, many allergists receive training in endoscopy during their fellowship or at subsequent courses.[3]

ADVANTAGES OF FLEXIBLE OVER RIGID ENDOSCOPES

In our experience, it is easier to examine certain areas such as the sphenoethmoidal recess, the anterior wall of the maxillary sinus (in patients who have had previous surgery), and the sphenoid sinus with a flexible endoscope. This is also true with respect to large patent accessory maxillary sinus ostia. Often, the entire maxillary sinus can be examined with the flexible endoscope in patients who have had previous surgery.

SAFETY ISSUES

Although concerns about safety have been expressed by some allergists, there are minimal concerns in reality other than vasovagal reactions.[15] Most allergists do not perform biopsies (other than perhaps mucosal brushings); as a result, there is little, if any, risk of bleeding. Assuming that one does not attempt to enter forcibly a small sinus ostium or pass through an area where there are sharp bony fragments such as the frontal recess, there is minimal, if any, risk of problems removing the endoscope.

EQUIPMENT

Although rigid endoscopes are the most popular among otolaryngologists, flexible endoscopes are preferred by allergists for the reasons mentioned.[3] Partly this relates to the fact that allergists, unlike ENT surgeons, do not perform procedures requiring rigid endoscopes (eg, FESS), but the main reason is the ease of use and the ability to manipulate the flexible endoscope easily into narrow recesses. On the contrary, many otolaryngologists prefer the superior optics and visualization afforded by the rigid endoscopes. In addition, it is easier to use another instrument alongside the rigid scope.

Rigid endoscopes are made in varying angles: 0°, 30°, 45°, and 70°. The less experienced examiner will typically start with a 0° endoscope. Flexible endoscopes are made by numerous manufacturers (Pentax, Montvale, NJ; Olympus, Center Valley, Pa; and others) in varying diameters. Endoscopes with and without procedure or biopsy channels are available. The narrowest useful diameter without a channel is approximately 2.2 mm; however, with the narrower pediatric fiberoptic endoscopes, some sacrifice must be made in image quality to use a smaller diameter endoscope. One must therefore choose whether to use a narrower scope and compromise some image quality. The 2.2-mm or 2.4-mm endoscopes are most commonly used. The narrowest endoscope with an internal biopsy channel is 3.4 mm.

Care must be taken in handling the endoscopes, because they are delicate and easily damaged. Repairs may cost several thousand dollars. Although more expensive xenon light sources can be used, halogen light sources are usually adequate. Cleaning of the endoscope is accomplished easily. Initially a leakage test should be performed to ensure that the integrity of the instrument has not been compromised and it will not be damaged in the cleaning process. The instrument is then rinsed to remove any gross debris and very gently wiped down to prevent damaging the instrument. The instrument is then placed in an enzymatic cleaner (eg, Endozime, Ruhoff, Mineola, NY; or Enzol, Johnson & Johnson, Irvine, Calif) for the recommended time (usually 10 minutes). The instrument is once again rinsed and gently wiped down. It is then placed in glutaraldehyde (eg, Cidex, Advanced Sterilization Products, Ethicon, Irvine, Calif; Metricide, Metrex, Orange, Calif) or a related product, ortho-phthalaldehyde (eg, Cidex-OPA) following the manufacturer's suggestions for duration of sterilization. For Cidex-OPA, the time required is 12 minutes. Thereafter, the endoscope must be thoroughly rinsed to remove all traces of the microbicide and then dried. A wall-mounted cleaning stand can be used to simplify the process (EndoCaddy; Aztec Medical Products, Williamsburg, Va). If an endoscope with a channel is used, more extensive cleaning is required. A suggested protocol for the use of Cidex-OPA is included in this article's Appendix E1 and E2 in the Online Repository at www.jacionline.org.

The endoscopic procedure can either be viewed through the eyepiece or through a video monitor. With the smaller diameter endoscopes, there is a significant reduction in image quality that may compromise the evaluation when used with a video monitor. Various video camera attachments are available for recording purposes. Although cameras (Fig 1) are now small (eg, 5 cm × 3 cm × 3 cm), the bulk at the head of the endoscope may make subtle maneuvers more difficult to perform. Alternatively, a video camera cable can be attached to the endoscope and connected to a table-mounted camera. It is also possible to mount the endoscope from a ceiling support.

During endoscopy, it is possible to perform a number of therapeutic procedures. First, in patients who are having acute pain during the procedure, it is possible to irrigate tissues with small amounts of lidocaine using a Sinus Irrigation Catheter (Medtronic Xomed, Minneapolis, Minn; Fig 2). (Otolaryngologists may use lidocaine or cocaine soaked pledgets or injections of local anesthetics, but these may not be available to allergists.) For patients with inflammatory disease or signs of infection, it is possible to directly instill corticosteroids, saline, or antibiotics into a sinus cavity if the sinus ostium is patent.

There are several options for patients who need procedures performed during the endoscopy. First, as described previously, fiberoptic endoscopes are available that have a separate channel contained within the endoscope through which procedures can be performed. The advantage of this is that the channel is self-contained within the endoscope. However, this type of endoscope is impractical for everyday use. Although the same endoscope can be used both for routine endoscopy and for cultures or other therapeutic endeavors, the greater diameter of the dual channel endoscope makes it more difficult to maneuver and more uncomfortable for the patient. Also, the dual channel endoscope requires more extensive cleaning or use of a protective sheath each time the endoscope is used, whether or not the channel is used. Hence, the dual channel scope is usually reserved for special procedures or research activities.

There is a sheath available with an external channel (Vision Sciences/Medtronic Xomed, Jacksonville, Fla; Fig 3). This has been a valuable addition to the endoscopist's armamentarium. Originally, sheaths were developed as a means for using endoscopes (particularly gastrointestinal endoscopes with internal channels) without having to sterilize them after each use. The

sheath is applied over the endoscope and disposed of after 1 use. This significantly shortens the time between procedures. The sheath protects the channel as well, and the cleaning process is therefore much easier. It was later discovered that it was possible to create a sheath with a channel external to the endoscope but self-contained within the sheath. Using this device, brushings or procedures such as foreign body or fungus ball removal can be performed by using a brush (Fig 4), snare (Fig 5), or basket (Fig 6) with an endoscope that was not originally designed for surgical procedures.

A sinus puncture device (Sinoject; Atos Medical, Milwaukee, Wis) was recently developed that has dramatically reduced the complexity of sinus puncture; however, this procedure remains infrequently used because of trauma, patient dislike for the procedure, and the risk of iatrogenically introducing organisms into the sinus.[16] The Sinoject is not currently distributed in the United States.

Unlike rigid endoscopes, with which the examiner can perform endoscopy and other procedures without assistance, use of the flexible scope requires an assistant to perform other procedures or cultures. The examiner must use 1 hand to hold the tip of the endoscope and the second hand for obtaining the cultures. With practice, the assistant can be taught to hold the endoscope during this procedure.

