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Key Points on Functional Rhinoplasty Patient Evaluation

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Abstract

Purpose of Review The goal of this review is to discuss the key points in the evaluation of patients for functional nasal airway surgery to help optimize outcomes.

Recent Findings Development of the clinical practice guideline for rhinoplasty was a recent effort to guide perioperative care and workup of patients undergoing rhinoplasty. This guideline highlighted the importance of patient reported outcome measures (PROMs) in evaluating surgical outcomes. There has also been an increase in publications regarding intervention in the pediatric population. Finally, there has been more work into the exact mechanics of nasal airway obstruction and lateral wall insufficiency.

Summary Functional rhinoplasty lacks clear objective tests to help guide surgery. PROMs are important in evaluating surgical outcomes and advances in technology such as computational fluid dynamics, and virtual surgical planning will hopefully provide insight into airflow patterns and where surgical intervention should be focused to maximize patient outcomes.

Keywords Functional rhinoplasty · Septoplasty · Nasal airway obstruction · Evaluation · Preoperative

Introduction

Nasal airway obstruction (NAO), the sensation of not being able to breathe through the nose, is a common presenting complaint to Otolaryngologists and Facial Plastic Surgeons. As NAO can have a significant impact on quality of life, there is a demand for treatment. Every year, about 60 million dollars are spent on surgical treatment of the nasal airway [1, 2].

The multifactorial nature of NAO can make management of this problem particularly challenging. The etiology of the problem can be primarily mucosal, as in allergic or non-allergic rhinitis, structural, or sensory [3]. Additionally, there is a lack of correlation between patient reported symptoms and objective findings with currently available measurement tools [2]. The subjective nature of the preoperative workup and surgical planning has led to the development of various practice guidelines and consensus statements for treatment of NAO [4, 5••, 6]. While septoplasty and functional rhinoplasty are successful procedures for many patients, there is a reported 20–30% rate of lack of postoperative improvement in some reviews [7, 8].

Due to the complex nature of NAO, measuring success and patient satisfaction can be difficult. The purpose of this review is to examine the factors around patient selection and evaluation that can enhance both patient and surgeon satisfaction postoperatively.

Initial Assessment

History

The initial patient evaluation should include a thorough history to assess for all potential etiologies of NAO, including mucosal and structural. Mucosal causes include allergic and non-allergic rhinitis, environmental irritants,

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chronic rhinosinusitis, drug-induced (i.e., rhinitis medicamentosa), inflammatory disorders, and tobacco use. A list of common medications associated with nasal congestion is found in Table 1 [9]. In patients who have concomitant mucosal etiologies of NAO along with structural causes, patient education regarding the potential need for ongoing medical management may be an important factor to maximize postoperative outcomes [3].

The patient history should also include evaluation of other medical comorbidities such as obstructive sleep apnea, prior nasal trauma, or injuries along with a complete review of any prior nasal surgeries. Other patient factors that should be taken into consideration include assessment for underlying psychological illnesses, such as body dysmorphic disorder, particularly in patients that may be interested in pursuing concurrent cosmetic changes to the nose.

To better understand the cohort of patients seeking nasal airway surgery, Justicz et al. completed a recent retrospective cross-sectional analysis of 1338 functional septorhinoplasty patients [10•]. They found that both genders experience symptoms equally. Interestingly, 20% of patients had a prior septoplasty and were more symptomatic than cohort average based on patient reported outcome measures. Those with prior rhinoplasty were not more symptomatic. Snoring, smoking, increasing age, and internal nasal valve narrowing on exam were all associated with worse preoperative symptoms.

Table 1 Medications associated with nasal congestion and rhinitis

Antihypertensives
Angiotensin converting enzyme (ACE) inhibitors
Hydrochlorothiazide
ß-blockers
Erectile dysfunction
Sildenafil, Tadalafil
Psychotropics, antidepressants
Risperidone
Chlorpromazine
Thioridazine
Estrogens
Oral contraceptives or exogenous estrogens
Alpha-blockers
Clonidine
Guafacine
Prazosin, Doxazosin
Rhinitis medicamentosa (chronic use)
Oxymetazoline
Phenylephrin
Ephedrine

Physical Exam

The exam should be focused on evaluating for anatomic causes of nasal airway obstruction including the nasal septum, turbinates, and internal and external nasal valves. The nasal mucosa should also be assessed, as evidence of allergy, chronic sinusitis, polyposis, or excessive crusting can all be signs of other contributing medical causes of nasal airway obstruction.

