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What is This?
Systematic Functional Assessment of Nasal Dyspnea: Surgical Outcomes and Predictive Ability

Daniel A. Larson, MD¹, and Benjamin W. Cilento, MD, MC, USN²,³

Abstract

Objective. Evaluate the ability of a systematic preoperative evaluation to determine the most appropriate procedures for patients undergoing functional septorhinoplasty and to accurately predict postoperative outcomes.

Study Design. Case series with chart review.

Setting. Tertiary care military hospital.

Subjects and Methods. Fifty-nine consecutive patients from a quality control database who underwent functional rhinoplasties for nasal dyspnea were evaluated. All patients underwent a full preoperative assessment using intranasal manipulation to determine the area(s) contributing to their nasal dyspnea. Rates of success for the predictive ability and for the functional outcome were determined for each side of the nose by comparing preoperative visual analog scale (VAS) scores (1-10) to postoperative scores.

Results. Overall there was a 91% success rate in predicting the outcome of surgery and a 95% success rate in improving nasal dyspnea at 1 year. There was no statistically significant difference in improvement between different surgical groups (septoplasty ± alar strut grafts ± spreader grafts) or between primary surgeries and revisions.

Conclusion. Using a systematic approach to evaluate patients for nasal dyspnea, it is possible to predict and improve outcomes by choosing the most appropriate surgery for each individual.

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Keywords
functional rhinoplasty, septoplasty, nasal dyspnea, nasal congestion

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Nasal dyspnea is a common complaint of patients presenting to otolaryngologists and facial plastic surgeons. The nasal airway is an intricate structure with rigid and flexible segments and a reactive lining. Nasal dyspnea can be due to pathology in one or any combination of these segments, and this can make determining the exact point of obstruction notoriously difficult at times. Often, correction of a deviated septum or inferior turbinate hypertrophy (ITH) is not enough to cure patients of their symptoms. Although patients usually report improvement in the immediate postoperative period, as Dinis and Haider² showed in their 2002 study, as little as 42% of patients report good to excellent results 5 to 6 years after septoplasty. Understanding of the nasal valve complexes has led to advances in the management of nasal dyspnea. Spreader grafts, various alar graft techniques, and turbinateplasty have been added to the surgeon’s armamentarium to more fully address the areas that contribute to nasal obstruction.³⁻⁵ Our goal was to attempt to appropriately stratify these patients to receive the appropriate procedure.

Constantinides et al⁶ in 2002 suggested a systematic approach using a series of modified Cottle maneuvers to evaluate the nasal airway to determine the precise point of obstruction and help direct preoperative planning. These maneuvers attributed the obstruction to the nasal valve area, the medial wall, and/or the lateral wall.⁷ Using the results from their systematic preoperative evaluation to guide surgical planning, they saw an improvement in 18 of 19 patients at 6 months after functional rhinoplasty. Using a slightly modified version of the Constantinides approach, we systematically evaluated all surgical candidates both preoperatively with specific maneuvers as well as postoperatively using visual analog scale (VAS) scores. Our evaluation concentrated on first manipulating the internal nasal valve (INV) and external nasal valve (ENV) in a systematic and surgically reproducible way.

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and recording the subjective improvement experienced by the patient.

The primary goal of our study then was to show that long-term outcomes for nasal dyspnea patients can be improved by preoperative stratification into surgical groups based on systematic functional evaluation. Second, we hoped to show that by using this systematic evaluation, it might be possible to predict postoperative outcomes in individual patients. In this way, we would be able to counsel patients with regards to their personal outcome using real data to support moving ahead with any surgery.

Methods

Data Analysis

Information for this study was prospectively collected in the form of a quality control database. This database was composed of consecutive patients referred to the Facial Plastics Clinic at Naval Medical Center Portsmouth (NMCP) over a 2-year period (September 2007 to August 2009) who underwent rhinoplasty for the correction of nasal dyspnea. Information collected included basic demographic and medical information, including age, sex, trauma history, previous rhinoplasties, allergy symptoms, and treatment. Medical information included the type of procedure performed, material used, systematic evaluation of the nasal airway (see below), and outcome data using VAS scores at regular intervals over the course of a year. Exam information collected included key preoperative findings: septal deviation, visible nasal side wall collapse, and inferior turbinate hypertrophy.

