Functionally Crippled Nose

Priyesh Patel, MD[1] Sam P. Most, MD[1]

[1] Division of Facial Plastic & Reconstructive Surgery, Stanford University School of Medicine, Stanford, California

Facial Plast Surg 2020;36:66–71.

Address for correspondence Sam P. Most, MD, Division of Facial Plastic & Reconstructive Surgery, Stanford University School of Medicine, 801 Welch Road, Stanford, CA 94305 (e-mail: smost@stanford.edu).

Abstract

Nasal obstruction is a common presenting symptom of patients seen by primary care physicians, otolaryngologists, and facial plastic surgeons. A variety of treatment strategies, both surgical and nonsurgical, have been used with success in improving nasal obstruction and quality of life. In a subset of patients, many of whom have either attempted these common treatment strategies or are intolerant of them, nasal obstruction remains a significant symptom. In these patients, there may be an identifiable problem, but it is simply not repairable or there is no identifiable anatomic issue. The management of these patients is discussed in this article, with an emphasis on a sensitive approach that takes into consideration a patient's mental health. While the need for diagnostic testing is generally not necessary for most cases of nasal obstruction, endoscopy and imaging should be considered in these patients. Validated patient-reported outcome measures are particularly helpful in providing an objective measure to a patient's frustrating symptoms. A variety of medications can be either contributory to the patient's symptoms or therapeutic if used appropriately. A variety of surgical interventions can also result in a functionally crippled nose and diagnoses including nasal valve stenosis, septal perforations, and empty nose syndrome are discussed. Importantly, further surgical interventions may not be appropriate if a deformity is minimal, and a surgeon should resist the temptation to proceed with surgery in those situations.

Keywords
- nasal obstruction
- congestion
- nasal valve
- rhinoplasty

Nasal obstruction is a common presenting symptom of patients seen by primary care physicians, otolaryngologists, and facial plastic surgeons. Although the term "obstruction" implies an anatomical blockage within the nasal cavity, it is commonly used by both patients and providers to describe a subjective sensation of inability to move airflow through the nose.[1] Therefore, nasal obstruction may be the manifestation of a variety of disease processes both structural and nonstructural. Regardless of etiology, nasal obstruction has implications on quality of life with effects on sleep, daytime fatigue, exercise tolerance, and overall well-being.[2–4] Nasal obstruction has also been associated with an increased risk of depression.[5]

A variety of treatment strategies, both surgical and nonsurgical, have been used with success in improving nasal obstruction and quality of life.[6–8] Surgical treatments include septoplasty, turbinate reduction, and functional rhinoplasty with repair of nasal valve stenosis. Nasal steroids and saline irrigation are among the more common medical treatment strategies. In a subset of patients, many of whom have either attempted these common treatment strategies or are intolerant of them, nasal obstruction remains a significant symptom. For a smaller subset, these symptoms are debilitating, and these patients are essentially functionally "crippled." This article discusses some of the pearls in approaching patients with such debilitating nasal function.

Patient Evaluation

Patients presenting with a functionally crippled nose can be categorized into either of two categories. In the first, there is an identifiable problem, but it is simply not repairable. For example, a patient presenting with a 1 mm discrepancy in the internal nasal valve may be obsessed with unilateral symptoms despite good overall airflow. Such a minor deformity is subtle and difficult to repair. Since this may seem counterintuitive to the patient, it is a source of frustration.

Issue Theme Challenges in Rhinoplasty; Guest Editor: Robin Lindsay, MD

DOI https://doi.org/10.1055/s-0040-1701488.
ISSN 0736-6825.

The second group of patients are those in whom there is no identifiable anatomic issue. In these patients, it is important to validate the symptoms, and also convey that there is no identifiable structural issue that can be corrected. The inability of our current state of knowledge to identify the issue is a source of frustration for both doctor and patient.