DIAGNOSTIC CULTURES

All too frequently in routine practice, patients treated for sinus infections do not respond to treatment. In part, this is because of empiric use of antibiotics without knowledge of the bacteria, fungi, mycobacteria,[17] or other organisms involved. There is also a real risk of creating more severe infections, such as those caused by Gram-negative or methicillin-resistant *Staphylococcus aureus* by repeatedly using antibiotics empirically. Fungal overgrowth is another possible side-effect. Obtaining meaningful cultures during endoscopy can help alleviate these problems and afford medical management a much greater likelihood of success.[16,18] That said, meaningful cultures are not simple to obtain and must be performed with proper techniques, appropriate collection vessels and transport media, and timely delivery to the laboratory. Therefore, the endoscopist must be aware of these factors before embarking on culturing sinus mucus. The techniques for specimen collection require some practice, and equipment must be obtained specifically for this purpose.[19]

Samples must be placed in proper transport media to avoid desiccation and to support the growth of pathogens. Specimens must be transported to the laboratory within time constraints set for the transport media selected; otherwise, the culture results cannot be trusted. Fungal cultures must be sent in appropriate transport medium to a laboratory with expertise in mycology, including speciation of fungi and determination of antifungal sensitivities. Adequate amounts of material must be sent for both bacterial and mycological cultures. The larger the volume of material, the more likely a pathogen will be recovered.[19] We recommend not obtaining cultures unless these points are taken into consideration.

Culturing for anaerobic bacteria is more difficult than culturing for aerobic bacteria and requires special techniques and specimen handling. The role of culturing for anaerobic bacteria has been emphasized by Brook et al[20] and Brook[21] but is of uncertain value in the outpatient management of chronic rhinosinusitis.



FIG 1. Videocamera. Courtesy of Pentax Medical.

Although strict criteria for timing of cultures do not exist, generally cultures should not be performed during antibiotic treatment. If they need to be performed, the presumption is that the antibiotic being used is not effective. Although some authors have suggested otherwise, to avoid misleading culture results, the antibiotic should be stopped for at least 48 hours before obtaining cultures.

Cultures should be taken from appropriate areas, especially from the middle meatus[16] or directly from the sinuses in patients who have patent ostia. Care must be taken not to contaminate the specimen. Unlike cultures taken from the nose, endoscopically guided cultures from the ostiomeatal unit using Dacron urethral swabs have been found to reproduce accurately cultures taken from within the sinuses, either at the time of surgery or via sinus puncture; however, larger studies still need to be performed.[16,18,22] Generally, the most reliable cultures can be expected when the mucus collected is visibly purulent,[16,23] but there may be exceptions to this rule. For instance, Orobello and Park[24] reported a strong correlation between middle meatal cultures and both maxillary and ethmoid sinus cultures in children, even though gross purulence was not present in the former location.

Devices such as the Xomed Sinus Secretion Collector (a catheter with long thin tubing for collection of sinus mucus and debris; Medtronic Xomed; Fig 7) can be directed into the middle meatus (ostiomeatal unit) or, occasionally, into a sinus ostia.[25] The sinus secretion collector consists of a 2-mm plastic malleable catheter inside a protective sheath. This is attached to a suction device. The protective sheath minimizes but does not completely

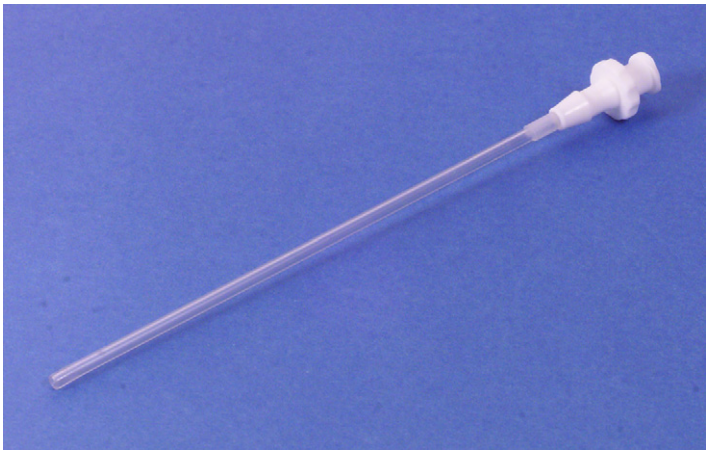


FIG 2. Irrigation catheter. Courtesy of Medtronic Xomed.



FIG 3. Endoscope with endosheath and external channel. Courtesy of Vision Sciences, Medtronic Xomed.



FIG 4. Brush. Courtesy of US Endoscopy.

eliminate contamination from the anterior nares. After introduction into the middle meatus or sinuses, the outer sheath is retracted, suction applied, and a sample taken. The cultured material is retained within a Lukens collection trap. This device allows collection of larger volumes of mucus for more accurate and less contaminated cultures. Once collected, the sample can be divided, transferred to special bacterial or fungal transport media, and then sent to the laboratory. In addition, a sample may be sent for cytology in an appropriate medium. Because of the low recovery rate for fungal stains and cultures, consideration should be made to sending specimens to more than 1 laboratory. Cultures should be relied on for species identification, because identification of species is often difficult on the basis of stain, cytology, or surgical specimen.

Equally important are discussions with the laboratory supervisor. These discussions should occur before the endoscopist



FIG 5. Snare. Courtesy of US Endoscopy.

begins performing cultures so the requirements for these cultures can be established. Depending on the clinical circumstances, bacterial and fungal cultures and sensitivities can be obtained by using the appropriate culture media suggested by the supervisor. If the patient has persistent infection despite adequate therapy, other unusual types of infections, such as those caused by atypical mycobacteria or other organisms, should also be considered. It may be necessary to consult the microbiologist and mycologist regarding what sensitivities may be done. Generally, if swabs are used for culture, it is preferable not to use cotton tipped swabs because they may reduce the yield of cultures. Purulent drainage from the middle meatus or sinus ostium can be collected on a calcium alginate swab on an aluminum shaft (eg, Calgiswab; Puritan Hardwood Products Co, Guilford, Me) or a Dacron-tipped swab or with a sinus aspirator (eg, Xomed aspiration system with a Lukens collection trap; Medtronic Xomed Tami Sinus Secretion Collector).

In some cases, a Gram stain or cytologic examination for eosinophils and Charcot-Leyden crystals may also be useful. Fungal stains such as Gomori methenamine silver or periodic acid-Schiff are most commonly used to stain mucus for fungal hyphae; however, staining may be unreliable. As a result, a more sensitive fluorescein-labeled chitinase stain that stains the chitin layer of the fungal organism (eg, Fungalase; Anomerics, Baton Rouge, La) has been described.[26] However, this stain is not yet in general use.

Molecular diagnosis of the presence of fungi in mucus or tissue specimens is a promising and emerging technology using either panfungal or species-specific nucleotide primers.[27,28] However, only limited studies have been performed, and the mere presence of fungal DNA or mRNA in mucus may not differentiate normal from abnormal levels of fungal colonization or disease. Elevated levels of major basic protein may allow such differentiation,[29] but further work needs to be done in this area.



FIG 6. Basket. Courtesy of US Endoscopy.

ENDOSCOPY IN THE PATIENT WHO HAS NOT HAD PREVIOUS SINUS SURGERY

The following section focuses primarily on patients who have not had surgery, although some aspects will also apply to postsurgical patients.

Anatomy

A detailed review of anatomy will not be provided here; however, the reader should be familiar with the anatomy of the nose and sinuses, especially the nasal valves, uncinate process, infundibulum, hiatus semilunaris, ethmoid bulla, and frontal recess, as well as the entire ostiomeatal unit (Figs 8 and 9). The ostiomeatal unit consists of an area including the middle meatus, uncinate process, infundibulum, anterior ethmoid cells, and ostia of the maxillary, ethmoid, and frontal sinuses.

