

The Surgical Management of Allergic Rhinitis

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KEYWORDS

- Allergic rhinitis • Nasal obstruction • Submucous resection
- Septoplasty • Inferior turbinate hypertrophy

Key Points: ALLERGIC RHINITIS: SURGICAL MANAGEMENT

- Allergic rhinitis is a widespread condition, and nasal obstruction is a defining and bothersome symptom.
- Allergic rhinitis that is refractory to medical therapy may necessitate surgical intervention.
- Reduction of the inferior turbinate is the primary means of augmenting the nasal airway in allergic rhinitis patients.
- A variety of procedures exist for the surgical reduction of inferior turbinate tissue, including outfracture, submucous resection, laser vaporization, radiofrequency ablation, and coblation.
- Septoplasty alone has little role in the treatment of nasal obstruction for allergic rhinitis.
- Endoscopic sinus surgery is an important treatment method for allergic rhinitis when it contributes to chronic sinusitis, nasal polyposis, or allergic fungal disease.
- No single operation has evolved as the gold standard for treatment of nasal obstruction in allergic rhinitis; instead the surgeon should be familiar and facile with several approaches.

Allergic rhinitis (AR) is a widespread condition that affects millions of patients yearly, and the hallmark complaint of nasal obstruction accounts for one of the most common reasons for outpatient otolaryngologic visits. Comorbid conditions often seen with AR include asthma, otitis media, atopic disease, and various forms of rhinosinusitis. The

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differentiation between rhinosinusitis and AR is often based on clinical history, associated perennial symptoms, nasal cytology, and response to different medical or surgical therapies.¹ Many interventions exist for the treatment of AR, but the most common surgical interventions are aimed at reducing nasal obstruction to better augment the nasal airway.

BACKGROUND

Allergic rhinitis has been described as the “total rhinologic disease,” and requires comprehensive otolaryngologic care.^{1,2} Treatment of patients with AR can be challenging, and has the goal of reducing perennial symptoms while improving quality of life. The disease process can contribute to chronic rhinosinusitis, nasal polyposis, and chronic rhinitis, and therefore AR may be difficult to differentiate from these associated conditions. Patients with chronic AR may also present with fungal disease of the paranasal sinuses or persistent acute sinus exacerbations, often caused by secondary ostial obstruction from edematous sinonasal mucosa (**Fig. 1**). These coexisting conditions may further complicate patient care.

The incidence of AR is steadily increasing, with up to 24% of the general population having this condition, including approximately 30% of the adult population and 40% of children.^{3,4} More than 600 million patients worldwide are afflicted, making AR the most prevalent atopic disorder.⁵ The total direct and indirect cost associated with AR treatment exceeds \$5 billion annually.⁶ The hallmark symptoms include nasal obstruction, sneezing, seromucosal rhinorrhea, and nasal pruritus.⁷ Symptoms may show seasonal or perennial variations, and medical therapy is generally implemented early in the disease process. Systemic symptoms or conditions may also be present with AR, including asthma, bronchitis, pneumonia, and atopic dermatitis. Clinical history is of central diagnostic value, and helps to delineate etiologic factors. Additional allergen testing or serum diagnostics are often used in the workup of patients and to confirm and help direct therapy.

The origin of AR has many contributing factors. The mucosa of the nose and paranasal sinuses is continuous with the lower airway, with only microscopic changes on different levels.¹ Based on this membrane continuum, the association among asthma, certain pulmonary conditions, and AR can be understood. Seasonal variations are often attributed to external factors, such as trees, grass, weeds, and molds. Skin prick, nasal allergen provocation or challenge, intradermal, or in vitro serum-specific testing can delineate allergens and narrow therapeutic regimens. Occupational

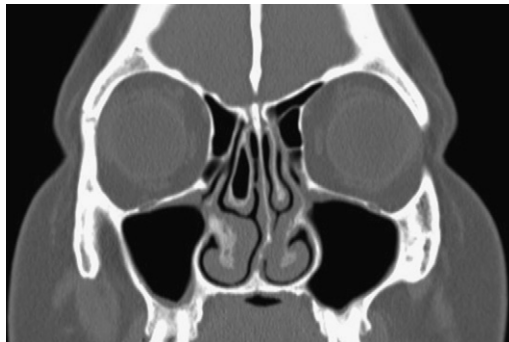


Fig. 1. A coronal CT scan showing bilateral maxillary ostial edema and closure from AR.

exposures often contribute to episodic AR, and common triggers include wood dust, latex, spores, or certain chemical irritants. Perennial disease is often caused by indoor allergens, but certain outdoor allergens that are present year-round can also be contributing factors.⁸ House dust mites, specifically *Dermatophagoides farinae* and *Dermatophagoides pteronyssinus*, pets, and cockroaches are common culprits of perennial AR.⁹

Allergen responses in the nasal mucosa are mediated by a variety of complex interactions among inflammatory markers. IgE is the main mediator of the allergen-allergic response and the resulting sequelae. Mast cells are present in ample quantities in the nasal mucosa, and IgE-mediated binding of allergens initiates a cascade of inflammatory mediator release, both immediate and delayed. Histamine, tryptase, kinins, leukotrienes, and prostaglandins are included in the array of mediators and lead to rhinorrhea.¹⁰ The effects include mucous gland stimulation and increased vascular permeability, resulting in increased secretions, edema, and exudate. Vasodilation leads to engorgement of nasal mucosa and structures, especially the inferior turbinates, thereby causing nasal obstruction, congestion, and discomfort. Inflammation of neuroepithelium and sensory nerve endings cause nasal pruritus and bothersome sneezing. The effects continue in a delayed fashion, causing recruitment and migration of inflammatory cells, including macrophages, neutrophils, and eosinophils. This late phase may persist for hours or days.