Patients with a functionally crippled nose may seek care from several providers and across several specialties including primary care, otolaryngology, facial plastic surgery, allergy, and pulmonology. Unfortunately, this can add to patient frustration, particularly if the patient's exhaustive attempts for medical advice do not yield any symptom benefit or if his or her concerns are dismissed. In addition, the underlying increased risk of depression suggests a need to be particularly sensitive to the emotional needs of these patients. Establishing an early sense of trust and building rapport with them is of importance. Moreover, consideration of referral to psychiatry, in situations where a patient's symptoms appear to be inconsistent with physical examination or compromising a patient's mental well-being, should be considered. This process may be familiar to facial plastic surgeons who interact with cosmetic patients who have underlying body dysmorphic disorder and present with self-thoughts that seem extreme for the degree of nasal or facial deformity.

A thorough medical history and physical examination should be performed on patients. Symptoms beyond nasal blockage or congestion may help suggest an underlying etiology. For example, patients presenting with facial pain or pressure and rhinorrhea may suggest a component of sinus disease. Smell disturbances may result from sinus disease, obstructive masses, atrophic rhinitis, or neurologic disturbance. It is also important to consider that patients with underlying pulmonary disease may experience additive effects on breathing from impairments in the lower airway. Addressing these comorbidities is imperative to improving a debilitated patients' nasal well-being and quality of life. Medication history, while providing information on previously attempted remedies, may also provide insight into the nature of the patients underlying disease (i.e., partial benefit from nasal steroids represents some degree of mucosal disease). A social history, including prior use of intranasal drugs, can have implications for nasal function and should be carefully obtained. For example, cocaine can cause significant osseocartilaginous destruction, alcohol can produce physiological vasodilation with nasal congestion, and smoking can impair mucociliary clearance with exacerbation of obstructive nasal symptoms.[9] Surgical history is particularly imperative as many patients presenting with problematic nasal obstruction have a history of prior nasal surgery that may be contributory to his or her symptoms.

Physical Exam Considerations

A standard nasal examination with external assessment followed by anterior rhinoscopy should be performed to evaluate for nasal aperture narrowing, septal deviation, turbinate hypertrophy, poor mucosal quality, and mucopurulence. An assessment for dynamic narrowing should also be performed. A previously validated grading scale for sidewall collapse at the scroll region (zone 1, internal nasal valve) and the ala (zone 2, external nasal valve) can be helpful in determining the location and degree of nasal narrowing secondary to lateral wall insufficiency (grade 1:$<$ 33%, grade 2:33–66%, grade 3:$>$ 66%).[10] While many physicians use the modified Cottle maneuver to assess subjective improvement in airflow with nasal collapse, it is important to note that this maneuver has poor specificity, and its validation as a presurgical tool is lacking.[11] In the subset of patients who present with a desperate need for improvement of their debilitating nasal obstruction, it is therefore important to use this tool cautiously to prevent overdiagnosing lateral wall insufficiency and subsequent poor surgical outcomes. When performed, very gentle traction of the sidewall to support any inward collapse should be used, with care not to significantly displace the sidewall laterally.

Diagnostic Testing

Further diagnostic testing, while unnecessary in patients with a clear etiology of nasal obstruction (i.e., septal deviation), can be particularly helpful for frustrated patients presenting with nasal obstruction. Nasal endoscopy, either rigid or flexible, can allow for examination of the posterior nasal airway and may reveal polyps, posterior septal deviations, adenoid hypertrophy, or nasal tumors. Adenoid hypertrophy in adults with nasal obstruction has been estimated to be as high as 64%, supporting the diagnostic yield of endoscopy in patients with persistent nasal obstruction.[12] Computed tomography scan of the nose and paranasal sinuses is the primary diagnostic imaging modality for nasal obstruction, with magnetic resonance imaging used as a secondary imaging tool.[9,13] Much like the modified Cottle maneuver, care must be taken to avoid overdiagnosis based on imaging, despite the temptation of wanting to help a frustrated patient with nasal obstruction. For example, a patient with a mild amount of sinus mucosal thickening may not benefit from any sinus surgery or mild enlargement of the inferior turbinate on imaging may not have clinical significance. As such, imagining modalities should be used always as an adjunctive tool with physical examination rather than an isolated diagnostic tool. While additional tools that assess nasal resistance, airflow, and/or airway cross-sectional area such as acoustic rhinometry, peak nasal airflow, and rhinomanometry have been shown to correlate with patient symptoms, they remain mainly as research tools.[14] Whether they would be clinically useful in a subset of challenging patients with nasal obstruction is unclear.