Review of endoscopic anatomy[30-32] or observing FESS or attendance at a training course for FESS (which includes cadaveric dissection) can be invaluable in training. Courses on advanced endoscopy have now been included at American Academy of Allergy, Asthma & Immunology meetings and are critical for the allergist who wishes to perform the techniques suggested here.

Septal deviation

Septal deviation is common but rarely severe enough to prevent nasal endoscopy, especially if a pediatric endoscope is used. After noting the amount of the septal deviation before decongestion, the

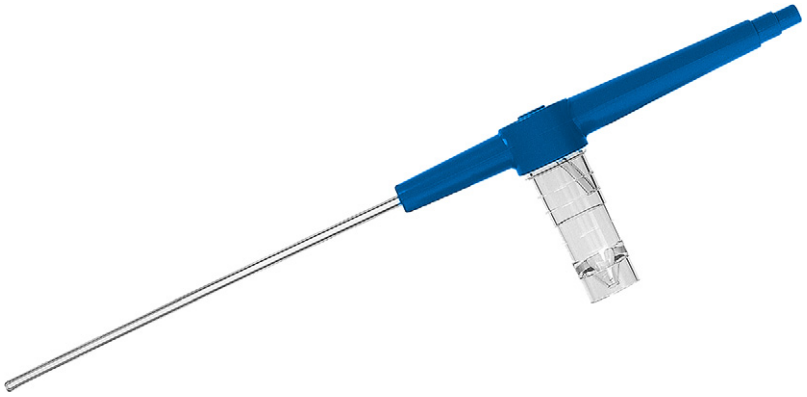


FIG 7. Sinus secretion collector. Courtesy of Medtronic Xomed.

examiner can evaluate the effects of the decongestant. It is important to observe the effect of the decongestant clinically before nasal endoscopy, particularly in regard to mucosal swelling, turbinate hypertrophy, and clinical symptoms such as headache. Septoplasty is often done at the same time as endoscopic sinus surgery but is not always necessary. Indications will not be addressed here, but there are numerous references concerning this subject.[33,34]

Middle meatus

The patient must be adequately anesthetized and decongested before the procedure. Sometimes one must decongest and reanesthetize the patient to examine the area adequately. It is possible to do so when performing the endoscopy by placing lidocaine saturated Dacron swabs in the middle meatus or wherever the patient is having discomfort. It is also possible to direct lidocaine solution with an irrigation catheter into the area that needs to be anesthetized further.

Injected hyperemic tissue is not unusual, but occasionally tissue may look normal despite inflammation in the sinuses. This can occur when there is complete obstruction of the ostiomeatal unit. Care must be taken not to inflict more pain than necessary on attempting to visualize the middle meatus. Swelling and inflammation with reduction in size of the meatus may significantly compromise the ability to examine the area. Inflamed turbinates may swell enough to compromise the meatus.

Uncinate process and hiatus semilunaris

The uncinate is located on the lateral nasal wall underneath the posterior portion of the middle turbinate. It is the most anterior portion of the middle meatus, and typically it is the first structure removed during endoscopic sinus surgery (Figs 10 and 11). The hiatus semilunaris is the area between the uncinate process and the ethmoid bulla.

Some endoscopists are able to examine these areas in selected patients before surgery by using flexible pediatric endoscopes, but this requires special skill and preparation. The middle meatus must be very well decongested and anesthetized to avoid discomfort. It is highly desirable to examine this area if possible to look for inflammation. This area may appear inflamed when other areas appear normal.

It is important for the endoscopist to gain experience in recognizing the appearance of the uncinate process as well as the appearance after uncinectomy. Extensive experience with endoscopy is important when making an assessment of this area. Observation of the sinus anatomy at the time of sinus surgery can be an invaluable learning experience in this regard.

Accessory ostia

Accessory ostia into the maxillary sinus have been reported in 25% to 50% of patients.[32,35] The ostium may vary from pinpoint size to several millimeters. The accessory ostia are found in the midportion of the lateral nasal wall at the sites of the anterior or posterior fontanelles. Sometimes it is possible to cannulate the ostium and directly visualize the mucosa of the maxillary sinus and perform cultures. Further discussions of the examination of the maxillary sinus are found in the section on postsurgical patients.

Sphenoethmoidal recess and choana

The sphenoethmoidal recess and choana can be inflamed as a result of drainage through the posterior ethmoid or sphenoid sinus where inflammation is present in those sinuses. On reaching the sphenoethmoidal recess and deflecting the tip of the endoscope superiorly, one should be able to visualize the superior turbinate and possibly the sphenoid sinus ostium. Less commonly, the posterior ethmoidal ostia are also visualized. It is sometimes possible to cannulate the sphenoid sinus ostium and inspect the mucosa in the sphenoid sinus. One can sometimes visualize pus streaming from 1 or more sinus ostia into the sphenoethmoidal recess.

Anatomic considerations in treatment of children

In children, adenoidal hypertrophy can play a significant role in causing sinus disease.[36] It is important to make an assessment of the percentage of airway obstruction in pediatric patients with nasal disease,[37] and this should be addressed and treated in conjunction with the sinusitis.[36] We have performed nasal endoscopy in infants a few months old in selected cases. Pediatric otolaryngologists will suggest adenoidectomy at the same time as sinus puncture in some patients before considering FESS.[36,38] One must remember that anesthesia must also be used for debridement after surgery in children. In adults, adenoidal hypertrophy is more a result of rather than a cause of sinusitis. It may contribute to upper airway obstruction in patients with obstructive sleep apnea. In

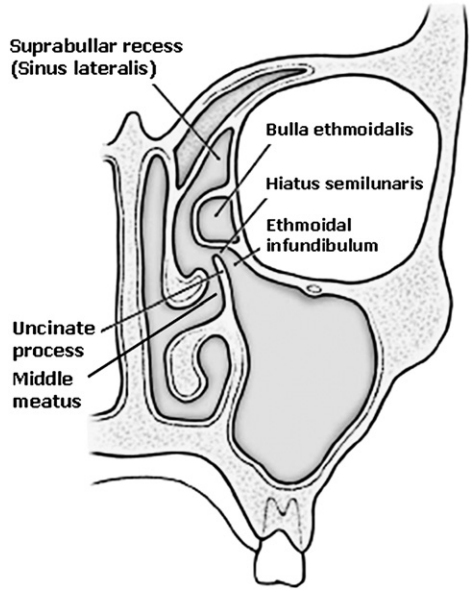


FIG 8. Coronal diagram of sinuses. Modified with permission,[31] Figs 1-4.

some cases, adenoidal hypertrophy may warrant a biopsy and concern for the possibility of malignancy or HIV disease.[39]

Epiglottis and larynx

Inflammation of the epiglottis and larynx may be the result of postnasal drainage from sinusitis[40] as well as nonrespiratory causes such as GERD.[41] Examination of these areas should be included in the complete endoscopic examination.

POSTSURGICAL CONSIDERATIONS

Once patients have had FESS surgery for sinus disease, additional structures become accessible to endoscopic evaluation, and postoperative complications can be evaluated.