After obtaining approval from the institutional review board at NMCP, we analyzed our database and identified 76 patients with at least 12 months of follow-up; patients <18 years old and pregnant patients were excluded from the analysis. Six patients were lost to follow-up due to transfer overseas and 11 had incomplete follow-up, leaving 59 patients for statistical analysis.

Preoperative/Postoperative Evaluation

Our preoperative evaluation process is similar to that described by Constantinides et al. with minor variations. The patients’ sense of nasal dyspnea is assessed at baseline and during manipulation using a VAS score of 1 to 10, with 1 being unobstructed breathing and 10 being complete obstruction. The right and left sides were recorded separately. All examinations were performed by the senior author (BWC).

After a complete physical exam, a systematic analysis of the nasal airway is undertaken. We first place the wooden end of a cotton-tipped applicator (CTA) into the angle created by the upper lateral cartilage (ULC) and the caudal septum corresponding to the INV, the goal being to widen this angle in such a way that mimics the effect of spreader grafts (Figure 1a-c). We chose to use a CTA because the 1.8–2-mm diameter mimics the typical width of our cartilage spreader grafts.

Second, we evaluated the ENV, described as the area bounded by the ala, caudal septum, medial crura, and nasal sill, by placing the CTA at the point of maximal dynamic collapse or maximal incursion on the airway. The examiner is careful during this maneuver not to overdistend the lateral wall but rather to stabilize the ENV and correct recurvature (if present) in a manner that mimics alar strut grafts (Figure 2a-c).

We then decongest the patient with topical oxymetazoline 0.05% with the goal of mimicking the effects of inferior turbinate reduction (ITR) and repeat the INV and ENV maneuvers.

Patients’ VAS scores were recorded at baseline and with each preoperative maneuver for the right and left sides, generating a total of 12 preoperative VAS scores. Postoperatively, we recorded the patients’ baseline VAS scores at 1 week, 2 weeks, 1 month, 3 months, 6 months, and 12 months after surgery. All patients included in the study were present for all follow-up appointments ±3 days.
Surgical Technique: Septorhinoplasty

All procedures were performed by the senior author (BWC) at NMCP. We used an open approach that consisted of a columellar incision connected to marginal incisions. Septal access consisted of an open approach in combination with separation of the upper lateral cartilages from the septum. How extensive the septal work was depended on the extent of previous surgeries and the relative strength of the existing structure. If a patient had adequate cartilage from the septum, this was our first choice in grafting material. More often, however, we would need to obtain cartilage from either the ear or costal cartilage. The rib cartilage harvest and carving was adapted from the technique of Toriumi. Spreaders grafts were fashioned from harvested cartilage and secured between the caudal septum and ULC. The ULCs were sutured back in place or redraped over the spreader grafts to promote better lateral wall suspension; no suspension sutures were used. Alar strut grafts were fashioned to a patient-appropriate size and secured in an underlay technique to the lower lateral cartilage in a position commensurate with the most collapsible or weakest area of the lateral wall. Care was taken to ensure that the lateral pocket receiving the alar strut graft rested over the piriform aperture. ITR was performed using radiofrequency ablation or submucosal resection with a microdebrider and outfracture as indicated.

Surgical Technique: Septoplasty

A hemitransfixion incision was made and bilateral mucoperichondrial flaps were raised. The offending cartilage and bone were identified and either removed or repositioned to the midline. All remaining strut curvatures were corrected and the wound closed with chronic gut.