Patient-Reported Outcome Measures

Managing patients with crippling nasal obstructive symptoms can be challenging and frustrating for both patients and

physicians. Some of the difficulty in treating these patients stems from the subjective nature of their symptoms and the perceived severity of their disease. Validated patient-reported outcome measures (PROMs) such as the Nasal Obstruction Symptom Evaluation and Standardized Cosmesis and Health Nasal Outcomes Survey (SCHNOS) scores are particularly helpful in this regard as they provide an objective measure to a patient's symptoms.[15,16] They thereby are a valuable tool for physicians to evaluate a patient's response to treatments. They may also be therapeutic for a patient who can visualize his or her progress with different interventions. The SCHNOS has the added benefit of evaluating a patient's aesthetic concerns and can be particularly helpful in patients who present with obstructive complaints after rhinoplasty. Many times, patients who suffer from debilitating nasal concerns have a variety of symptoms beyond nasal obstruction (headache, postnasal drip, chronic cough, etc.). The use of PROMs can be helpful in directing a patient's complaints to those specifically related to nasal obstruction. In addition, they allow for a discussion of those symptoms that may benefit from treatment aimed at improving the patency of the nasal airway and avoid discordant patient expectations.

Medication Considerations

In the overwhelming number of patients who have no clear structural abnormality or anatomic obstruction on examination, the presumed dysfunction is mucosal and treatment is considered to be largely medical. However, in the subset of patients who have "failed" medical therapy, several considerations should be made. Intranasal corticosteroids are considered first-line therapy for nasal congestion (regardless of etiology), with several double blind, randomized clinical trials demonstrating greater efficacy of this medication versus placebo, antihistamines, and montelukast.[17] While they are therefore commonly recommended by providers, patients may not initiate, adhere to, or correctly use this therapy. In patients who are being seen for "refractory" medical treatment, detailed assessment of medication use and potential barriers to use is imperative. Fear of side effects has been reported in 48% of patients with allergic rhinitis, including fear of habituation or damage to intranasal tissue.[18] The safety profile of these medications should be discussed with patients and daily use should be encouraged. In addition, correct application with administration away from the nasal septum may limit unwanted side effects such as nasal irritation and epistaxis. While a variety of nasal steroids show similar efficacy, sensory attributes (i.e., odor, taste, or burning) can limit medication use and patients may prefer one product over another in this regard.[19] In general, patients have been shown to prefer several intranasal steroids, including fluticasone furoate (over fluticasone propionate), mometasone furoate, and triamcinolone acetonide.[18] Providing patients with education and options in regard to intranasal steroids may help with adherence and ultimately nasal obstruction improvement.

In patients who are adherent to but have limited benefit with intranasal steroid use, adjunctive medications such as antihistamines (intranasal and oral), leukotriene antagonists, and anticholinergic agents (e.g., Ipratropium) can be used. Referral to an allergist can help with selection of appropriate medications and titration of dosing. Moreover, allergy testing (if not already done) may not only help provide a diagnosis for patients with long-standing debilitating nasal obstruction but also introduce the possibility of treatment with immunotherapy or allergen reduction strategies. Even if patients remain symptomatic, the confirmation of a diagnosis (e.g., allergic rhinitis) may be of some therapeutic benefit in patients with functionally crippled noses.