Anatomical changes after surgery

Understanding of sinus anatomy is essential in evaluating the postsurgical patient. This is especially true with respect to the complex anatomy of the ostiomeatal unit and adjacent structures.[30-32]

Depending on the amount of surgery performed, there may be a septal perforation, reduction in size or absence of the turbinates, inferior or middle meatal antrostomies, removal of the uncinate processes and part of the lateral nasal wall, resection of the ethmoid or sphenoid sinuses, or resection of the frontal recess and frontal sinus. In some patients, the frontal sinus surgery may involve a frontal sinus obliteration (osteoplastic flap) in which the frontal sinuses are obliterated with transplanted fat. Extremely rarely, resection of the posterior portion of the septum may be performed.

Complications may occur in the immediate postoperative period, but the otolaryngologic surgeon is primarily responsible for care in these cases. Potential complications include cerebrospinal fluid leak, hemorrhage, periorbital ecchymosis, emphysema or hematoma, visual changes, arterial injury or stroke, or meningitis. These have been discussed in a recent review.[42]

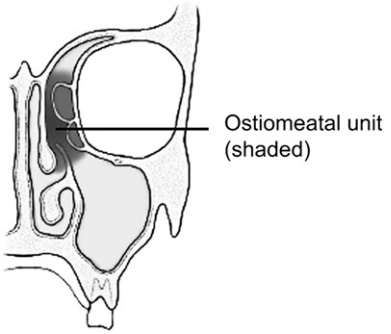


FIG 9. Ostiomeatal unit *(shaded).* Modified with permission,[31] Figs 1-7.

Perforated septum

Perforation of the septum can occur as a result of septal surgery or noniatrogenic causes.[43] The septum is most commonly damaged at the time of a septoplasty.[44] It is possible that the perforation may be appreciated during the postoperative period. The septum is potentially vulnerable to injury after surgery, both from the patient and during postoperative debridement.[44,45]

Retained secretions

Retained mucus in the maxillary sinus may be caused by infection, inspissation of secretions, foreign body (rarely), abnormal mucus rheology, mucus recirculation, continued ostiomeatal obstruction, or mucociliary disturbance. It is not a *sine qua non* for infection. Nonetheless, retained mucus is often colonized with pathogens, and the colonized mucus can elicit local inflammation. For this reason, it is often helpful to obtain cultures (bacterial and fungal) from the mucus.

Even though patients have had their ostia surgically enlarged, patients may be found to have mucus inside the sinuses. The quality of the mucus can vary from thin white to yellowish or greenish purulence to dark, almost black and inspissated. Occasionally, fungal growth can be seen on surface of black mucus. It may be possible to remove it at the time of endoscopy with a rigid catheter or a sinus secretion collector. The secretions may be so viscous as to obstruct the secretion collector. A sinus irrigation catheter may be needed to irrigate with saline, antibiotics, steroids, or lidocaine (in patients who need additional anesthesia). In addition, the endoscope procedure channel may be used (either external in the endosheath or internal) to remove this material as well as perform brush biopsies or tissue removal (eg, fungal balls).

Patency of the surgical ostium

An assessment of the patency of the surgically created ostium should be made. Some otolaryngic surgeons prefer to create a small (3-4 mm) surgical ostium.[46] Discussion of the reasons for different surgical techniques is beyond the scope of this review; however, it is important to examine the surgical ostium for postoperative narrowing as a result of synechiae, edema, thickened mucus, fungus balls, or polyps.[47-49] The thickness of the lateral nasal wall at the margin of the surgical ostium should also be noted. This wall is usually a thin structure. Thickening can occur as a result of scarring but may represent inflammatory or polypoid thickening within the maxillary sinus.

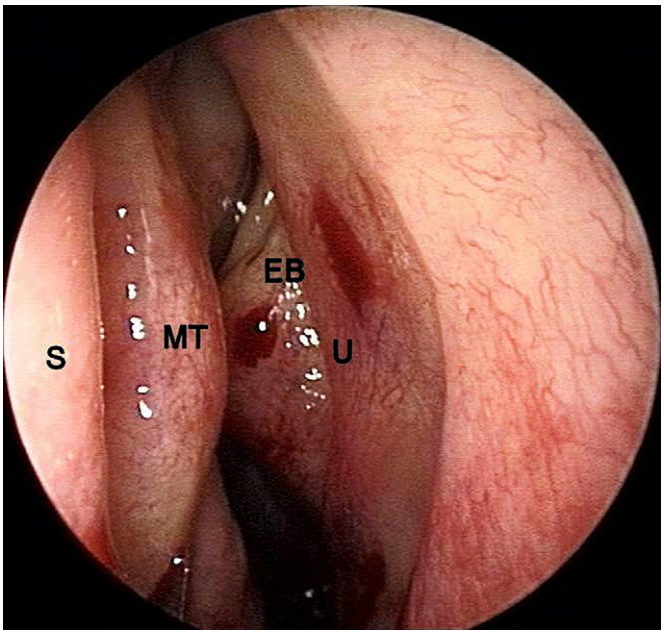


FIG 10. Middle meatus and uncinate process. *EB,* Ethmoid bulla; *MT,* middle turbinate; *S,* septum; *U,* uncinate process.

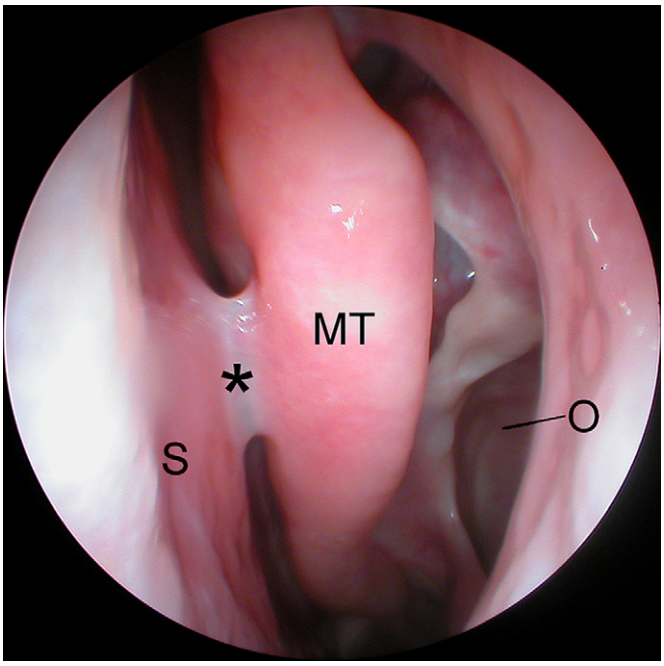


FIG 11. Resected uncinate with maxillary antrostomy. *MT,* Middle turbinate; *O,* surgical ostium; *S,* septum; *synechiae and purulent discharge.

Caldwell Luc procedure

Before current endoscopic surgery, the standard operation was a Caldwell Luc procedure, in which an inferior meatal antrostomy and maxillotomy were performed, typically after an incision above the canine fossa. The uncinate was typically not removed. As a result, the basic pathology in chronic sinusitis, obstruction of the naturally directed mucociliary flow toward the middle meatus, was not altered, leading to accumulation of mucus in the middle meatus and inadequate drainage. Consequently, the inferior antrostomy was not entirely successful.[50-52] Occasionally, a middle meatal antrostomy would be performed, but the uncinate would not usually be removed. Hospitalization time and postoperative recovery were much longer than with the more recent endoscopic procedures.

