

Minimally Invasive Surgery of Chronic Rhinitis, Deviated Nasal Septum, Rhinosinusitis, and Nasal Polyps

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Introduction

Over the past decade, rhinology has experienced a period characterized by numerous innovations. Most, but not all, of these developments have been related to strategies for endoscopic sinus surgery (ESS). In its original form, ESS was conceived as a method to treat refractory inflammatory disease of the paranasal sinuses through improving sinus ventilation. Over the years, endoscopic techniques have become increasingly sophisticated and the indications for endoscopic approaches have grown. Various factors have catalyzed a shift in the management of sinonasal diseases. Otorhinolaryngologists have embraced the trend for minimally invasive surgery and have developed endoscopic techniques for conditions that previously would have required more extensive "open" procedures.

Technologic developments have also had a dramatic impact. Diagnostic imaging supports more accurate and precise diagnosis. Better instruments designed to meet the needs of the endoscopic surgeon have been introduced. Powered instrumentation, including drills, lasers, and radiofrequency have been significantly improved. Computer-aided surgery serves as a platform for preoperative planning and intraoperative surgical navigation. Thus, the tools available to the otorhinolaryngologist are much more sophisticated today than even a few years ago.

This chapter summarizes some of the latest developments in surgical rhinology. It focuses on providing an overview of advanced techniques in a practical, clinically useful fashion. Endoscopic approaches to chronic rhinitis, deviated nasal septum, rhinosinusitis, and nasal polyps are presented.

Chronic rhinitis

Nonallergic and allergic rhinitis are usually managed medically with oral decongestants, steroid nasal sprays, antihistamines, or in acute and short-term usage, topical nasal decongestants. In spite of adequate medical management, some patients either do not wish to use the medications,

cannot tolerate them, or find them ineffective. Surgical options may need to be considered. The ideal turbinate reduction procedure would be one that effectively reduces the turbinate volume, preserves physiologic function, and avoids complications (e.g., atrophic rhinitis, "empty nose" syndrome). Most often, turbinate reduction is commonly practiced concomitantly with nasal septal work.

Minimally invasive techniques of inferior turbinate reduction that have been reported since 2002 are laser techniques, radiofrequency reduction, submucous methods, and the use of powered instrumentation.

Lasers

Six basic laser systems are used for the treatment of hyperplastic inferior turbinates: carbon dioxide (CO_2), diode, neodymium-yttrium aluminium garnet (Nd:YAG), potassium-titanyl-phosphate (KTP), argonion, and holmium-yttrium aluminium garnet (Ho:YAG) laser. With the exception of the CO_2 laser, all the other lasers can be delivered using a flexible quartz fiber in a contact or non-contact mode. Reported techniques of laser application to the inferior turbinate vary. Generally, radiation is applied as linear, anterior-to-posterior stripes either along the entire turbinate or merely along the inferior edge. Alternatively, a cross-hatched pattern along the turbinate surface can be applied. Some authors have sought further improvement of the nasal valve region with the additional delivery of laser spots to the anterior turbinate head. The goal is to induce partial destruction of the soft tissue of the inferior turbinate without excessive damage that could result in extreme mucosal loss and bony exposure. All of these methods demonstrate widely variable success rates, ranging from 50 to 100% improvement of nasal obstruction.^{1,2} These reported results are difficult to compare because each series differs in terms of follow-up length. Reported complications include nasal crusting, epistaxis, and synechiae.

Taking advantage of the fiber optic delivery of light energy from a KTP laser, Supiyaphun et al.³ used an 18-gauge needle to introduce an optical fiber into the inferior turbinate. Retrograde photocoagulation was performed while the fiber was slowly withdrawn from the nose. Post-treatment results demonstrated a significant decrease in nasal symptoms (sneezing, rhinorrhea, itching, and obstruction) as assessed by both the patient and the physician. Improvements in inspired nasal airflow and nasal cavity volume (measured via acoustic rhinometry) were significant. This submucous laser method capitalizes on the soft tissue reduction ability of the KTP laser while making an effort to reduce mucosal damage.