While medications are used as therapeutic agents, a variety of medications can contribute to nasal obstructive symptoms. Drugs that affect the autonomic nervous system can have a vasoactive effect on the nasal mucosa with resulting nasal obstruction. A list of these medications, including nonsteroidal anti-inflammatory drugs, antihypertensives, psychotropic drugs, hormones, and immunosuppressants, have been outlined in detail elsewhere.[20] Nasal decongestants including oxymetazoline, xylometazoline, ephedrine, and cocaine have a localized effect on autonomic control and prolonged use can result in rebound rhinitis (rhinitis medicamentosa), although the pathophysiology of this is not entirely understood. In patients with particularly troublesome nasal function, the initial brief benefit of these medications can result in prolonged use and subsequent paradoxical worsened symptoms. The severity of the obstruction correlates with the length of use.[21] Of note, α-adrenergic agonists used for glaucoma can enter the nose through the nasolacrimal canal and also act like topical decongestants with resulting rebound nasal congestion with prolonged use.[20] The process of titrating a patient off nasal decongestants can be challenging. One approach is to dilute the decongestant with nasal saline after each use to decrease each subsequent dose while simultaneously using a nasal steroid.

Postsurgical Considerations

Several patients with debilitating functional nose complaints have undergone prior surgical intervention. The nasal obstruction may have preceded surgery or may be an unanticipated outcome of surgery. In the former category, it is important to elicit the degree of functional impairment prior to the first surgery, to set expectations in regard to realistic improvements in nasal breathing and be mindful in suggesting another surgical intervention (particularly in the absence of a very clear etiology of persistent nasal obstruction).

Post-Rhinoplasty

In patients with new postsurgical nasal obstruction, a particular challenging scenario is encountered in those who have undergone an aesthetic reduction rhinoplasty. The prevalence of nasal obstruction after cosmetic rhinoplasty has been previously reported to be as high as 10%, but may be lower with greater attention to functional outcomes with aesthetic rhinoplasty.[22,23] Regardless, this complication

requires a sensitive approach to patients, many of whom may be skeptical of further surgical treatment recommendations. The etiology of postrhinoplasty nasal obstruction may be over-correction of the nasal supporting structures (i.e., over-aggressive reduction of latera crura), in-fracture of nasal bones, septal irregularities, and surgical adhesions.[22] It is also important to consider minor intranasal pathologic conditions that were present prior to surgery may become more noticeable to the patient postoperatively with a narrower nasal airway.[24] In addition to structural obstruction, mucosal disease may be exacerbated or be a new finding postsurgically (i.e., vasomotor rhinitis).[24,25] As such, even in the absence of a clear anatomic obstruction on examination, the subjective obstructive complaints of patients should not be dismissed. In these patients, aforementioned medical treatment strategies should be implemented. In a subset of patients, presumed autonomic changes in the turbinates can lead to an "obstructive rhinitis" and injection of the turbinate with a local anesthetic or corticosteroids has been reported to improve symptoms.[24] If autonomic dysfunction is a potential etiology of the patients nasal symptoms, use of topical anticholinergic agents (i.e., ipratropium) can be trialed.

In the group of patients with static structural abnormalities or dynamic narrowing of the airway, a variety of surgical treatments may be considered. However, it is worth noting that in the functionally crippled nasal patient, these surgical interventions may not be appropriate if the deformity is minimal. The surgeon should resist the temptation to proceed with surgery in those situations.

(a) In patients who underwent removal of septal cartilage for grafting purposes, a caudal dislocation or persistent deviation is a common residual septal deformity.[24] In particular, the posterior aspect of the remaining caudal "L strut" may be more prone to deviate into the airway after removal of cartilage behind it. This may appear subtle and be dismissed by physician as a source of obstruction. In these patients, however, modified extracorporeal septoplasty techniques to correct caudal deviation should be considered. The anterior septal reconstruction technique, in which the caudal septum can be reconstructed without disruption of the keystone area or dorsal profile, is particularly valuable in caudal deviations in postrhinoplasty patients.[26,27]