The sequence of events initiated by the allergen also causes secondary sinus ostia closure, which results in negative pressure within the sinus cavities and sets the stage for bacterial invasion.¹¹ Further reduction in ciliary function leads to accumulation of secretions, bacterial stasis, or biofilm formation. A cycle of sinusitis may ensue and quality of life can be significantly impaired (**Fig. 2**). First-line treatment includes aggressive nasal hygiene, parenteral therapy, and topical nasal corticosteroids. More complex or persistent disease may benefit from immunotherapeutic desensitization or surgical intervention. Additionally, certain patients are refractory to even long-term medical management, and repeated physician visits for immunotherapy may not be feasible.

The literature agrees that nasal obstruction is the symptom in AR that is most refractory to medical management. It is also perhaps the most important symptom in



Fig. 2. Pansinusitis in a patient with AR.

improving quality of life for these patients. Surgical intervention may be necessary to address this issue, and also to reduce fixed obstruction and aid in dynamic compliance of the nasal airway. Although surgery will not eliminate the inflammation central to AR, additional patency of the nasal fossa reduces the effects of edematous mucosa and may alleviate symptoms. Before the era of endoscopic sinus techniques, septoplasty and inferior turbinate reduction were the classic surgical interventions for the treatment of AR. Neurectomy and selective nasal tissue reduction have been used, though limited data is available to support their routine use. Endoscopic sinus surgery has gained increasing popularity in the past decade and has proven useful, especially when AR contributes to chronic sinusitis, fungal disease, or polyposis. Still, inferior turbinate reduction is perhaps the most common and widely used procedure for treating nasal obstruction in AR that is refractory to medical therapy.

The Role of the Inferior Turbinate in AR

Hypertrophy of the inferior turbinates has long been established as the central cause of symptomatic nasal obstruction in AR. Allergic inflammation causes vasoreactive engorgement of turbinate tissue and associated inflammation of the mucosal lining. The mucosal epithelium of the inferior turbinates has been regarded as the central site for IgE-mediated reactions and nasal eosinophilia.¹² Topical intranasal corticosteroid therapy targets the inferior turbinate epithelium to help attenuate the allergic inflammatory response. In certain refractory cases or in chronic rhinosinusitis, surgical reduction/removal of turbinate tissue may help alleviate symptoms.

The effect of reducing allergic symptoms using surgical reduction of turbinate tissue can best be understood through histologic and anatomic considerations of the inferior turbinate. The lower turbinates have a very important role in nasal physiology and airway compliance. They are bony structures lined with mucosa consisting of ciliated pseudostratified columnar epithelium.¹³ The submucosal lamina propria supports this superficial epithelial layer and contains key histologic elements, including parasympathetic nerve fibers, mucous glands, Goblet cells, and abundant vasculature.^{13,14} Hyperplasia of glandular elements within the submucosal layer of the turbinate may worsen nasal obstruction and rhinorrhea in AR.¹³ The inferior turbinates modulate inhaled air temperature and nasal resistance, while sharing important mucociliary functions with surrounding nasal tissue. The first points of contact for allergens are the lower turbinates, and deposition in these areas results in localized inflammation stemming from submucosal structures. The goal of surgery of the inferior turbinate is to minimize allergen effects through reducing bulky inflammatory tissue or inducing scar formation, while enhancing patency of the nasal fossa.

Inferior Turbinate Reduction in AR

Over the years, total turbinectomy has become significantly less common and essentially obsolete, partly because of fear of complications such as atrophic rhinitis or empty nose syndrome (ENS).¹⁵ Radical turbinectomy also compromises ciliary function and reduces nasal resistance and humidification. Additionally, technological advances have led to the development of a broader and less-traumatic armamentarium of surgical techniques for turbinoplasty.

Mechanisms accounting for symptomatic improvement in patients with AR after turbinate surgery are likely a combination of various factors. The net mucosal surface may be slightly decreased after volume reduction of the turbinates, thereby reducing available contact points for allergens.¹⁶ Scar tissue develops within the submucosal layer after surgical manipulation, thereby destroying vasculature and glandular structures while impeding regrowth through fibrosis. The reduced volume of the inferior

turbinate results in increased nasal patency, allowing the nasal fossa to accommodate swelling of the turbinate from AR. The net effect is improved quality of life through decreased nasal obstruction.