Laser surgery of inferior turbinates can be performed as an outpatient procedure under local anesthesia. It achieves comparable or better results than most of the conventional techniques for turbinate surgery like conchotomy, electrocautery, cryotherapy, and chemical cauterization. However, more invasive (radical) operative methods, such as inferior turbinoplasty, submucous turbinectomy, lateral outfracture, partial and total turbinectomy, seemed to be more effective than laser surgery in the long-term.⁴

Radiofrequency ablation

Radiofrequency tissue reduction, commonly used in otolaryngology for the reduction of redundant soft palate and base of tongue tissue in snoring individuals, also has its application in turbinate reduction. The advantages of radiofrequency over electrocautery and laser surgery reside in its precision in thermal ablating tissues, less postoperative pain and the ease of use during operation. A probe is used to deliver low-frequency energy, which induces ionic agitation of surrounding tissues. This produces localized elevation in temperature, causing a thermal lesion. The delivery of energy, and therefore the extent of injury, is controlled by monitoring the rise of tissue temperature. Postoperative wound contracture and fibrosis induces tissue volume reduction within 6–8 weeks. The probe, which typically has a distal active portion and a proximal insulated portion, is inserted into the turbinate. Many studies describe subjective improvement in nasal obstruction reported by the patient and the physician after radiofrequency turbinate reduction.^{3,6} Coste et al.⁷ demonstrated significant changes in nasal volume, turbinate volume, and cross-sectional area after radiofrequency treatment. They treated each turbinate at three separate sites. Examination of the turbinate mucosal epithelium 60 days after treatment revealed maintained ciliary beat frequency and even improved saccharin transit times after radiofrequency application. Similar results were seen by Rhee et al.⁸ who also measured nasal resistance via rhinomanometry. A statistically significant decrease in resistance was seen at 8 weeks postoperatively. Even as early as 1 week postoperatively, no changes in saccharin transit time or ciliary beat frequency were seen, implying that radiofrequency techniques do not disturb turbinate function. So far, the duration of radiofrequency effect on nasal obstruction reported by several authors have been at least 1–2 years.⁶

Another radiofrequency device is “Coblation”. This bipolar radiofrequency thermal ablation device is touted to cause molecular degeneration through a less heat generating process. The probes are supposed to convert a conductive medium (saline) into an ionic plasma layer that

disrupts adjacent tissue with minimal thermal effect. Black et al.⁹ reported improved subjective scores and increased nasal volume measured 6 and 12 months postoperatively. No adverse effect was seen upon saccharin transit time or olfactory threshold.

Conventional submucous techniques

The fear of turning patients into nasal cripples as a result of chronic crusting and osteitis from exposed bone had originally led many practitioners to support the practice of submucosal turbinate resection technique as opposed to more radical methods such as total turbinectomy. Many variations of this technique exist. Their common aim is to resect soft tissue and/or bone of the inferior turbinate while preserving enough overlying mucosa to prevent bone exposure. Although submucosal techniques are perhaps not as innovative as lasers, they still remain popular due to their effectiveness.¹⁰ Proponents of submucosal techniques argue that less invasive techniques (such as cryosurgery and lasers treatments) do not effectively address soft tissue and have no effect upon bony turbinate enlargement. Submucous resection may benefit other allergic rhinitis symptoms besides congestion. Mori et al.¹¹ investigated preoperative, 1-year, 3-year, and 5-year results in 45 patients, none of whom were lost to follow-up after their surgery. In these authors' method, an incision was made along the inferior turbinate and the turbinate bone was isolated and removed. Postoperative allergy symptoms—congestion, sneezing, and rhinorrhea—demonstrated statistically significant improvement as measured subjectively from symptom diary cards. An objective nasal challenge test was performed by placing a disk containing house-dust mite allergen on the mucosa of the anterior inferior turbinate. Remarkably, a reduction of allergy symptoms during a 15-minute exposure period was evident even 3 years postoperatively.

Powered instrumentation

Powered instrumentation has been adopted for inferior turbinate reduction. Gupta et al.¹² described using an endoscopic microdebrider to remove the lateral mucosa and portion of the inferior turbinate bone and found that the debrider allowed greater precision of resection, especially while utilizing endoscopic visualization. Patient satisfaction was favorable. Somewhat similar results were seen by Van Delden et al.¹³

A true submucous resection, in which there is an attempt to reduce turbinate volume with minimal violation of the mucosa, has also been described using the microdebrider. Generally, an

incision is made on the anterior head of the turbinate to allow access into the body of the structure. A submucous pocket is dissected medial to the bony turbinate. The microdebrider is then used to remove hypertrophic turbinate stroma and bone. Yanez¹⁴ studied 63 patients with a 2-year follow-up. By 1 year, all patients were noted to have improvement in obstructive symptoms. No bleeding, crusting, or persistent rhinorrhea was noted. Furthermore, Friedman et al.¹⁵ adopted the use of a sinus endoscope for better visualization during the procedure. They noted improvement in a majority of patients' symptoms by 6 weeks postoperatively. Although the goal was to preserve turbinate mucosa as much as possible, it was noticed that 55% of patients had mucosal tears immediately following the procedure. However, no crusting or foul odor was observed in follow-up. Postoperative bleeding requiring operative intervention was noted in 1.6% of patients and synechiae were seen in 5% of patients.