- Septum

  Assessment of the nasal septum is a critical part of the evaluation of nasal airway obstruction. Various grading and classification schemes have been proposed, and knowledge of these can help with surgical planning and expectations. More straight forward deflections would include nasal septal spurs or straight septal tilts which are often deflected off the maxillary crest and can typically be managed through endonasal approaches. More complex, twisted septal deformities are described as C-shaped and S-shaped and can occur in a vertical (cephalocaudal) or horizontal (anteroposterior) plane. Horizontal C-shaped deformities are associated with external deviations to the opposite side. Vertical C or S-shaped deformities are seen visually externally and the external deviation follows the curve of the septum [11]. These deformities typically require more complex surgical techniques, often through an open rhinoplasty approach [12, 13].
- Nasal Valve

  The internal and external nasal valves are flow limiting segments of the nasal airway. The internal valve is defined as the area under the upper lateral cartilages between the septum medially and head of the inferior turbinate laterally. The external nasal valve is the region within the vestibule of the nose bound by the caudal septum and medial crura, alar rim and nasal sill [6, 14]. Static narrowing of the external nasal valve can be seen with caudal septal deviations, while the internal nasal valve region can be narrowed by dorsal septal deviations. Additionally, due to the Bernoulli effect, as airflow enters these segments, velocity increases and wall pressure decreases which predisposes patients to dynamic collapse known as lateral wall insufficiency. Special attention to these regions is a critical part of the initial assessment.

  Tsao et al. described a validated grading scheme for the various types of dynamic lateral wall insufficiency [15]. They described two zones of collapse: zone 1 includes the region of the scroll/upper lateral cartilages (internal nasal valve) and zone 2 includes the lower lateral cartilages (external nasal valve). The zones were graded on a visual scale measuring degree of collapse transnasally from grade 1 (< 33%), grade 2 (33–66%) and grade 3 (> 66%). The grading scheme proved quick and easy with sufficient interrater reliability (77%) and minimal intrarater variability with (88% agreement).

Cephalic malposition has been described as a common anatomic finding which may contribute to lateral wall insufficiency, specifically in zone 2. The angle of the lateral crura of the lower lateral cartilages can be measured off the midline. Cephalic malposition has been described as when the caudal margin of the lateral crura is < 30 degrees from midline, tending to have a vector towards the medial canthus. Normal variation of the lateral crura should be ≥ 45° from the midline in a vector towards the lateral canthus [16]. On exam, cephalic positioning can be seen in patients with a bulbous tip and fullness in the supratip region which has been described as a "parenthesis" sign.

Assessment of the nasal valve regions can be difficult. Cottle or modified Cottle maneuvers can be considered; however, the data surrounding these tests are controversial. One recent study demonstrated improvement in 97% of healthy controls with this test [17]. Another single surgeon study found no difference in outcomes for patients who had a positive versus negative preoperative Cottle maneuver [18]. While these studies argue against the routine use of these maneuvers to evaluate the lateral nasal wall and external valve, they still can provide some information about each patient's specific anatomy if executed correctly.

- Turbinates

  Given the location of the turbinate at the internal nasal valve, reduction of the inferior turbinates has been investigated as a means of improving nasal airway obstruction both alone and as an adjunct to functional rhinoplasty or septoplasty. While isolated turbinate hypertrophy should first be treated with medication alone, when in conjunction with other anatomic obstruction reduction of turbinate size has been found to be beneficial [19]. A systematic review of reduction techniques found that radiofrequency ablation or submucosal resection are the best modalities that provide long lasting results and minimize complications [20]. They also found that turbinate outfracture alone was a commonly used technique; however, it lacked objective data for improvement [20]. Partial turbinectomy, while another common reduction technique was associated with higher complication rates including most commonly crusting and persistent rhinorrhea [20]. Regardless of technique, the recent consensus statement on turbinate reduction at time of septoplasty supported the reduction when turbinate hypertrophy was present [19].