Many techniques are available for turbinate reduction, including classic lateral outfracture techniques, submucosal resection, radiofrequency ablation, coblation, and laser reduction.

Lateralization Outfracture of the Inferior Turbinate

Lateral outfracture of the inferior turbinates has a longstanding history in the otolaryngologic treatment of nasal obstruction. The anterior and inferior portions of the lower turbinate are the main determinants of nasal resistance, and hence are the target of outfracture. Poiseuille's law states that the laminar flow rate of air along a pipe is proportional to the fourth power of the pipe's radius.^{17,18} Therefore, small changes in the inferior turbinate will dramatically affect nasal airflow, which is the physiologic basis on which reduction of lower turbinate tissue rests.

Of all the turbinate reduction techniques, outfracture lateralization is the most surgically conservative and considered the least traumatic to mucosa and surrounding nasal structures. The outfracture procedure was first described by Killian in 1904 as an alternative and replacement to the more historic radical turbinectomy.¹⁷ The risk of nasal adhesions is negligible and there is a minimal chance of developing atrophic rhinitis. Historically, outfracture techniques were thought to produce only short-lasting benefits with a modest increase in nasal patency that is not predictable, especially because the turbinate may medialize over time and symptoms may recur.^{19,20} The classic method is displacement of the inferior turbinate in a lateral, then superior, and then inferior fashion until a crunching sound is heard (**Fig. 3**). Minor variations exist; some authors prefer to first displace the turbinate in an inferomedial direction, whereas others will add chiseling to the lateral wall attachment to facilitate anterior lateralization.

Aksoy and colleagues¹⁷ evaluated the effectiveness of bilateral turbinate outfracture in 40 patients as a function of the angles and distances between the inferior turbinate and lateral nasal sidewall on paranasal coronal CT scans. They found statistically significant reductions in the angle and distance between the inferior turbinate bone and lateral nasal wall and the area lateral to the inferior turbinate. This reduction was sustained at 6 months postoperatively, leading the authors to conclude that medialization does not occur in at least the first 6 months after outfracture. In general, lateralization outfracture of the inferior turbinate is a safe and simple method of enhancing nasal patency and can be accomplished with routine instrumentation. Additionally, there is virtually no disruption of mucosa and sensory afferents or risk of damage to surrounding structures, including the nasolacrimal system. Further studies with large patient populations are needed to evaluate the long-term efficacy of lateralization outfracture.

Laser Vaporization of the Inferior Turbinate

Six basic laser systems are available for the treatment of hypertrophic inferior turbinates: carbon dioxide (CO₂), diode, neodymium-yttrium aluminum garnet (Nd:YAG), potassium-titanyl phosphate (KTP), argonion, and holmium-yttrium aluminum garnet (Ho:YAG) lasers.²¹ Each laser differs slightly in depth of penetration and the optimum chromophore. Cited benefits of laser therapy include enhanced hemostasis, reduced postoperative pain, and improved healing.

The concept of laser therapy is to prevent excessive mucosal damage or bony exposure while inducing fibrosis and reducing turbinate bulk and surface area.

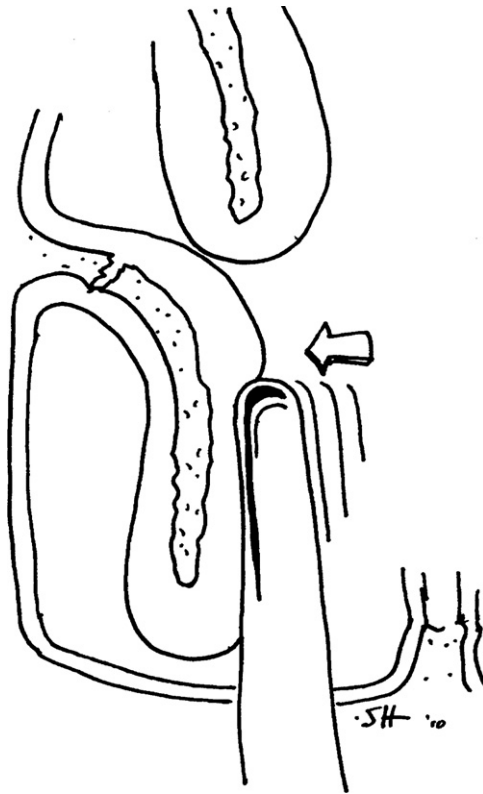


Fig. 3. Schematic representation of outfracture lateralization of the right inferior turbinate.

Vaporization of the entire turbinate has been reported but is not widespread.²² The laser may be applied in a linear fashion, anterior-to-posterior stripes, cross-hatching across the entire mucosal surface, or along only the anterior or inferior aspect of the turbinate.²³ Spot treatment based on obvious areas of edema or inflammation or any combination of these techniques may also be used for increased efficacy.