No one technique has established itself as the gold standard for inferior turbinate reduction. Several methods continue to be practiced, and each patient should be individually assessed to determine which method may provide the best result. The newer procedures highlighted here certainly begin to push surgical management of the inferior turbinate out of the operating room and into the clinic setting.

Deviated nasal septum

Endoscopic septoplasty is a minimally invasive technique that enables correction of septal deformities

under excellent visualization with minimal trauma. Endoscopic septoplasty is not only for treating symptomatic nasal obstruction but also for improving intraoperative and postoperative surgical access to the middle meatus as an adjunct to ESS. When compared with standard headlight septoplasty, the endoscopic technique provides several important advantages. Visualization with the endoscope enables improved evaluation of septal deformities in the nasal valve region and is particularly helpful in diagnosis and correction of posterior septal deformities. In addition, the improved visualization permits limited, minimally invasive surgery for isolated deviations or for revision cases, minimizing the extent of flap dissection and postoperative edema. These advantages are particularly useful in patients requiring limited revisions after septoplasty or submucosal resection and in patients with preexisting septal perforations. Furthermore, a more natural transition between septoplasty and ESS is possible when the 2 procedures are performed jointly with the endoscope.

Finally, endoscopic septoplasty provides an excellent teaching tool when used in conjunction with video monitors.¹⁶ The major relative contraindications for endoscopic septoplasty are, firstly, when the deformity involves a significant caudal deflection, and secondly, when significant associated external deformities are present, for which a septorhinoplasty approach would be indicated.

Technique of endoscopic septoplasty¹⁶

If septoplasty is planned as a concurrent procedure with ESS, sinus surgery is performed first on the nonobstructed side. Septoplasty then follows with the septoplasty incision typically placed on the side on which sinus surgery has already been completed. After correction of the septal deviation, sinus surgery can then be performed in an unobstructed field on the previously narrowed side. Because the septoplasty incision has been made contralaterally, contamination of the endoscopes during the second sinus procedure by any bleeding from the septoplasty can be avoided. Great care is taken during the septoplasty not to create a mucosal laceration on the side on which ESS is still to be performed.

The patient is positioned, prepared, and draped for septoplasty as for standard ESS. Topical ephedrine or oxymetazoline is applied for decongestion; 1% lidocaine with 1:100,000 epinephrine is injected subperichondrially along the septum bilaterally. As described above, the incision for septoplasty is best made contralateral to the side of maximal deviation. For a broadly deviated septum, a standard Killian or hemitransfixion incision is used. For more posterior isolated deformities, the incision may be placed more posteriorly in the immediate vicinity of the deformity, obviating extraneous flap elevation. After the mucosal incision, mucoperichondrial flap elevation is performed with a Cottle elevator under direct endoscopic visualization with a 0-degree endoscope. A suction elevator may be used as an alternative dissecting instrument to simultaneously clear any blood from the field of view during flap elevation. The septal cartilage is then incised and stairstepped several millimeters posterior to the mucosal incision. The contralateral mucoperichondrial flap elevation is then performed. Flap elevation is continued bilaterally until the complete extent of the septal deformity has been dissected. At this point the deviated cartilage is excised or scored with endoscopic scissors, punches, or forceps. Deviated portions of bone from the vomer or perpendicular plate of the ethmoid are removed as necessary. Larger pieces of excised bone and cartilage are saved in saline solution for possible replacement later in the procedure.

When septoplasty is being performed for impaired surgical access to the middle meatus, progress toward achieving adequate surgical exposure can be readily gauged throughout the course of the septoplasty by viewing the middle meatal region endoscopically. The use of an endoscope is advantageous in this regard because the potentially awkward transition back and forth between headlight and endoscope is thus avoided. Typically, reconstruction of the septum and suturing of the flaps is delayed until after completion of the sinus surgery on the previously narrowed side. At this time, morselized cartilage is replaced as needed. The septal flaps are then reapposed, and a running quilting suture is placed across the septal flaps. In most cases, placement of splints and packing of the nasal cavity are unnecessary.