Statistical Analysis

To calculate the ability of our preoperative evaluation to predict postoperative outcomes, we compared the best (ie, lowest) preoperative VAS score obtained with the maneuvers to the 1-year postoperative VAS score. This was performed for both the right and left sides, giving us 118 sides to evaluate. Of these, 19 were excluded because their initial VAS score at baseline was ≤2, meaning there was no room for significant improvement with maneuvers or surgery. If the 1-year postoperative VAS score was less than or equal to the preoperative predicted value, this was considered a success in terms of our ability to predict outcomes.

To calculate the success of surgery overall, we compared the initial VAS score at baseline to the 1-year postoperative VAS score for the 99 sides described above. If there was a decrease of 2 or more between the initial preoperative VAS score and the 1-year postoperative score, this was considered a surgical success. We chose 2 points on the VAS scale because, by convention, it is a “noticeable and reproducible” improvement.

We calculated the percentage of successful predictions and successful surgery. These were compared between groups with a \( \chi^2 \) analysis or Fisher exact test. Overall improvement in nasal dyspnea from the initial preoperative VAS score to the 1-year postoperative VAS score was compared between groups using repeated-measures analysis of variance (ANOVA). Number of procedures per patient was compared between the different groups using ANOVA. All statistical analyses were performed using SPSS software version 16.0 (SPSS, Inc, an IBM Company, Chicago, Illinois); \( P \) values <.05 were considered significant.

Results

A majority of our patients were male (80%), with an age range of 18 to 59 years and a mean (SD) age of 31.1 (9.1) years. Aside from male sex, there was no dominant demographic characteristic: 42% of patients had previous rhinoplasties, 56% had a history of trauma that was felt to have contributed to their nasal dyspnea, and 24% had a history of allergic rhinitis. All patients who had a history of nasal allergies had previously been treated with oral antihistamines, nasal steroids, and/or immunotherapy without resolution of nasal dyspnea.
On the basis of their preoperative evaluation, 8 patients underwent only a septoplasty + ITR; the other 51 patients underwent open septorhinoplasty (SRP). Of the SRP patients, 5 had a septoplasty + alar strut grafts (ASG), 19 had a septoplasty + spreader grafts (SG), and 27 had septoplasty + ASG + SG. SRP patients were also divided into groups for analysis based on the choice of grafting material: 8 used septal cartilage to fashion grafts, 19 used ear cartilage, and 24 used rib cartilage.

A total of 182 procedures were performed on the 51 SRP patients for a mean of 3.6 per patient. All SRP patients had a septoplasty (100%), 22 (43%) had ITR, 32 (63%) had osteotomies, 46 (90%) had SG, and 32 (63%) had ASG. Comparing the average number of procedures per patient between groups, we found no significant difference between SRP with septal, ear, or rib cartilage (3.3 vs 3.3 vs 3.9; \( P = .15 \)). We did find that a significantly higher percentage of patients who underwent SRP with rib cartilage were revision cases compared to SRP with ear cartilage (88% vs 21%; \( P = 1.3 \times 10^{-5} \)).

Overall, among all patients, our average preoperative VAS score was 6.2 (95% confidence interval [CI], 5.8-6.6), and this improved to 2.0 (1.8-2.2) at 1 year postoperatively. It is important to reiterate that our statistical analysis consisted of 99 patients for a mean of 3.6 per patient. All SRP patients had a septoplasty (100%), 22 (43%) had ITR, 32 (63%) had osteotomies, 46 (90%) had SG, and 32 (63%) had ASG. Comparing the average number of procedures per patient between groups, we found no significant difference between SRP with septal, ear, or rib cartilage (3.3 vs 3.3 vs 3.9; \( P = .15 \)). We did find that a significantly higher percentage of patients who underwent SRP with rib cartilage were revision cases compared to SRP with ear cartilage (88% vs 21%; \( P = 1.3 \times 10^{-5} \)).