Adjunctive Assessment Tools

Objective Testing

Objective testing such as peak nasal inspiratory flow (PNIF), rhinomanometry, and acoustic rhinometry have been used in the past as part of the work up of nasal airway obstruction. Each of these tests provide insight into nasal airflow parameters and are used in measuring objective improvement in nasal airflow before and after intervention [2]. The literature is mixed on the usefulness of this data. To date, each of these objective measures has not been found to correlate with patients' subjective experience of nasal airway obstruction [21]. As the quality of life and subjective improvement experienced by the patient is the primary goal of surgery, measures that directly look at this are the key. This highlights the importance of patient reported outcome measures in following clinical symptoms and improvements.

Pre-operative Imaging

While plain X-ray imaging is generally thought to be of little value, a debated part of the workup of nasal airway obstruction is preoperative CT imaging. Arguments against the use of routine imaging for nasal airway obstruction are the ability to evaluate the airway effectively with anterior rhinoscopy, radiation exposure, and extra cost. The recent rhinoplasty clinical practice guidelines and septoplasty consensus statements do not recommend routine use of CT imaging unless there is concern for paranasal sinus disease [5••, 19]. While not universally applicable, there can be some situations in which preoperative CT imaging can help in the NAO work up. Imaging may identify posterior septal deviations which may not be identified on anterior rhinoscopy and can limit the efficacy of anterior septoplasty [22]. It can also identify concomitant paranasal sinus disease or anatomic variations aside from the septum that could contribute to NAO.

In a recent retrospective cohort study of patients undergoing nasal airway surgery, 56% of the patients undergoing surgery of deviated nasal septum or turbinate hypertrophy underwent preoperative CT imaging. The surgical plan was altered in 84% of the cases based on radiologic findings. The most common findings were concha bullosa (35%) and sinusitis (17%) [23]. Other retrospective series have demonstrated incidental findings in 29% of preoperative CT scans in patients undergoing septoplasty and septorhinoplasty for NAO [24]. It is important to remember that while imaging can help provide additional information about each patient's specific anatomy, it must be interpreted with caution. There is no correlation between findings on CT imaging and preoperative patient reported outcome measures [25, 26].

As it stands now, our current understanding of imaging findings does not seem to correlate with patients' symptoms or predict improvement. However, with patients who do not have a clear cause of their nasal airway obstruction, imaging may provide necessary details. The importance of a good physical exam and judicious use of imaging based on each patient's symptoms may have a role in improving outcomes.

Patient Reported Outcome Measures

Obtaining preoperative patient reported measures is also an important metric that can be followed postoperatively for measuring improvement and outcomes. This is also a recommendation in the recent clinical practice guidelines on improving nasal form and function after rhinoplasty [27]. One such measure is the nasal obstruction symptom evaluation (NOSE) scale. This is a validated patient reported quality of life measure for nasal airway obstruction that is a brief, five question survey. The NOSE score has also been shown to demonstrate early and durable improvement in patient symptoms as early as 3 months [28•]. Normative data for the NOSE scale demonstrated consistent findings with asymptomatic individuals with a score of 15, general population with a score of 42, and patients with nasal airway obstruction having a score of 65. It also demonstrates postoperative improvement, with a normative drop in score of 40 [29]. In an effort to combine a PROM that takes both the functional and aesthetic considerations of the nasal airway, Most et al. developed the standardized cosmesis and health nasal outcomes survey (SCHNOS). This is a newer 10-item survey that is a validated instrument to evaluate both nasal obstructive and cosmetic concerns [30•, 31]. The obstructive domain of the SCHNOS has high correlation with NOSE scores. Other outcome assessments have been used as well, including the rhinoplasty outcomes evaluation (ROE) or Glasgow Benefit Inventory. The sino-nasal outcome test (SNOT-22) is another nasal specific survey that includes more categories of nasal function for those with concomitant sinusitis. The use of these measures preoperatively and following patients postoperatively with them has quickly become an important recognized metric.