The effect of laser therapy on allergen-mediated responses of the inferior turbinates has been studied in histochemical models. Elwany and Abel Salaam²⁴ reported on 15 patients undergoing CO₂ laser ablation turbinoplasty. Biopsy specimens taken 1 month after laser treatment showed many disorganized seromucinous acini in a background of dense fibrous stroma. Electron microscopy showed an overall reduction in the number of active nasal glands, likely accounting for the postoperative reduction in nasal rhinorrhea. Although this study included specimens only up to 1 month postoperatively, other authors have verified the long-term histologic changes induced by the laser.²⁵

Caffier and colleagues²⁶ recently reported on the effects of diode laser turbinoplasty on 40 subjects, both seasonal and perennial sufferers. Some patients had concomitant septal or middle turbinate pathology that was also addressed, but overall, 95% of patients had diode laser inferior turbinoplasty. The investigators noted statistically significant improvements in both objective rhinomanometry and subjective scores for nasal obstruction, rhinorrhea, sneezing, and nasal pruritus. The improvement was greatest in symptomatic nasal obstruction and was initially higher in perennial

patients, but was more sustained in the seasonal rhinitis population. No significant group differences were seen in symptoms of rhinorrhea, sneezing, or itching. Overall, 80% and 65% of patients experienced a stable, nonmedicated course at 1 and 2 years, respectively.²⁶ In some cases, bony exposure of septal crests or spurs occurred, but no significant long- or short-term adverse outcomes were seen.

Takeno and colleagues²⁷ prospectively compared CO₂ laser partial turbinectomy in perennial and seasonal patients, and noted initially less-pronounced improvement in sneezing and rhinorrhea in the seasonal group and greater cross-sectional enlargement of nasal cavity volume in the perennial group. These findings led the authors to conclude that laser therapy may be beneficial for acute seasonal exacerbations, but the effects may not be maximally therapeutic until later in the allergy season. Supiyaphun and colleagues²⁸ found no statistically significant differences in total airway resistance assessed by rhinomanometry after KTP turbinoplasty, although improvements in total inspired nasal airflow were noted.

Overall, symptomatic improvement from laser turbinoplasty and turbinectomy is varied in the literature, from 50% to 100% effectiveness. Proponents advocate less postoperative pain, better hemostasis, and more precise delivery of focused energy to achieve results. Additionally, the use of in-office lasers obviates the need for general anesthesia. Although lasers have a very low side-effect profile, the equipment can be expensive, bulky, and unavailable in many medical centers. Complications include crusting, synechiae formation, and bony exposure of nasal structures.

The Role of Submucosal Resection

The classic procedure of submucous resection involved an incision and the raising of a mucosal flap on the medial/septal side of the lower turbinate, followed by resection of bone with forceps (Fig. 4). The mucosa overlying the inferior meatus on the lateral aspect of the inferior turbinate was often also removed, and the medially conserved mucosa was then redraped over the resection site. Over time, the term *submucous resection* has become somewhat unclear and is now used throughout the literature in reference to a variety of techniques, including thermal ablation of cavernous submucosal tissue, laser reduction, and powered instrumentation. Navigating the literature,

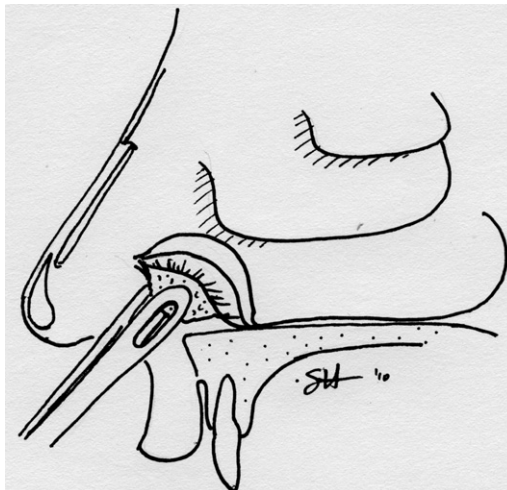


Fig. 4. Classic submucous resection of the lower turbinate.

one will find that submucous resection is used loosely and the specific technique may not be elucidated. The authors advise the judicious use of the term *submucous resection* and instead recommend naming and clearly describing the specific technique used. When referencing submucous resection of the inferior turbinate, this term should be reserved for the classic open technique.

Reduction of the submucous component of the inferior turbinate has a role in chronic nasal obstruction, rhinosinusitis, obstructive sleep apnea, and AR. The fundamental goal is to reduce bulky inflammatory tissue and perhaps turbinate bone, thereby enhancing nasal patency and improving the obstructive component. The overlying mucosa is maximally preserved, so as to not compromise ciliary function. Maintenance of surface epithelium is also necessary to reduce feared complications of crusting, synechiae, and osteitis that may result from bony exposure.²³

Total inferior turbinectomy

As described by Passali and colleagues,¹⁹ total inferior turbinectomy may result in significant adverse outcomes. In this regard, radical turbinectomy has largely fallen out of favor and is no longer routinely practiced. The development of empty nose syndrome is an iatrogenic disorder resulting from the loss of turbinate tissue.²⁹ Although the development of ENS is somewhat controversial and rare, it can be a devastating complication and its incidence is greatly reduced through conservative measures.^{15,29} Therefore the authors recommend the cautious approach to inferior turbinate resection and advocate mucosal-sparing operations, which carry less risk for the development of ENS unless performed in an overly aggressive fashion.