(b) In patients with lateral wall insufficiency and alar collapse due to loss of lateral crural cartilage support, generally insertion of a batten type graft (e.g., lateral crural strut or alar batten graft) helps introduce integrity to the lower lateral crura.[28] While this limits dynamic sidewall collapse, an aesthetic consequence of widened ala will likely be dissatisfying for postrhinoplasty patients. In addition, although alar collapse may be the primary etiology of obstruction, any other minor contributory factors that increase resistance and negative pressure within the nasal cavity will make even a relatively minor weakness in the alar cartilage manifest as collapse. Therefore, an effort should be made to correct other obstructive factors, regardless of how mild, prior to addressing alar collapse. If necessary, placement of grafts along the nasal sidewall can be performed without an external approach that may disrupt other modifications made during prior rhinoplasty.

(c) Adequate tip support is essential for normal nasal breathing. If there has been compromise of this support after rhinoplasty with resulting tip ptosis, a septal extension graft or an anterior septal reconstruction graft (in the event that the caudal septum needs to be reconstructed) allows for a stable structure to reposition the medial crura and thereby the nasal tip.[26,27,29]

(d) In the event of nasal adhesions or webbing, simple lysis of the mucosal soft tissue can yield significant symptom relief.[24] Importantly, placement of silastic sheeting or an intervening barrier between the denuded opposing surfaces is needed to prevent recurrence during remucosalization. Even small scar bands within the nasal cavity can result in significant limitation of airflow and should not be ignored. Larger webs can additionally result in obstructive septal deflection. Excision of larger webs may require mobilization and rotation of septal mucosa or skin grafting for coverage of demucosalized tissue.

Septal Perforation

Septal perforations can result from a variety of etiologies including vascular, traumatic, inflammatory, drug-induced, and neoplastic causes. However, the majority of cases are the result of prior surgical intervention. In a retrospective review, septorhinoplasty and septoplasty accounted for 62.4% of perforations that presented to a facial plastic surgery clinic.[30] While symptoms from septal perforations are variable based on the size and location, anterior perforations of moderate size can result in turbulent airflow that desiccates nasal mucosa and impedes moisture exchange leading to nasal crusting, epistaxis, rhinorrhea, and a sensation of obstruction.[31] Patients with septal perforations can have debilitating nasal symptoms, and their frustration can grow if providers are unable to offer repair. While not all perforations are amenable to repair, it is beneficial to address them earlier if possible as perforations can enlarge over time.

Nonsurgical treatment strategies for septal perforations include emollients, nasal saline irrigation, and silicone septal buttons. Septal buttons are particularly useful for very large perforations that are unlikely to be successfully repaired or for patients that are poor surgical candidates. Although they reduce turbulent airflow, nasal buttons do not eliminate all symptoms and require continued nasal hygiene (i.e., nasal irrigation).[31] A variety of surgical treatments have been advocated for closure of perforations. Surgical treatment strategies may include the mobilization of either unilateral or bilateral septal mucosal flaps with reapproximation of the flaps for closure of the perforation.[31] In addition, the placement of connective tissue between the mucosa at the site of the perforation (i.e., acellular dermis, temporalis fascia, cartilage, or bone) has been reported to improve results.[31–34] The use of interposition grafts of polydioxanone plates combined with a temporoparietal fascia graft for septal perforation has also been shown to result in

remucosalization at the site of the perforation and improved nasal obstruction.[35] Regardless of strategy employed, a surgeon should counsel patients on possible failure of closure or persistent symptoms to limit postoperative frustration. A systematic review has found the combined closure rate of perforations smaller than 2 cm and for those larger than 2 cm to be 93 and 78%, respectively.[36]