Pediatric Nasal Airway Surgery

Timing of functional nasal surgery in pediatric patients has been debated in the literature. This is due to concerns regarding disruption of the sphenodorsal and sphenospinal growth centers [32]. Various observational and animal studies noted disruption of the growing facial skeleton leading to underdevelopment of the maxilla and nose [33, 34]. Additionally, anthropometric data suggests nasal height and bridge length reach facial skeletal maturity at 15 and 12 in males and females, respectively [33]. This led to delay of surgery until later teenage years for patients apart from cleft deformity, rare nasal tumors, or septal hematoma.

Recent data suggests surgery may be indicated in some children for NAO. Children with NAO have been found to have worse quality of life, and pediatric septoplasty has been found to improve outcome measures [32, 35–37]. Additionally, chronic mouth breathing has been found to lead to subsequent dental and oral facial changes [38]. Conservative intervention with care to avoid aggressive cartilage resection and disruption of the bony cartilaginous junction has not been found to alter nasal growth in this group [32, 34]

In summary, pediatric septoplasty is increasingly being performed for NAO in patients who have severe obstruction, decreased quality of life, or mouth breath as young as 6 years of age [33, 34]. While rhinoplasty in this young age group has not been found to impact nasal growth, septoplasty has been controversial [32]. Emerging data suggests that conservative resections while avoiding the dorsum and separation of the bony cartilaginous junction can improve quality of life without impacting nasal growth [33].

Non-surgical Management Options

Non-surgical options can play a role in patients who are not ideal surgical candidates or who choose to not undergo surgery. Decongestants or topical nasal steroids may help in those with boggy edematous turbinates, though in patients with a clear anatomic cause of nasal airway obstruction such as septal deviation, a trial of steroids is unlikely to be effective [39]. Over the counter adjuncts such as nasal dilator strips or other external nasal or internal nasal splints can help stent the lateral nasal wall. Improvements with these adjuncts may also provide information in targeting lateral wall insufficiency if they decide to proceed to surgical intervention [3]. However, to date, there are no published studies demonstrating correlation between preoperative benefit with these adjuncts and successful surgical correction of the nasal valve.

Computational Fluid Dynamics

The future of functional rhinoplasty evaluation lies in better objective measures. As discussed, there is a paucity of objective measures that correlate with subjective symptoms and improvement. While patient reported outcome measures can help delineate disease burden and improvement, they do not help clarify which techniques or areas should be targeted for symptom relief. Computational fluid dynamics (CFD) is a tool that has been increasingly utilized to better understand nasal airflow with objective, quantitative metrics. This technique utilizes CT data to generate patient specific nasal airway computer models and run flow simulations to generate quantitative measures of airflow, nasal resistance, and wall shear stress [40].

In addition, CFD can be used to measure heat flux, which can highlight regions within the nasal cavity that will undergo more energy loss as increased flow cools the surface of the mucosa. This is important as sensation of nasal airflow is currently best explained via mucosal cooling. Temperature gated receptors in the mucosa of the nasal cavity are activated when airflow over the mucosa cools the surface [41–43]. In this way, CFD and calculating heat flux can be a proxy for identifying regions within the nose that may be important for the sensation of breathing or conversely, identifying regions that are contributing to a sensation of obstruction [44–46]. There are studies that support its use in correlating objective findings with patient symptoms with septal deviations [47].

More recent work has attempted using CFD to identify regional airflow within the nose of healthy versus NAO patients to evaluate where targeted nasal surgery may help most [48]. Work has also gone into making virtual surgical software less labor intensive to increase its applicability in the clinical setting [49]. Further work is necessary to confirm that alterations created in virtual surgical planning correspond to subjective patient improvement.

Conclusions

Functional rhinoplasty is an effective procedure to address anatomic causes of nasal airway obstruction. Given the lack of meaningful objective preoperative testing, critical appraisal of each patient's anatomy and subjective complaints are important to maximizing postoperative success. Utilization of patient reported outcome measures is critical to follow improvement and surgical success. While traditionally functional nasal airway surgery is delayed in the pediatric population, recent publications have promoted conservative early intervention. Imaging, while not routinely used, may have a role in identifying other causes of NAO. Medical management trials with external splints or nasal cones can be helpful for non-surgical patients. Finally, the future of nasal airway surgery lies in better understanding of each individual's specific anatomy through objective measures and targeting specific interventions by virtual surgical planning to help optimize patient outcomes.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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