Other techniques

Passali and colleagues¹⁹ compared classic submucosal resection of the inferior turbinate to various other modalities, including cryosurgery, laser cautery, and radical turbinectomy, over a 4-year follow-up period. Turbinectomy had the greatest effect on reducing nasal obstruction, but incurred adverse effects on mucociliary transport time and caused secondary hemorrhage. Submucous resection showed a lower incidence of bleeding and crusting, and the greatest improvement in mucociliary clearance and secretory IgA production, although patients had longer hospital stays compared with other groups. Additionally, when combined with lateralization outfracture, submucous resection had even further benefit, but the difference was not statistically significant. The addition of outfracture added minimal morbidity and time, and the authors recommend it as a useful adjunct to submucous resection alone.

Outcomes with submucous turbinectomy

Mori and colleagues¹² reported on 60 patients with severe perennial AR who underwent submucous turbinectomy. Subjects were followed up for 1 year and the authors evaluated changes in subjective nasal symptoms, rhinometry, nasal provocation, and immunohistochemistry from nasal biopsies. Results showed that submucous turbinectomy had statistically significant effects on the reduction of nasal discharge, stiffness, and sneezing. Eosinophils and infiltrating IgE cells were reduced in the turbinate tissue, although serum IgE levels were unaltered. Additionally, saccharin transport times were maintained primarily because of preservation of the overlying epithelium. These investigators hypothesized that submucous resection may be superior in reducing allergic symptoms beyond just nasal obstruction, possibly because of disruption of autonomic and sensory nerve fibers from the sphenopalatine foramen that travel submucosally or in the periosteal region of the inferior turbinate.¹² These nerves have shown important functions in the physiology of the nasal mucosa, microvascular circulation, and immunoglobulin production.^{12,30}

Mori and colleagues³¹ further reported on long-term outcomes over a 5-year follow-up period. The investigators noted a significant increase in total nasal airflow, a gradual reduction in the total nasal symptom score, and reduced nasal allergen responses over several years postoperatively after submucous resection of inferior turbinate tissue. At more than 3 years after surgery, 72.5% of patients were free of nasal allergic reactions. Moreover, quality of life was enhanced in this patient population, with 60% of patients noting excellent improvement in nasal allergic and 50% of patients maintaining a treatment-free disease state postoperatively. The authors identified a nerve fiber during endoscopic submucous resection that histochemical analysis suggested was a branch of the postnasal nerve. The authors believe that transection of this nerve may be responsible for the reduced sneezing and hypersecretion seen after submucous resection, as originally proposed in their previous study.¹²

Submucous electrocautery

Submucous electrocautery of the lamina propria after bony turbinate resection has shown promising reduction in symptoms with minimal crusting.¹⁴ Ishida and colleagues^{14,32} showed a significant reduction in anti-tryptase-positive mast cells after surgery, resulting in decreased histamine levels in nasal lavage. The authors advocate maximal preservation of overlying mucosa to aid with mucociliary transport, warming, and humidification of the nasal passages. The destruction of the lamina propria is perhaps the most important component of submucous resection. Preservation of normal nasal mucosa while adequately resecting submucosal tissue will maximize benefit to patients with AR.

Microdebrider turbino-plasty

Microdebrider turbino-plasty is a form of submucosal resection that uses a small stab or pocket-type submucosal incision, followed by resection of the cavernous tissue surrounding the bony turbinate (**Fig. 5**). Advantages include real-time suction with precise tissue removal, and this method has gained increasing popularity in recent years.³³ Chen and colleagues³⁴ compared submucosal resection with microdebrider-assisted turbino-plasty in 160 patients with perennial symptoms and turbinate hypertrophy. The study groups consisted of microdebrider-assisted turbino-plasty with lateral outfracture and submucous resection alone. Visual analog scales, saccharin transport testing, and anterior rhinomanometry were used to compare outcomes between the groups. The investigators noted an improvement in subjective complaints, nasal airflow, and mucociliary transport across both groups. They concluded that microdebrider turbino-plasty is equally as effective as submucous resection in these assessment

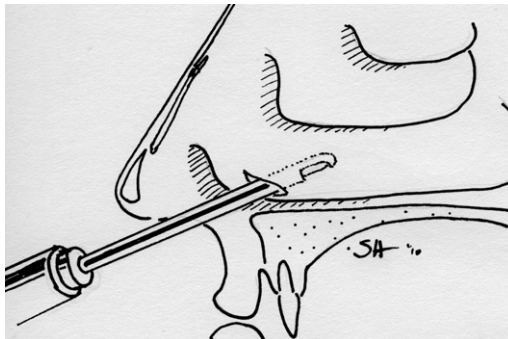


Fig. 5. Microdebrider-assisted turbino-plasty.

dimensions up to a 3-year follow-up period. Their data suggest improved mucociliary time with microdebrider technique compared with submucous resection, likely because of less trauma to overlying mucosa. The authors advocate microdebrider turbinoplasty as an effective method for turbinate reduction in AR, but unlike in submucous resection, bone is not removed, which may be problematic in patients with thick or calcified bony turbinates.