With the exception of malignant disease, Caldwell Luc procedures are rarely performed now.[53] During the endoscopic examination, an examination of the inferior meatus should be made to determine whether a previous antrostomy was performed. Occasionally, patients are unaware of which procedure was performed. Patients with previous Caldwell Luc procedures may be able to irrigate their sinuses, but they may nonetheless have continued middle meatal obstruction.[53]

Recirculation of mucus

Mucus recirculation occurs when mucus draining through a sinus ostium re-enters the maxillary sinus through a different ostium in proximity. These ostia can include surgically created ostia, accessory sinus ostia, or the natural ostium. This is now recognized as a potential cause of persistent sinusitis.[33,53-55] Irrigation may sometimes resolve this problem; however, surgery may be needed to create a single ostium instead of 2 or more ostia.

Hyperplastic nasal disease

Patients may have persistent disease involving nasal polyps, mucosal edema, or polypoid mucosa despite surgery.[53] Sinus endoscopy greatly facilitates the assessment of hyperplastic mucosal disease. Other exacerbating factors, such as aspirin sensitivity, fungal disease, allergic rhinitis, or cystic fibrosis also need to be addressed in patients with this condition.

Synechiae (bridging scar formation)

Synechiae or bridging scar formation is not uncommon after sinus surgery.[49] Careful surgical follow-up in the immediate postoperative period will minimize this[6,56]; however, despite good surgical follow-up, synechiae may still be found especially between the middle turbinate and the lateral nasal wall, or between the middle turbinate and the nasal septum. The former may result in lateralization of the middle turbinate and obstruction of the middle meatus.[57] Occasionally synechiae may be severe enough to reduce the size of the middle meatus or maxillary ostium, and revision surgery may be needed to remove them. In some cases, this can be done in-office by the surgeon. Surgical procedures involving mucosal stripping are associated with an increased risk of scarring and are typically no longer performed.[58]

Synechiae may occasionally form in the ethmoid sinuses, creating a completely normal appearing mucosa. One must be careful not to dismiss patient complaints after surgery on the basis of normal-appearing tissue in this area because disease may still be present in one of the ethmoid cells. A follow-up computed tomography scan may be needed for adequate evaluation.

In the situation in which synechiae form in the area of the anterior ethmoids and frontal recess, frontal sinus disease may develop after surgery.[25] This may be more common in patients with previous middle turbinate surgery.[59-61]

Empty nose syndrome

Some patients who have had excision of the inferior and/or middle turbinates may report increased symptoms thereafter.[62]

They may report a reduction in nasal mucus, nasal dryness or sensation of nasal obstruction or blockage and a general reduction in their sense of well being. Out of concern for this problem, many surgeons are now reluctant to perform any significant amount of surgical turbinectomy. As a result, preservation of as much turbinate tissue as is possible is now considered by many to be an important part of surgical management.

Many surgeons will remove only a very small portion of the middle turbinate if absolutely necessary to achieve adequate visualization or to remove devitalized tissue. Operative descriptions of the extent of resection may be variable, and the endoscopist should make an independent assessment of the amount of resection performed. Radiofrequency ablation of the turbinates (eg, Somnoplasty) has not caused the same problems as surgical turbinate reduction.[63]

Frontal sinus disease

It is often possible to visualize the frontal sinuses in patients who have had previous frontal sinus surgery. During the course of endoscopy, the examiner may be able to see light emanating from the forehead as the frontal sinuses are entered. The frontal sinus must be entered with care, because the ostia are often very small with bony prominences.

Evaluation of frontal recess disease is very difficult, even for the experienced endoscopist. Previous surgery can cause scarring and obstruction of mucus outflow from the frontal recess. If revision surgery must be performed, it is often possible to resect the scarring in the anterior ethmoids including remnants of the uncinate and frontal recess without entering the frontal sinuses.[33] The advent of image-guided surgery has facilitated frontal sinus surgery in some centers by those skilled in the procedure[64,65]; however, a decision regarding this must be made by a surgeon with extensive experience in revision surgery.

Dental and related disease

Dental material as well as other foreign bodies can be found in the nose and sinuses. These can be evaluated during endoscopy. This material can create a variety of inflammatory responses and must typically be removed, usually at the time of surgery. Foreign bodies can include periodontal disease, infected roots of normal teeth, remnants of partially extracted molars, hydroxyapatite, other dental material, implants, and so forth.[66] During endoscopy, one must remove all mucus and other nondental debris from the base of the sinuses, because pus or other material in the base of the maxillary sinuses may obscure diseased dental or mucosal tissue as well as other foreign bodies. Gentle probing with the endoscope can also be helpful in determining disease, particularly if there are areas of tenderness. Oroantral fistulae may also be identified. Few oral surgeons have the capability to evaluate and treat odontogenic sinus disease adequately, but it is important to involve them in its treatment. Dental CT scans may also be required, but interpretation may be very difficult.

Atrophic rhinitis

With age, it is not unusual for patients to develop dry, inflamed, thin, crusted mucosa. This must be recognized and treated appropriately with saline or other agents. A similar condition occurs with the empty nose syndrome.[62]

Other potential anatomic reasons for recurrent disease after sinus surgery

Persistence of disease in the maxillary or anterior ethmoid sinus after surgery may be caused by anatomic factors, such as a retained uncinate process or partial ethmoidal resection. Persistence of disease in the frontal sinus may be a result of frontal recess disease. These conditions relate to important and often subtle aspects of sinus anatomy that require considerable experience to recognize. If a portion of the uncinate is retained, functional drainage from the maxillary sinus may remain impaired, and mucus may continue to collect in the middle meatus.[67] It is important to examine the surgical ostium and the sinus mucosa to address the adequacy of drainage through the middle meatus. Endoscopic examination may sometimes reveal an apparent middle meatal antrostomy when in actuality the resection has been made of an ethmoid air cell. In this case, the uncinate process will not have been removed, and the middle meatus will continue to be obstructed, leading to lack of proper drainage through the ostiomeatal unit.

Residual disease in the anterior or posterior ethmoid sinuses may occur as a result of incomplete resection of ethmoidal cells with persistence of infection, mucus impaction, or development of new disease in these cells.[53] Disease in the posterior ethmoid sinuses may be more difficult to resolve because surgery involving the posterior ethmoids may be more technically difficult.

If any of these conditions is suspected, the allergist should consult with an otolaryngologist, raising specific questions about these concerns and whether revision endoscopic surgery is advisable.

Preparation for surgery

One of the most valuable functions of the allergist is to evaluate and provide proper medical treatment for nasal and sinus disease up to the point that sinus surgery is deemed necessary. This evaluation should include an understanding of the points at which medical therapy will no longer be successful and surgical intervention preferable. We have also found that preoperative discussions with the otolaryngologist can promote higher quality patient care and foster greater physician communication. Discussions regarding the role of allergic sensitivities and immunotherapy, aspirin desensitization (especially before nasal polypectomy), stains, and cultures of surgical specimens are examples. If the allergist has previously followed the patient, suggestions may be made regarding operative management by those allergists experienced with endoscopic sinus surgery. Once postoperative management has been completed, allergists can again provide valuable follow-up care and periodic reassessments to identify recurrence of disease.