Empty Nose Syndrome

In patients who have undergone prior turbinate reduction surgery and without evidence of clear anatomical obstruction on examination, a diagnosis of "empty nose syndrome" (ENS) should be considered.[37] The pathophysiology of ENS remains controversial. With turbinate reduction, there may be decreased humidification, reduced nasal airflow resistance, as well as impaired central nervous system sensory signaling that results in a subjective sensation of nasal congestion.[38] It is thought to represent a distinct entity from atrophic rhinitis in which there is inflammatory infiltrate in the nasal mucosa. Both disease processes can present with mucosal atrophy and paradoxical nasal obstruction despite a patent nasal airway. In addition, the lack of mucosal cooling by airflow may be interpreted by the brain as inadequate ventilation and can result in respiratory distress.[37] In the presence of a patent airway, these patients do not find common medical management strategies of nasal obstruction helpful and their symptoms may be discounted by physicians, adding to their frustration.

Two validated tools may help physicians better diagnose ENS: The empty nose syndrome 6 item questionnaire (ENS6Q) and the cotton test. The ENS6Q contains questions about the cardinal symptoms of ENS and has been able to differentiate between patients who have ENS, no pathology, and those with sinus disease without ENS.[39] During the cotton test, a small piece of dry cotton is placed in front of the inferior turbinate on the affected side (for 20–30 minutes) and patients who have improvement in the ENS6Q after the test may benefit from specific surgical treatment for ENS.[40] In addition to humidification strategies, surgically increasing the volume of the inferior turbinate using biosynthetic or homologous implants has been shown to have variable improvement in patient symptoms.[37] Importantly, psychological complaints have been shown to improve with this surgical strategy. This is of particular value in ENS as approximately ⅔ of these patients have been shown to have clinically significant depression and/or anxiety.[41] Much like other patients presenting with debilitating nasal obstruction symptoms, the psychological care for the patients with ENS should be addressed and appropriate referrals to mental health providers placed.

Future Directions

Some new areas of research may shed some light on patients with symptoms of persistent nasal obstruction after medical or surgical intervention. The first is the area of computational flow dynamics (CFD), which allows us to visualize computer models of airflow in patients.[42] The second area of research is related to this, and involves understanding the role of temperature sensors in detection of airflow in the nose.[43]

Conclusion

In patients with a functionally crippled nose, the sensation of diminished nasal airflow can be disabling and a source of frustration. A thorough history and physical examination, in addition to use of adjunctive diagnostic tools including endoscopic evaluation and imaging, can help improve diagnostic yield. Validated PROMs are useful for assessing both the severity of a patient's subjective complaints and evaluating improvements with specific interventions. A variety of diagnoses are possible in patients with debilitating nasal obstruction including both mucosal disease and structural abnormalities. While several medications are used as therapeutic agents, many may also be contributory to nasal obstruction. Postsurgical changes from rhinoplasty, septoplasty, and/or turbinate reduction including loss of nasal supporting structures, mucosal disease, formation of adhesions, septal perforations, and loss of turbinate volume with resulting ENS may be challenging causes of nasal obstruction. Treatment of these conditions may be multifactorial and secondary surgical interventions should be considered after thorough patient counseling. Importantly, regardless of etiology and the treatment strategy selected for a patient's nasal obstruction, physicians should be mindful of the impact of a patient's symptoms on his or her quality of life and mental well-being. Future research into CFD and temperature detection in the nose may shed some new light on nasal obstruction symptoms in these patients.

Conflict of Interest
None.