Summary: submucous resection of inferior turbinate

Submucous resection of the inferior turbinate has been shown to provide beneficial effects to patients with AR and is generally well tolerated with few long-term side effects. Despite the various terms used within the realm of submucous resection, the basic principles of augmenting the nasal airway through reduction of lower turbinate tissue remain the same. Regardless of the specific method used, respect for the superficial mucosal layer and conservative technique are vital to optimize outcomes. However, excessive or overzealous submucous resection of turbinate tissue may potentially lead to paradoxical nasal obstruction, the hallmark of empty nose syndrome, and the senior author has seen this complication from submucous resection.

Radiofrequency Ablation and Coblation Turbinoplasty

Radiofrequency ablation (RFA) has been well established as a means to achieve volume reduction of tissue of the upper airway. This technology has been applied to oropharyngeal, tongue base, and palatal tissue to alleviate obstructive symptoms in patients.³⁵ Radiofrequency reduction has also found a place in the treatment of nasal obstruction. A probe is inserted directly into the inferior turbinate and is used to deliver a low-frequency energy, which induces ionic agitation of tissues.²³ A thermal effect occurs from elevated temperature, resulting in postoperative wound contracture and fibrosis.²³ The energy is apparently limited to the submucosa, which preserves the surface epithelium and, therefore, ciliary function.³⁶

Coagulative necrosis is the first step in the process of tissue destruction by RFA, and the effects of scar contracture and tissue retraction occur later in the wound healing process. Over time, portions of the fibrotic scar undergo resorption and the submucosal scar will adhere to the bony periosteum, both reducing turbinate bulk while rendering it less susceptible to edema and engorgement.^{36,37} The output frequency of most RFA devices and generators varies from 100 to 4,000 kHz, and the relationship between frequency and extent of the thermal lesion produced is not yet clear.³⁶ Coblation technology, which relies on electrodissection by molecular activation, is generally grouped as a subset within RFA and similarly targets the submucosal layers.^{36,38}

Outcomes and complications of RFA

Hytönen and colleagues³⁶ performed a comprehensive review of the literature in 2009 to study the effectiveness and complications of RFA on patients with nasal symptomatology. The most common indication for RFA was inferior turbinate hypertrophy that was refractory to medical management. AR was an inclusion criterion in 6 of the 35 reviewed studies. Multiple devices were studied, including the coblation system. The outcome of RFA on symptomatic improvement in AR was primarily based on subjective measures, such as quality of life questionnaires and patient or physician visual analog scales. Of these, only one study was placebo-controlled and double-blinded.¹⁸ Overall, the AR studies showed a statistically significant effect on symptoms and, in one case, rhinomanometry confirmed this effect.³⁹ In general, subjective improvement of nasal patency peaked around 3 weeks after treatment. When

compared with other methods of turbinoplasty, RFA reduced nasal obstruction in a statistically significant manner, although microdebrider-assisted turbinoplasty showed superior results in reducing nasal volume and nasal blockage.^{36,40} In the comparative studies, RFA had fewer side effects.

RFA is generally well tolerated across both pediatric and adult populations. Hytönen and colleagues³⁶ noted the absence of significant complications related to RFA across the 35 studies they reviewed. The most common complaint was pain during and after the procedure, and in some cases the treatment was terminated because of intraoperative pain.⁴¹ RFA is often performed in the outpatient or clinical office setting; therefore, appropriate local or block anesthetic is imperative in minimizing intraoperative discomfort. Bleeding, crusting, and postoperative edema are also possible adverse effects, and some authors have noted the presence of localized infections.⁴²

In the first long-term study of its kind, Lin and colleagues¹⁶ recently published on 101 patients undergoing RFA turbिनoplasty for the treatment of AR refractory to medical therapy. Patients were followed up to at least 5 years postoperatively. Both global patient questionnaires and visual analog scales were used to evaluate the efficacy of RFA in this series. Response rates at 6 months and 5 years were 77.3% and 60.5%, respectively, and statistically significant improvement in nasal obstruction, rhinorrhea, sneezing, itchy nose, and itchy eyes was noted. RFA alone produced no improvement in 17 patients, who subsequently underwent additional turbinate procedures, such as laser ablation or submucosal resection. The authors hypothesized that the reduction in ocular symptoms in their study, approximately 43%, may be from an RFA mediated inhibitory effect on the local immune response or naso-ocular reflex; however, further research is necessary to elucidate potential mechanisms. The authors acknowledge the lack of a control group, the need for objective measures to verify the subjective results, and a substantial number of patients lost to follow-up.

Garzaro and colleagues⁴³ recently published objective data on the effects of RFA on olfactory function on 40 patients with both allergic and nonallergic rhinitis presenting with nasal obstruction caused by inferior turbinate hypertrophy. Anterior rhinomanometry, subjective questionnaire, and odor identification, discrimination, and thresholds were used in this series. Although no correlation between allergy and the improvement of olfactory function was found, the authors showed statistically significant improvements in basal nasal resistance 2 months after surgery, and net improvement in the sum of odor thresholds, discrimination, and identification. Improvements in olfactory function may be related to the surgical modification of airspaces medial to the inferior turbinate or volume changes of the inferior meatus, which are induced by RFA.⁴⁴ Further research in the realm of olfactory function after RFA therapy is needed.