In our practices, patients are typically referred to the surgeon after medical treatment options have been exhausted and the sinus CT scan suggests disease amenable to surgical correction. As a result, almost all patients referred to the surgeon ultimately undergo surgery. A busy surgeon will appreciate referrals much more if the patient presents to their office prepared for surgery. A detailed discussion of the parameters we use to make a decision about surgery is not feasible here, but several points will be highlighted.

In considering whether surgery (either endoscopic sinus surgery, septoplasty, osteoplastic flap, and so forth) may provide benefit to a patient whose disease has failed to respond to medical

management, the endoscopist should consider how well the patient's symptoms correlate with objective measures of disease, including the findings on endoscopy (both before and after treatment) and the findings on CT scan, and the patient's response to medical treatment. If sinus surgery is considered likely, it may be cost-effective to obtain an image-guided CT scan before the surgical referral. (This is usually done after communication with the surgeon before the surgical referral, especially because there are several image-guided systems currently available.) An image-guided CT is an essential component of image-guided surgery and is helpful when there is concern about entering the orbit, the skull base, or the frontal recess, or when previous surgery has removed landmarks.[68,69] It is recommended that allergists interested in treatment of sinusitis observe a surgeon perform imaged-guided endoscopic sinus surgery to better understand its usefulness and to become familiar with the various image-guided techniques currently in use. Review of recently published articles can also be helpful in understanding the treatment technique.[33,64,65,70]

CONCLUSION

There is no doubt that many cases of chronic rhinosinusitis are difficult to manage, including many cases that are refractory to endoscopic sinus surgery. It has been our experience that most of these cases benefit from conscientious attention to aspects of medical management. Aided by training and experience in rhinoscopic evaluation and methods to obtain mucus samples and bacterial cultures, the allergist/immunologist is in a unique position to provide these services. To a great extent, this represents an area of untapped need. Patients with chronic rhinosinusitis deserve the care of a physician knowledgeable in the medical management of their condition. Endoscopic evaluation is a critical component of this evaluation. This article provides a basic introduction to the endoscopic procedure and outlines the many ways it can be used to evaluate and manage such patients properly.

Videos of the culture technique described as well as common endoscopic findings are available in this article's Online Repository (see Videos E1 and E2 at www.jacionline.org).

We acknowledge those members of the Rhinosinusitis Committee of the American Academy of Allergy, Asthma & Immunology who reviewed this article, the many otolaryngology colleagues of ours who offered their helpful comments and perspective in the development of this article, and Jerome Schultz, the liaison between the Rhinosinusitis Committee and the American Academy of Allergy, Asthma & Immunology.

REFERENCES

1. Selner J, Koepke J. Rhinolaryngoscopy in the allergy office. Ann Allergy 1985;54:479-82.
2. Georgitis J, Druce HM, Goldstein S, Meltzer EO, Okuda M, Selner JC, et al. Rhinopharyngolaryngoscopy. J Allergy Clin Immunol 1993;91:961-2.
3. Selner J. Visualization techniques in the nasal airway: their role in the diagnosis of upper airway disease and measurement of therapeutic response. J Allergy Clin Immunol 1988;82:909-16.
4. Rohr A, Hassner A, Saxon A. Rhinopharyngoscopy for the evaluation of allergic-immunologic disorders. Ann Allergy 1983;50:380-4.
5. Aukema AA, Fokkens WJ. Chronic rhinosinusitis: management for optimal outcomes. Treat Respir Med 2004;3:97-105.
6. Bolger W, Kennedy D. Surgery of the paranasal sinuses in adults. In: Druce H, editor. Sinusitis: pathophysiology and treatment. New York: Marcel Dekker; 1994. p. 107-28.
7. Kennedy D, Senior B. Endoscopic sinus surgery: a review. Otolaryngol Clin North Am 1997;30:313-30.
8. Druce H. Diagnosis of sinusitis in adults: History, physical examination, nasal cytology, echo, and rhinoscope. J Allergy Clin Immunol 1992;90:436-41.
9. Lipworth B, White P. Allergic inflammation in the unified airway: start with the nose. Thorax 2000;55:878-81.
10. Levine HL. Functional endoscopic sinus surgery: evaluation, surgery, and follow-up of 250 patients. Laryngoscope 1990;100:79-84.
11. Kennedy D. Prognostic factors, outcomes and staging in ethmoid sinus surgery. Laryngoscope 1992;102(suppl 57):1-18.
12. Senior BA, Kennedy DW, Tanabodee J, Kroger H, Hassab M, Lanza D. Long-term results of functional endoscopic sinus surgery. Laryngoscope 1998;108:151-7.
13. Desrosiers M. Refractory chronic rhinosinusitis: pathophysiology and management of chronic rhinosinusitis persisting after endoscopic sinus surgery. Curr Allergy Asthma Rep 2004;4:200-7.
14. Lavigne F, Nguyen CT, Cameron L, Hamid Q, Renzi PM. Prognosis and prediction of response to surgery in allergic patients with chronic sinusitis. J Allergy Clin Immunol 2000;105:746-51.
15. Pfleiderer A. Antroscopy via the inferior meatal route under local anaesthetic: a practical guide to technique. J Laryngol Otol 1987;101:1035-9.
16. Vogan J, Bolger W, Keyes A. Endoscopically guided sinonasal cultures: a direct comparison with maxillary sinus aspirate cultures. Otolaryngol Head Neck Surg 2000;122:370-3.
17. Spring P, Miller R. Initial report of primary sinusitis caused by an atypical pathogen (Mycobacterium chelonae) in an immunocompetent adult. Ear Nose Throat J 1999;78:358-9, 362-4.
18. Gold S, Tami T. Role of middle meatus aspiration culture in the diagnosis of chronic sinusitis. Laryngoscope 1997;107:1586-9.
19. Gill V, Fedorko D, Witebsky F. The clinician and the microbiology laboratory. In: Mandell G, Bennett J, Dolin R, editors. Principles and practice of infectious diseases. Philadelphia: Churchill Livingstone; 2000. p. 184-222.
20. Brook I, Yocum P, Frazier E. Bacteriology and beta-lactamase activity in acute and chronic maxillary sinusitis. Arch Otolaryngol Head Neck Surg 1996;122:418-22.
21. Brook I. Microbiology and antimicrobial management of sinusitis. Otolaryngol Clin North Am 2004;37:253-66.
22. Benninger MS, Appelbaum PC, Denneny JC, Osguthorpe DJ, Stankiewicz JA. Maxillary sinus puncture and culture in the diagnosis of acute rhinosinusitis: the case for pursuing alternative culture methods. Otolaryngol Head Neck Surg 2002;127:7-12.
23. Poole M. Endoscopically guided vs. blind nasal cultures in sinusitis. Otolaryngol Head Neck Surg 1992;107:272.
24. Orobello P, Park R. Microbiology of chronic sinusitis in children. Arch Otolaryngol Head Neck Surg 1991;117:980-3.
25. Kuhn F, Javer A. Current concepts in the surgical management of frontal sinus disease: primary endoscopic management of the frontal sinus. Otolaryngol Clin North Am 2001;34:59-75.
26. Taylor MJ, Ponikau JU, Sherris DA, Kern EB, Gaffey TA, Kephart G, et al. Detection of fungal organisms in eosinophilic mucin using a fluorescein-labeled chitin-specific binding protein. Otolaryngol Head Neck Surg 2002;127:377-83.
27. Hendolin PH, Paulin L, Koukila-Kähkölä P, Anttila VJ, Malmberg H,Richardson M, et al. Panfungal PCR and multiplex liquid hybridization for detection of fungi in tissue specimens. J Clin Microbiol 2000;38:4186-92.
28. Polzehl D, Weschta M, Podbielski A, Riechelmann H, Rimek D. Fungus culture and PCR in nasal lavage samples of patients with chronic rhinosinusitis. J Med Microbiol 2005;54:31-7.
29. Ponikau JU, Sherris DA, Kephart GM, Kern EB, Congdon DJ, Adolphson CR, et al. Striking deposition of toxic eosinophil major basic protein in mucus: implications for chronic rhinosinusitis. J Allergy Clin Immunol 2005;116:362-9.
30. Messerklinger W. Endoscopy of the nose. Baltimore: Urban & Schwarzenberg; 1978.
31. Bolger W. Anatomy of the paranasal sinuses. In: Kennedy D, Bolger W, Zinreich S, editors. Diseases of the sinuses: diagnosis and management. Hamilton, Ontario, Canada: BC Decker Inc; 2001. p. 1-12.
32. Stammberger H. Functional endoscopic sinus surgery: the Messerklinger technique. Philadelphia: BC Decker; 1991.
33. Witterick I, Kolenda J. Surgical management of chronic rhinosinusitis. In: Denberg J, Keith P, editors. Immunol Allergy Clin North Am 2004. p. 199-134.
34. Hwang PH, McLaughlin RB, Lanza DC, Kennedy DW. Endoscopic septoplasty: indications, technique, and results. Otolaryngol Head Neck Surg 1999;120:678-82.
35. Anon J, Rontal M, Zinreich S. Maxillary sinus anatomy. In: Anon J, Rontal M, Zinreich S, editors. Anatomy of the paranasal sinuses. New York: Thieme; 1996. p. 18-21.
36. Tuncer U, Aydogan B, Soylu L, Simsek M, Akcali C, Kucukcan A. Chronic rhinosinusitis and adenoid hypertrophy in children. Am J Otolaryngol 2004;25:5-10.
37. Cassano P, Gelardi M, Cassano M, Fiorella ML, Fiorella R. Adenoid tissue rhinopharyngeal obstruction grading based on fiberendoscopic findings: a novel approach to therapeutic management. Int J Pediatr Otorhinolaryngol 2003;67:1303-9.