References

1 Jessen M, Malm L. Definition, prevalence and development of nasal obstruction. Allergy 1997;52(40, Suppl):3–6
2 Shedden A. Impact of nasal congestion on quality of life and work productivity in allergic rhinitis: findings from a large online survey. Treat Respir Med 2005;4(06):439–446
3 Udaka T, Suzuki H, Fujimura T, et al. Chronic nasal obstruction causes daytime sleepiness and decreased quality of life even in the absence of snoring. Am J Rhinol 2007;21(05):564–569
4 Stewart M, Ferguson B, Fromer L. Epidemiology and burden of nasal congestion. Int J Gen Med 2010;3:37–45
5 Phillips KM, Hoehle LP, Bergmark RW, et al. Association between nasal obstruction and risk of depression in chronic rhinosinusitis. Otolaryngol Head Neck Surg 2017;157(01):150–155
6 Yamasaki A, Levesque PA, Bleier BS, et al. Improvement in nasal obstruction and quality of life after septorhinoplasty and turbinate surgery. Laryngoscope 2019;129(07):1554–1560
7 Kahraman E, Cil Y, Incesulu A. The effect of nasal obstruction after different nasal surgeries using acoustic rhinometry and nasal obstruction symptom evaluation scale. World J Plast Surg 2016;5(03):236–243
8 Fuller JC, Levesque PA, Lindsay RW. Assessment of the EuroQol 5-dimension questionnaire for detection of clinically significant global health-related quality-of-life improvement following functional septorhinoplasty. JAMA Facial Plast Surg 2017;19(02):95–100