Coblation

A technique that has garnered increasing popularity in recent years is coblation, which exists within the umbrella of RFA. The coblation technology exploits molecular ionization to achieve low-temperature disintegration of tissues, with minimal damage to surrounding structures.³⁸ Fundamentally, this technology should incur less pain and is therefore especially popular in the pediatric population. Siméon and colleagues³⁸ investigated the efficacy of the Coblator (Arthocare Corporation) radiofrequency device on nine patients with AR with a mean age of 12.7 years. In this study, assessment consisted of rhinomanometry, visual analog scales, and quality of life questionnaires. Favorable and statistically significant decreases in binasal resistance, pruritus, sneezing, hyposmia, and rhinorrhea were observed and sustained at 6-month follow-up. The authors noted that coblation turbिनoplasty did not abolish rhinitis but rather

assisted in the efficacy of topical corticosteroids. Additionally, although this study did not specifically focus on pulmonary disease associated with AR, most patients showed some concomitant pulmonary improvement, possibly related to normalization of nasal airflow from the Coblator device.³⁸

Summary: RFA and coblation

RFA and coblation have shown promising results. The procedures are well tolerated with minimal adverse effects, including less likelihood of empty nose syndrome, and can be performed safely in an outpatient clinical or in-office setting. Coblation, in particular, heralds less pain and may have expanded implications for the pediatric population. The main disadvantage of RFA technology relates to a lack of well planned, double-blind, placebo-controlled randomized trials to better elucidate causal relationships.³⁶ Additionally, longer patient follow-up, further objective assessment, and side-by-side comparison of various devices to evaluate cost-effectiveness and general efficacy are needed.

Septoplasty in Allergic Rhinitis

Septoplasty has long existed as a means to treat symptomatic nasal obstruction. However, the role of septoplasty in nasal obstruction associated with AR is poorly understood. A paucity of literature has investigated septoplasty alone as a means to improve nasal patency in AR, largely because the nasal septum is not believed to be a major contributor to the disease process or to nasal obstruction seen in AR. Compared with the nasal septum, the inferior turbinate has a more central role in symptomatology. The septum does not experience the extent of dynamic changes as turbinate tissue, including engorgement, mucosal edema, and glandular hyperplasia. The septum is also thought to have a lesser contribution to allergen deposition and mucociliary clearance. Historically, some authors have even cited AR as a relative contraindication to septal surgery, primarily because of the lack of significant improvement in nasal obstruction.^{45,46} Structural support and regulation of airflow are key functions of the nasal septum. In many cases, anatomic deformities, such as bony spurs or cartilaginous deviation, may affect the normal laminar airflow in the nasal fossae and may worsen subjective nasal obstruction in patients with AR (**Fig. 6**). Most often, septoplasty is combined with turbinoplasty or endoscopic sinus surgery,

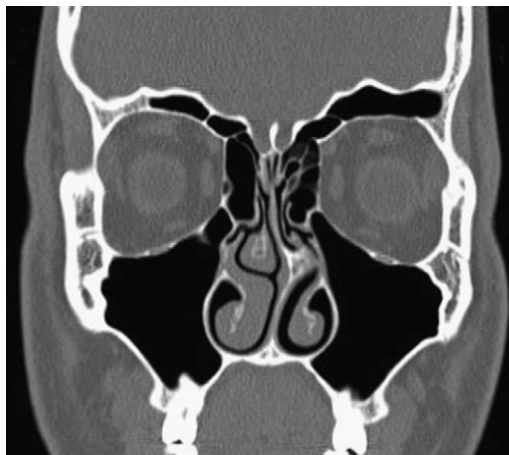


Fig. 6. Obstructive septal spur of the left nasal fossa.

especially when obvious anatomic septal deformity or obstruction exists.³⁶ Septoplasty may be undertaken to improve function and quality of life in patients afflicted with AR, although it is rarely used alone as primary surgical therapy.

In 1988, Fjermedal and colleagues⁴⁶ compared septal submucous resection with septoplasty in 478 patients. Of this group, 72 patients had AR based on either skin prick or serum IgE values. The authors noted that improvements in nasal patency and air passage were comparable between the allergic and nonallergic patients, whereas rhinorrhea remained unchanged from the preoperative state. With regard to patient satisfaction, the investigators found that patients with AR were significantly less satisfied than their nonallergic counterparts.⁴⁶ The authors concluded that patients with AR may undergo septal surgery on general lines, but did not advocate for AR as an absolute indication for septoplasty.