38. Hytonen M, Atula T, Pitkaranta A. Complications of acute sinusitis in children. Acta Otolaryngol Suppl 2000;543:154-7.
39. Desai S. Seropositivity, adenoid hypertrophy, and secretory otitis media in adults: a recognized clinical entity. Otolaryngol Head Neck Surg 1992;107:755-7.
40. Baker H. The many faces of atypical sinusitis. J Natl Med Assoc 1993;85:773-6.
41. Rosanowski F, Rabenstein T, Hahn EG, Eysholdt U. Reflux-associated diseases of the otorhinolaryngology tract. Laryngorhinootologie 2001;80:487-96.
42. Terrell J. Primary sinus surgery. In: Cummings C, Fredrickson JM, Harker LA, Krause CJ, Schuller DE, Richardson MA, editors. Otolaryngology: head and neck surgery. St Louis: Mosby-Year Book; 1998. p. 1145-89.
43. Price D, Sherris D, Kern E. Computed tomography for constructing custom nasal septal buttons. Arch Otolaryngol Head Neck Surg 2003;129:1236-9.
44. Ridenour B. The nasal septum. In: Cummings C, Fredrickson JM, Harker LA, Krause CJ, Schuller DE, Richardson MA, editors. Otolaryngology: head and neck surgery. St Louis: Mosby-Year Book; 1998. p. 921-48.
45. Romo T, Sclafani AP, Falk AN, Toffel PH. A graduated approach to the repair of nasal septal perforations. Plast Reconstr Surg 1999;103:66-75.
46. Setliff R. The small-hole technique in endoscopic sinus surgery. Otolaryngol Clin North Am 1997;30:341-54.
47. Catalano P, Roffman E. Evaluation of middle meatal stenting after minimally invasive sinus techniques (MIST). Otolaryngol Head Neck Surg 2003;128:875-81.
48. Selivanova O, Kuehnemund M, Mann WJ, Amedee RG. Comparison of conventional instruments and mechanical debriders for surgery of patients with chronic sinusitis. Am J Rhinol 2003;17:197-202.
49. Stankiewicz JA. Complications of endoscopic sinus surgery. Otolaryngol Clin North Am 1989;22:749-58.
50. Cutler JL, Duncavage JA, Matheny K, Cross JL, Miman MC, Oh CK. Results of Caldwell-Luc after failed endoscopic middle meatus antrostomy in patients with chronic sinusitis. Laryngoscope 2003;113:2148-50.
51. Dalziel K, Stein K, Round A, Garside R, Royle P. Systematic review of endoscopic sinus surgery for nasal polyps. Health Technol Assess 2003;7:1-159.
52. Lusk R. Surgical management of pediatric sinusitis. In: Druce H, editor. Sinusitis: pathophysiology and treatment. New York: Marcel Dekker; 1994. p. 129-57.
53. Richtsmeier W. Top 10 reasons for endoscopic maxillary sinus surgery failure. Laryngoscope 2001;111:1952-6.
54. Ramadan H. Surgical causes of failure in endoscopic sinus surgery. Laryngoscope 1999;109:27-9.
55. Kane J. Recirculation of mucus as a cause of persistent sinusitis. Am J Rhinol 1997;11:361-9.
56. Anand V, Panje W. Avoidance and successful management of complications of endoscopic sinus surgery. In: Anand V, Panje W, editors. Practical endoscopic sinus surgery. New York: McGraw-Hill; 1993. p. 87-98.
57. Lofchy N, Bumsted R. Revision and open sinus surgery. In: Cummings C, Fredrickson JM, Harker LA, Krause CJ, Schuller DE, Richardson MA, editors. Otolaryngology: head and neck surgery. St Louis: Mosby-Year Book; 1998. p. 1173-89.
58. Chow J. Technical reasons for endoscopic sinus surgery failures. Curr Opin Otolaryngol Head Neck Surg 2002;10:33-5.
59. Bolger W, Kuhn F, Kennedy D. Middle turbinate stabilization after functional endoscopic sinus surgery: the controlled synechiae technique. Laryngoscope 1999; 109:1852-3.
60. Kennedy D. Middle turbinate resection: evaluating the issues-should we resect normal middle turbinates? Arch Otolaryngol Head Neck Surg 1998;124:107.
61. Swanson P, Lanza DC, Kennedy DW, Vinning EM. The effect of middle turbinate resection on frontal sinus disease. Am J Rhinol 1995;9:191-5.
62. Moore E, Kern E. Atrophic rhinitis: a review of 242 cases. Am J Rhinol 2001;15: 355-61.
63. Fischer Y, Gosepath J, Amedee RG, Mann WJ. Radiofrequency volumetric tissue reduction (RFVTR) of inferior turbinates: a new method in the treatment of chronic nasal obstruction. Am J Rhinol 2000;14:355-60.
64. Kingdom T, Orlandi R. Image-guided surgery of the sinuses: current technology and applications. Otolaryngol Clin North Am 2004;37:381-400.
65. Orlandi R, Kennedy D. Revision endoscopic frontal sinus surgery. Otolaryngol Clin North Am 2001;34:77-90.
66. Kulacz R, Fishman G, Levine H. An unsuccessful sinus surgery caused by dental involvement within the floor of the maxillary sinus. Oper Techn Otolaryngol Head Neck Surg 2004;15:2-3.
67. Parsons D, Stivers F, Talbot A. The missed ostium sequence and the surgical approach to revision functional endoscopic sinus surgery. Otolaryngol Clin North Am 1996;29:169-83.
68. Jiang R, Hsu C. Revision functional endoscopic sinus surgery. Ann Otol Rhinol Laryngol 2002;111:155-9.
69. Koele W, Stammberger H, Lackner A, Reittner P. Image guided surgery of paranasal sinuses and anterior skull base: five years experience with the InstaTrak-System. Rhinology 2002;40:1-9.
70. Ludwick JJ, Taber KH, Manolidis S, Sarna A, Hayman LA. A computed tomographic guide to endoscopic sinus surgery: axial and coronal views. J Comput Assist Tomogr 2002;26:317-22.