Septal spurs typically do not interfere with visualization of the middle meatus for ESS, and therefore spur resection is most typically performed after any sinus surgery has been completed. In this instance, a modified technique, previously described by Lanza et al.¹⁷ may be applied. An ipsilateral incision is placed parallel to the floor of the nose on the apex of the spur. Flaps are then elevated superiorly and inferiorly with a Cottle elevator to expose the underlying bony or cartilaginous spur. An osteotome is then seated against the base of the spur and is used to remove the bone protrusion. Additional remnants of spur can be trimmed back with through-cutting endoscopic forceps. Alternatively, powered instrumentation can also be used, although care must be taken not to traumatize the adjacent mucosal flaps. After complete removal of the spur, the mucoperiosteal flaps are restored to their native position. If the flaps are well apposed, no suturing is required. In this case, the incision line may be covered with a small segment of gelfoam coated with chloramphenicol eye ointment.

Rhinosinusitis

Surgical intervention for patients with rhinosinusitis is reserved for those in whom attempts at appropriate medical therapy fail to clear sinus disease or for those with recurrent acute problems in whom clear-cut anatomic abnormalities are present. Before a surgical approach to the management of refractory sinus disease is undertaken, a CT scan of the paranasal sinuses is mandatory. It not only helps to establish the extent of the disease, but also provides an indispensable view of the individual patient's anatomy. Functional ESS (FESS), as initially described by Messerklinger and expanded upon by Kennedy and Stammberger, is a limited approach directed to the sinus involved, as assessed by pre-operative endoscopic evaluation and CT scan.¹⁸ This surgery has become the most commonly

used technique because of the reduced morbidity in comparison with that after traditional procedures. The major principle is that anatomic anomalies in the areas of mucociliary transport from the sinuses compromise drainage. Correction of outflow obstruction promotes drainage and leads to reversal of mucosal changes within the paranasal sinuses. FESS was the first sinus procedure to address the underlying pathophysiologic mechanisms of sinusitis.

Subjective and objective improvements after FESS were demonstrated in both short- and long-term follow-up.¹⁸⁻²¹ However, while FESS initially established itself as a less invasive, targeted, and more effective technique than its predecessors, conventional FESS has evolved beyond this description. Over time, there has been a departure from these conservative principles, a tendency toward more aggressive intervention, and lack of standardization. Since osteitis of ethmoid and maxillary sinus bone, serving as a nidus, may be responsible for persistent/recurrent disease following medical/surgical intervention, aggressive removal of all ethmoidal sinus partitions and wide drainage of the maxillary sinus are proposed to minimize recurrence.

Minimally invasive sinus technique (MIST)

The MIST, introduced in 1996,²² is a targeted endoscopic intervention, with virtually identical goals to those originally reported for FESS. Unlike contemporary FESS, MIST strictly upholds Messerklinger's functional concepts and consists of much more than not performing a middle meatal antrostomy. The procedure is the only stepwise intranasal intervention with a defined beginning and end for all patients regardless of disease severity, thereby standardizing the procedure for surgeons and patients alike. Furthermore, the procedure still allows for extension into the less involved posterior ethmoid and/or sphenoid cavities while maintaining an anatomically based progression. Since this elegant, reproducible method avoids unnecessary disruption of normal mucosa, it is perhaps best defined as "threshold surgery," or the minimum intervention required to reverse rhinosinusitis.

Although not specific to MIST, endoscopically guided powered instrumentation is employed to enhance mucosal preservation efforts. Real-time continuous suctioning at the tip of the instrument obviates the need for frequent instrument removal for cleaning and improves intraoperative visibility (with the potential for reduced operative morbidity and increased surgical precision). Because MIST markedly reduces mucosal trauma, minimizes exposed sinus bone, and preserves mucosa, the healing burden placed on the nose is minimal and the need for uncomfortable

nasal packing is eliminated. While proponents of MIST recognize conventional FESS as an effective surgical option for select patients with rhinosinusitis, they question its universal application and departure from Messerklinger's functional concepts. MIST is a true embodiment of these principles and improves upon FESS by providing an anatomically based stepwise approach to sinus surgery.