The mean preoperative VAS scores and 1-month, 3-month, 6-month, and 1-year postoperative scores for each group are displayed in Figure 3. We found that on average, patients had an improvement of 4.2 points from the preoperative VAS to the 1-year VAS. We found no significant difference in the average level of improvement at 1 year between the different groups listed in Figure 3 (\( P = .38 \)). We then looked at patients who had septoplasty + ASG ± SG to assess the effectiveness and durability of our alar strut grafts. We found that rib and ear cartilage grafts initially had similar improvements at 1 month (4.4 vs 4.5; \( P = .86 \)), but by 1 year, rib patients had a significantly greater improvement than patients who had ear cartilage (4.3 vs 3.4; \( P = .039 \)), even though overall success rate was not affected (Figure 4). There was no significant difference between the number of procedures performed between these 2 groups (3.9 vs 4.1; \( P = .67 \)).

Our overall success rate at predicting our outcomes was 91% with a range of 81% to 100% using the criteria described in the Methods section. The highest prediction success rates were in patients who had septoplasties + ITR and septoplasties + ASG (100%); the lowest rate was in patients who had septoplasties + SG (81%). Our overall surgical success rate was

\[ \text{Mean VAS score (SD)} \]

- **Septoplasty + ITR**: Mean VAS score = 6.2, SD = 1.3
- **Septoplasty + ASG**: Mean VAS score = 6.1, SD = 1.2
- **Septoplasty + SG**: Mean VAS score = 6.0, SD = 1.1
- **Septoplasty + ASG + SG**: Mean VAS score = 6.2, SD = 1.3

95% with a range of 88% to 100% at 1 year. Again, the highest surgical success rates were in patients who had septoplasties + ITR and septoplasties + ASG (100%); the lowest rate was in patients who had septoplasties + SG (88%). The success rates for each surgical group are displayed in Table 1. There was no significant difference between the success rates for any of the operative groups (\( P = .28 \)).

Preoperative factors that may have influenced surgical outcomes were analyzed and are displayed in Table 1. There was no significant difference in the rates of predictive success or
surgical success between revisions vs primaries (P = .27), trauma vs no trauma (P = .59), allergies vs no allergies (P = .24), and male vs female (P = .27).

Of 59 patients, 4 had minor postsurgical complications. Four patients required revision for continued nasal dyspnea; 2 were SRPs with ear cartilage, which were revised with rib grafts, both of which had near resolution of dyspnea at 3 and 6 months. The remaining 2 functional revisions were SRPs with rib cartilage, 1 for a columellar strut revision and 1 patient who had continued dynamic ENV collapse that resolved with the addition of alar strut grafts.

**Discussion**

Nasal dyspnea is a common presenting complaint of patients referred to otolaryngologists and continues to present not only a diagnostic dilemma but a treatment dilemma as well. Surgical stratification of these patients allows us to determine which procedures will be most successful in correcting their nasal dyspnea. This is conducted by analyzing the improvement obtained with each preoperative maneuver. If there was an improvement with INV manipulation, we performed spreader grafts; if ENV manipulation produced improvement or obvious collapse was present on inspiration, battens were placed. The response to oxymetazoline and physical exam findings of inferior turbinate hypertrophy were used to assess which patients would benefit from ITR. Interestingly, only 45% of our patients had significant improvement with oxymetazoline, indicating that their primary source of dyspnea was another subsite (INV, ENV, or septum).

Our main scoring system, the VAS, is straightforward and simple for patients and surgeons to understand. The VAS score facilitates comparison between pre- and postoperative symptoms, and it has been shown to correlate highly with objective measures such as rhinometry. In our experience with this population of patients, a VAS score of ≤2 on one side of the nose represents an essentially normal nasal passage; these patients had surgery to correct the other side, even though both sides were operated on for the purpose of maintaining symmetry.

Using our systematic approach for preoperative evaluation, we obtained a 100% success rate with septoplasties and septoplasties + ASG. We feel that the key to obtaining high success rates in functional rhinoplasties is in choosing the most appropriate procedures for each patient in addition to meticulous surgical technique. We found this applied to all patients we evaluated, and our success rates were not affected by a history of previous nasal surgeries, nasal trauma, or allergic rhinitis. Success was independent of the number of procedures performed on each patient; that is, patients who had more procedures did not have significantly better outcomes at 1 year than patients who had fewer procedures.