9 Fraser L, Kelly G. An evidence-based approach to the management of the adult with nasal obstruction. Clin Otolaryngol 2009;34(02): 151–155
10 Tsao GJ, Fijalkowski N, Most SP. Validation of a grading system for lateral nasal wall insufficiency. Allergy Rhinol (Providence) 2013; 4(02):e66–e68
11 Mohan S, Fuller JC, Ford SF, Lindsay RW. Diagnostic and therapeutic management of nasal airway obstruction: advances in diagnosis and treatment. JAMA Facial Plast Surg 2018;20(05):409–418
12 Hamdan AL, Sabra O, Hadi U. Prevalence of adenoid hypertrophy in adults with nasal obstruction. J Otolaryngol Head Neck Surg 2008;37(04):469–473
13 Chandra RK, Patadia MO, Raviv J. Diagnosis of nasal airway obstruction. Otolaryngol Clin North Am 2009;42(02):207–225, vii
14 Kjaergaard T, Cvancarova M, Steinsvåg SK. Does nasal obstruction mean that the nose is obstructed? Laryngoscope 2008;118(08): 1476–1481
15 Stewart MG, Smith TL, Weaver EM, et al. Outcomes after nasal septoplasty: results from the Nasal Obstruction Septoplasty Effectiveness (NOSE) study. Otolaryngol Head Neck Surg 2004; 130(03):283–290
16 Moubayed SP, Ioannidis JPA, Saltychev M, Most SP. The 10-Item Standardized Cosmesis and Health Nasal Outcomes Survey (SCHNOS) for functional and cosmetic rhinoplasty. JAMA Facial Plast Surg 2018;20(01):37–42
17 Benninger M. Diagnosis and management of nasal congestion: the role of intranasal corticosteroids. Postgrad Med 2009;121(01):122–131
18 Bridgeman MB. Overcoming barriers to intranasal corticosteroid use in patients with uncontrolled allergic rhinitis. Integr Pharm Res Pract 2017;6:109–119
19 Mahadevia PJ, Shah S, Leibman C, Kleinman L, O'Dowd L. Patient preferences for sensory attributes of intranasal corticosteroids and willingness to adhere to prescribed therapy for allergic rhinitis: a conjoint analysis. Ann Allergy Asthma Immunol 2004;93(04):345–350
20 Cingi C, Ozdoganoglu T, Songu M. Nasal obstruction as a drug side effect. Ther Adv Respir Dis 2011;5(03):175–182
21 Graf PM. Rhinitis medicamentosa. Clin Allergy Immunol 2007; 19:295–304
22 Rozner L, Isaacs GW. Nasal obstruction after rhinoplasty. Aesthetic Plast Surg 1979;3(01):89–96
23 Okland TS, Kandathil C, Sanan A, Rudy S, Most SP. Analysis of nasal obstruction patterns following reductive rhinoplasty. Aesthetic Plast Surg 2019
24 Beekhuis GJ. Nasal obstruction after rhinoplasty: etiology, and techniques for correction. Laryngoscope 1976;86(04):540–548
25 Joe SA. The assessment and treatment of nasal obstruction after rhinoplasty. Facial Plast Surg Clin North Am 2004;12(04):451–458, vi–vii
26 Surowitz J, Lee MK, Most SP. Anterior septal reconstruction for treatment of severe caudal septal deviation: clinical severity and outcomes. Otolaryngol Head Neck Surg 2015;153(01):27–33
27 Most SP. Anterior septal reconstruction: outcomes after a modified extracorporeal septoplasty technique. Arch Facial Plast Surg 2006;8(03):202–207
28 Gunter JP, Friedman RM. Lateral crural strut graft: technique and clinical applications in rhinoplasty. Plast Reconstr Surg 1997;99 (04):943–952, discussion 953–955
29 Sawh-Martinez R, Perkins K, Madari S, Steinbacher DM. Control of nasal tip position: quantitative assessment of columellar strut versus caudal septal extension graft. Plast Reconstr Surg 2019; 144(05):772e–780e
30 Kridel RWH, Delaney SW. Simultaneous septal perforation repair with septorhinoplasty: a 31-year experience. Facial Plast Surg 2018;34(03):298–311
31 Kridel RWH, Delaney SW. Approach to correction of septal perforation. Facial Plast Surg Clin North Am 2019;27(04):443–449
32 Nuñez-Fernández D, Vokurka J, Chrobok V. Bone and temporal fascia graft for the closure of septal perforation. J Laryngol Otol 1998;112(12):1167–1171
33 Ribeiro JS, da Silva GS. Technical advances in the correction of septal perforation associated with closed rhinoplasty. Arch Facial Plast Surg 2007;9(05):321–327
34 Pedroza F, Patrocinio LG, Arevalo O. A review of 25-year experience of nasal septal perforation repair. Arch Facial Plast Surg 2007;9(01): 12–18
35 Morse J, Harris J, Owen S, Sowder J, Stephan S. Outcomes of nasal septal perforation repair using combined temporoparietal fascia graft and polydioxanone plate construct. JAMA Facial Plast Surg 2019;21(04):319–326
36 Kim SW, Rhee CS. Nasal septal perforation repair: predictive factors and systematic review of the literature. Curr Opin Otolaryngol Head Neck Surg 2012;20(01):58–65
37 Gill AS, Said M, Tollefson TT, Steele TO. Update on empty nose syndrome: disease mechanisms, diagnostic tools, and treatment strategies. Curr Opin Otolaryngol Head Neck Surg 2019;27(04): 237–242
38 Payne SC. Empty nose syndrome: what are we really talking about? Otolaryngol Clin North Am 2009;42(02):331–337, ix–x
39 Velasquez N, Thamboo A, Habib AR, Huang Z, Nayak JV. The Empty Nose Syndrome 6-Item Questionnaire (ENS6Q): a validated 6-item questionnaire as a diagnostic aid for empty nose syndrome patients. Int Forum Allergy Rhinol 2017;7(01):64–71
40 Thamboo A, Velasquez N, Habib AR, Zarabanda D, Paknezhad H, Nayak JV. Defining surgical criteria for empty nose syndrome: validation of the office-based cotton test and clinical interpretability of the validated Empty Nose Syndrome 6-Item Questionnaire. Laryngoscope 2017;127(08):1746–1752
41 Manji J, Nayak JV, Thamboo A. The functional and psychological burden of empty nose syndrome. Int Forum Allergy Rhinol 2018;8 (06):707–712
42 Burgos MA, Sevilla García MA, Sanmiguel Rojas E, et al. Virtual surgery for patients with nasal obstruction: use of computational fluid dynamics (MeComLand®, Digbody® & Noseland®) to document objective flow parameters and optimise surgical results. Acta Otorrinolaringol Esp 2018;69(03):125–133
43 Bailey RS, Casey KP, Pawar SS, Garcia GJ. Correlation of nasal mucosal temperature with subjective nasal patency in healthy individuals. JAMA Facial Plast Surg 2017;19(01):46–52