APPENDIX E1

Policy and procedure for use of CIDEX OPA solution for high-level disinfection of nonlumened rhinoscopes

(Hospital-based allergists should consult with the Infection Control Officer before implementing this procedure)

POLICY: It is the policy of _____ _____that all high-level disinfectants be used in a safe and effective manner.

OBJECTIVES:

- To provide guidelines for staff using high-level disinfectants.
- To identify employee safety practices when working with high-level disinfectants.
- To utilize the high-level disinfectants in an efficacious manner.

NOTE: Contact with Cidex OPA solution may stain skin or clothing. If the solution contacts skin, wash with soap and water for a few minutes. The stain should disappear within 1 to 2 days. The solution may also stain environmental surfaces such as walls, floors, and countertops. Cidex OPA is a proven skin sensitizer and a potent irritant and can elicit allergic reactions. It should not be used in patients who are sensitive.

PROCEDURE:

Nursing actions	Rationale
1. Don personal protective equipment (PPE): • Double glove (not vinyl or neoprene) • Eye protection • Fluid-repellent gown	PPE must be worn when handling contaminated instruments and equipment or working with chemicals.
2. Thoroughly clean rhinoscope in enzymatic detergent. Wipe handle thoroughly with 70 % alcohol.	The first step in the disinfection process is thorough cleaning with a mild protein-dissolving detergent.
3. Rinse instrument surfaces with large amounts of fresh water.	Residual detergent must be removed before disinfection.
4. Remove excess moisture from the instrument by drying gently.	This will reduce the dilution of CIDEX OPA solution by residual rinse water. Refer to instrument manufacturer's labeling for additional instructions on disassembling, cleaning and leak testing of particular instruments.
5a. Read the directions for use on the bottle label and package insert, then pour CIDEX OPA solution into a CIDEX solution tray or appropriate Container. Label and date container.	
5b. Solution left in the bottle may be stored as long as 75 days.	
6. Record the date that the solution was poured from the original container and the date that it can no longer be used (not to exceed 14 days).	
7. Immerse clean, dry instrument in the Cidex OPA.	Ensure that all contaminated surfaces are completely submerged.
8. Soak instrument for 12 minutes at 20°C.	High-level disinfection is accomplished in 12 minutes.
9. After disinfection, rinse instrument thoroughly with 2 gallons of water.	Sterile water is recommended for rinsing. See package for detailed directions.
10. Repeat the rinse process twice, for a total of 3 rinses. Each rinse should use a fresh bottle of sterile water. Do not reuse rinse water.	Each rinse should be a minimum of 1 minute in duration.
11. Thoroughly dry the instrument.	See manufacturer's instructions for drying flexible endoscopes.
12. Disinfected instruments should be used immediately, or stored in a manner to minimize recontamination.	Refer to manufacturer's labeling for additional storage and handling instructions.
13. Test Cidex OPA Solution on a daily basis before use with Cidex OPA Solution Test Strips. Results are recorded.	Verify the minimum effective concentration (MEC) is present. Discard solution if MEC not verified.
14. Discard Cidex OPA Solution after 14 days, even if the test strips indicate a concentration above the MEC.	Cidex OPA Solution may be discarded down hospital and office drains in accordance with local regulations.

APPENDIX E2

Policy and procedure for high-level disinfection with the use of CIDEX OPA solution test strips

POLICY: It is the policy at _____ _____ that test strips will be used before each use to verify the minimum effective concentration (MEC) of CIDEX OPA Solution.

OBJECTIVES:

- To provide guidelines for staff when testing high-level disinfectants.
- To identify employee safety practices when working with CIDEX OPA Solution test strips.
- To verify the MEC of CIDEX OPA Solution.

PROCEDURE:

Nursing actions	Rationale
1. Don personal protective equipment (PPE): • Double glove (not vinyl or neoprene) with chemicals • Fluid-repellent gown • Eye protection	PPE must always be worn when working.
2. Check the date on the test strip bottle.	Test strips have a 2-year shelf life. DO NOT use outdated test strips.
3. Record the date that the bottle of Cidex OPA Test Strips was opened on the container label.	Do not use any remaining strips 90 days after opening the bottle.
The following quality control (QC) test was previously recommended by the manufacturer, but is no longer suggested. It should be considered optional now.	
4. Prepare the control solutions to perform the QC test: • Verify the expiration date on the Cidex OPA Solution. • Full-strength Cidex OPA Solution may be used as the positive control. • Prepare a negative control by diluting 1 part full strength Cidex OPA Solution with 1 part water. • Label each solution.	Positive and negative controls are required to verify the efficacy of the test strips.
5. Following the instructions for use, dip 3 test strips into each of the prepared solutions.	Ensure that the strip is entirely submerged for 1 full second.
6. Check for the following test results: • Positive control solution strips should appear completely purple. • Negative control solution strips should either remain blue or exhibit an incomplete change to purple.	Any shade of blue indicates failure, except for the blue on the top line.
7. If the results of the QC test indicate that the test strip is not functioning properly, discard the remaining strips.	Contact Advanced Sterilization Products at 1-888-783-7723 for technical product information.
8. Cidex OPA Solution will be tested for the MEC before each use.	This ensures that the effective concentration of the disinfectant is present.
9. Dip entire pad at the end of the test strip onto the container. Hold in the solution for 1 full second before removing.	Do not stir the solution with the test strip.
10. Remove excess solution from the indicating pad by standing the strip upright on a paper towel.	Do not shake the strip or blot face down on the towel.
11. Read the results of the color reaction on the indicating pad exactly 90 seconds after the test strip was removed from the solution.	If read under 90 seconds, the color may be incomplete. After 90 seconds, the color will gradually fade.
12. The indicating pad will be completely purple to indicate that the MEC is present.	If any blue color is present on the indicating pad, the solution is below the MEC and must be discarded.
13. Discard Cidex OPA Solution after 14 days, even if the test strips indicate a concentration above the MEC.	Cidex OPA Solution may be discarded down hospital and office drains in accordance with local regulations.