We found a statistically significant difference in the improvement obtained at 1 year in patients with alar strut grafts fashioned from rib cartilage compared to ear cartilage (Table 1). Following the trend in mean VAS scores from 1 month to 1 year, patients who had ear cartilage alar strut grafts lost 25% of their initial postoperative improvement by 1 year. What is unclear is if this improvement is clinically significant and continues past 1 year or if ear graft patients may require more revisions in the future.

In our patients, we chose an underlay (strut) technique to support the ENV because of the decreased risk of cosmetic

<table>
<thead>
<tr>
<th>Table 1. Rates of Successful Prediction and Successful Surgery by Group</th>
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<tr>
<td></td>
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<tr>
<td>All surgeries (n = 99)</td>
</tr>
<tr>
<td>Septoplasty + ITR (n = 13)</td>
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<tr>
<td>Septoplasty + ASG (n = 9)</td>
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<tr>
<td>Septoplasty + SG (n = 32)</td>
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<tr>
<td>Septoplasty + ASG + SG (n = 45)</td>
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<tr>
<td>All ASG with ear cartilage (n = 16)</td>
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<tr>
<td>All ASG with rib cartilage (n = 35)</td>
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<tr>
<td>Primary surgery</td>
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<td>Yes (n = 56)</td>
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<tr>
<td>No (n = 43)</td>
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<td>History of trauma</td>
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<tr>
<td>Yes (n = 54)</td>
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<tr>
<td>No (n = 45)</td>
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<tr>
<td>Allergy symptoms</td>
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<tr>
<td>Yes (n = 25)</td>
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<tr>
<td>No (n = 74)</td>
</tr>
<tr>
<td>Male sex</td>
</tr>
<tr>
<td>Yes (n = 77)</td>
</tr>
<tr>
<td>No (n = 22)</td>
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</table>

N for each group is equal to the nostrils where the initial preoperative visual analog scale (VAS) ≥3. AGS, alar strut graft; ITR, inferior turbinate reduction; SG, spreader graft.
deformity and feedback from our quality control database showing high rates of success in correcting dynamic ENV collapse. It is difficult to say if our results would have been equivalent had we used an overlay (batten) graft technique because to our knowledge, there has been no randomized trial comparing strut grafts to battens grafts.\textsuperscript{12}

Limitations of our study include its retrospective nature, although we feel our data were obtained with a higher level of control because they were collected prospectively in a quality control database. Also, our method of obtaining VAS scores depends on the patients' perception of their nasal dyspnea and is therefore subject to variability. However, we feel that functionally, our stratification is a strong instrument for showing relative improvements both from the preoperative maneuvers and from surgery itself. Another shortcoming is that the surgeon obtaining the VAS scores was unblinded to the procedure the patient had and may have been subject to observer bias. Our military population was a positive factor for early follow-up because of easy access to health care, although for long-term follow-up, we lost 17 patients overall due to a combination of military transfers, retirements, and attrition. Inclusion of these patients may have changed our outcomes.

Conclusions
Our preoperative maneuvers offer a tool to diagnose the source(s) of nasal obstruction and help determine the proper surgical procedures for each patient to maximize improvement. They also allow us to predict individual postoperative outcomes with \textgreater 90\% accuracy. This preoperative tool works well for patients regardless of previous history of rhinoplasty, trauma, or allergies.

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Author Contributions
Daniel A. Larson, project design, data analysis, article drafting, final approval for submission; Benjamin W. Cilento, project design, data collection, article revision, final approval for submission. The principal investigator (BWC) had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. The views expressed in this article are those of the author(s) and do not necessarily reflect the official policy or position of the Department of the Navy, Department of Defense, or the United States Government.

Disclosures
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