Technique of MIST²³

Prior to surgery, patients receive a series of vasoconstrictive and anesthetic nasal sprays. General or local anesthesia can be delivered. Three injections of lidocaine 1% with epinephrine 1:100,000 are given. The first is injected into the anterior and lateral attachment of the middle turbinate to the lateral nasal wall. Two subsequent injections are placed directly into the anterior tip and body of the middle turbinate. After injections, the middle turbinate is medialized. Surgery then progresses anatomically in a stepwise manner, beginning with identification of the uncinate process. If polyps are present within the nasal cavity, they are removed with powered instruments to allow visualization of the lateral wall anatomy. The transition space associated with the uncinate process is the ethmoidal infundibulum. A pediatric backbiter is used to incise the uncinate process from the hiatus semilunaris toward the nasolacrimal duct (posterior to anterior). Powered instruments are then employed to complete the uncinectomy and uncover the agger nasi cells superiorly and the primary maxillary sinus ostium inferiorly. The next landmark is the posteromedial wall of the agger nasi cell (best viewed with a 30- or 45-degree telescope). The retroagger space or nasofrontal recess (transition space for the frontal sinus) lies just behind this landmark. Occasionally, the posterior wall of the agger dome must be removed to further enlarge this transition space. The next landmark is the face of the ethmoidal bulla. The associated transition space is the hiatus semilunaris superior, that space between the lateral edge of the middle turbinate and medial edge of the ethmoid bulla (this is the transition space for the remainder of the anterior ethmoid sinus). Powered instrumentation is used to remove the entire medial wall of the bulla, thereby exposing the basal lamella and enlarging this transition space. Projections of the anterior ethmoid sinus through the basal lamella, termed the retrobulla space, are now visualized. If a posterior ethmoidectomy is required, the basal lamella is opened in the inferomedial quadrant using powered instruments. Posterior ethmoid partitions are judiciously removed as required. Care is taken not to leave bare bone at the margins of resection. The superior meatus is examined to evaluate the primary drainage pathway from the posterior ethmoid cells. Polyps in this area are removed with powered instruments. The sphenoidal recess should

also be examined. The space between the middle turbinate and septum is inspected and contact points are reduced with a freer. Upon completion of surgery, no nasal packing is placed. For all patients undergoing middle meatal surgery, a Meroceel stent is placed into the middle meatus to help prevent synechiae. Middle meatal debridement is rarely required postoperatively. Most patients are able to return to work or school within 24 to 48 hours of surgery. There are usually no diet or activity limitations. Pain is typically minimal.

Outcome studies of MIST

Since its introduction in the literature in 1996,²² MIST has grown in popularity worldwide. In January 2002, the first formal outcome study was published comparing MIST to FESS.²⁴ Outcome from MIST as measured by the Chronic Sinusitis Survey (CSS), the quality of life outcome instrument, either equaled or surpassed those after conventional FESS. In addition, the surgical revision rate following MIST was 5.9%, compared with an average of 10% following FESS. Furthermore, the results after MIST were consistent across the spectrum of disease severity (from minimal to severe), disproving the opinion that the procedure is only effective for minimal disease. Minimal medical/surgical morbidity is experienced by geriatric patients after MIST, making the procedure safe for the oldest.²⁵ A combination of minimally invasive mucosal sparing surgery and biocompatible, biodegradable middle meatal stents can eliminate intranasal synechiae.²⁶ Because MIST does not manipulate the primary maxillary sinus ostium, the ostium remains in the oblique or horizontal plane, making it less likely to be obstructed by a lateralized middle turbinate.

These findings strongly support MIST as the initial surgical intervention for the treatment of chronic rhinosinusitis. An excellent quality of life for chronic sinus sufferers could be achieved with threshold surgery. It validates Messerklinger's transition space theory and the reversibility of diseased nasal membranes and contradicts the rationale for the routine creation of a middle meatal anastomy. MIST is a construct between the foundation principles of FESS, advances in instrument technology, and a surgical model based on anatomical stepwise progression.

Nasal polyps

Sinonasal polyposis represents a chronic inflammatory condition of unknown etiology. Endoscopy has enhanced the diagnosis and treatment of nasal polyps. Surgical removal is performed for non-responders to medical treatment, those with continued or recurrent infections, as well as

patients who are developing mucocoeles or other complications of coexistent sinusitis. The purpose of surgery is to restore the nasal physiology by making the nose free from nasal polyps and allowing drainage of infected sinuses. Recent advances in endoscopic surgery of nasal polyps involve computer-assisted navigation and power instrumentation.^{27,28} Patients with extensive polyp or sinus disease and those undergoing revision surgery benefit from image-guided surgery by localizing areas of the sinuses within 2 mm, improving the thoroughness of the surgery and reducing complications.²⁷ Powered instrumentation with microdebriders facilitates surgical removal of polyp by minimizing inadvertent mucosal trauma and stripping.²⁸ The microdebrider can be used for removing nasal polyps in the sinonasal cavity without altering the specimen for histopathology.²⁹ In 40 cases of ESS performed with the microdebrider, patients who had at least a 5-month follow-up showed rapid mucosal healing, minimal crust formation, and a low incidence of synechiae formation.³⁰

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