A 2009 study by Karatzanis and colleagues⁴⁷ confirmed these findings. In this study, 176 patients underwent septoplasty and all patients were evaluated using both anterior rhinomanometry and subjective questionnaires. Patients with AR with nasal septal deviation and those with nasal septal deviation alone were compared. The authors found that after septoplasty, subjective improvement in breathing was present in both groups but was significantly higher in patients without AR. Anterior rhinomanometry showed improvement in nasal airflow also in both groups, but the result was substantially higher in the group that had nasal septal deviation only. The authors therefore recommend a cautious approach to the management of nasal septal deviation in AR, because these patients are less likely to be satisfied after surgery than nonallergic patients.⁴⁷

A recent study by Topal and colleagues⁴⁸ investigated the risk of septal perforation in patients with AR after septoplasty. The loss of epithelial integrity of nasal mucosa, chronic use of intranasal steroids, and increased mucosal fragility from chronic inflammation may predispose these patients to septal perforation.^{48,49} The authors address the important question of whether septal procedures may increase the risk of nasal septal perforations in this patient population. In this study, septoplasty as described by Cottle and colleagues⁵⁰ was performed on 352 patients, 70 of whom had AR. The study group did not undergo concomitant turbinate or endoscopic procedures. The nonallergic and allergic groups had septal perforation rates of 1.4% and 0.7%, respectively. No statistical significance was found between the groups, and the authors concluded that septoplasty for AR does not impart a higher risk for nasal septal perforation.

Septoplasty has shown a beneficial effect on nasal obstruction in general, and may improve subjective nasal patency, especially when fixed anatomic obstruction of the septum is present. However, its role in the treatment of AR as a sole surgical modality is not convincing, although it may be a useful adjunct to turbinoplasty in the presence of an obvious and contributing obstructive component of the nasal septum. Additionally, the otolaryngologist should bear in mind that patient satisfaction after septoplasty may not be as substantial in allergic patients as in their nonallergic counterparts. Therefore, the authors recommend the judicious use of septoplasty in allergic patients.

Endoscopic Sinus Surgery and Vidian Neurectomy

Endoscopic sinus surgery has gradually evolved as one of the most common otolaryngologic procedures for the treatment of nasal obstruction caused by chronic sinusitis, paranasal and sinus polyposis, and allergic fungal sinusitis. Although endoscopic sinus surgery does not have a direct role in treating AR, it is of indirect benefit in patients with AR who also have chronic rhinosinusitis or polyposis. The main goal of endoscopic surgery is to maximize nasal patency and to alleviate the effects of

edematous ostia leading to chronic sinusitis. Polyp disease that obstructs the ostio-meatal complex or nasal fossa should also be addressed, and surgical reduction of polyposis will assist with medical therapy and topical intranasal corticosteroids. Allergic fungal disease that is unresponsive to medical management is another indication for endoscopic sinus surgery, and mechanical debridement and removal of inspissated secretions and allergic mucin may be necessary. In these patients, maximizing medical management is of central importance in conjunction with endoscopic sinus procedures. Additionally, endoscopic interventions may be combined with turbino-plasty to provide relief to more refractory or advanced cases of AR, in which turbino-plasty alone may be inadequate.

Vidian neurectomy

Vidian neurectomy is of historical importance and is briefly mentioned. Originally described by Golding-Wood in 1961,⁵¹ vidian neurectomy involves transection of the efferent pathway of the parasympathetic reflex, and a variety of methods have been described.⁵² The vidian nerve gains contributions from the superficial and greater petrosal nerves and the pericarotid sympathetic plexus before joining the sphenopalatine ganglion. Injury to the sensory nerve fibers reduces hyperreactivity of the nasal reflex, effectively reducing sneezing and nasal hypersecretion.⁵¹ Although historically effective, vidian neurectomy has largely fallen out of favor because of adverse outcomes. The most frequent and long-term side effect of vidian neurectomy is loss of lacrimation, or keratoconjunctivitis sicca, which mandates the use of artificial tear substitution.⁵¹ This effect can be severely disabling and bothersome to patients, especially in warm weather climates. Abducens paralysis or other eye movement disorders and postoperative hemorrhaging have also been described.⁵³ Advances in both medical and surgical therapy have largely replaced the classic vidian neurectomy. Research into alternatives, such as selective ganglion ligation or endoscopic posterior neurectomy, is underway but further studies are needed to elucidate their role.^{23,31,51} Presently, vidian neurectomy is seldom a treatment for AR and, when used, is a last resort after other surgical therapies have failed and the patient is adequately apprised of potential side effects.

SUMMARY: SURGERY FOR AR

AR is a very common condition, and the complaint of nasal obstruction can significantly affect the quality of life in patients. The surgical goal in AR is to augment the nasal airway through reducing turbinate tissue or obstructive components, such as septal spurs or polyposis. The inferior turbinate has proven to be the most important contributor to nasal obstruction and dynamic compliance of the nasal fossa in patients with AR. A variety of procedures for the surgical reduction of lower turbinate tissue have been described, although no single operation has been defined as the gold standard. Meticulous surgical technique, respect of tissue planes, and conservative reduction of lower turbinate tissue to help reduce adverse outcomes such as empty nose syndrome are crucial in maximizing surgical outcomes and improving symptoms.

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