Nasal Obstruction Symptom Evaluation (NOSE) Score Outcomes After Septorhinoplasty

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Objectives/Hypothesis: The time interval at which Nasal Obstruction Symptom Evaluation (NOSE) scores stabilize after functional septorhinoplasty has not been determined. Our goal was to characterize longitudinal trends of patient-reported outcomes of nasal obstruction using the NOSE survey instrument following functional septorhinoplasty.

Study Design: Prospective longitudinal cohort study.

Methods: Adult patients (≥18 years) with nasal obstruction who underwent functional septorhinoplasty by three different surgeons at a single academic, tertiary referral center were identified. NOSE scores were obtained preoperatively and prospectively during three postoperative intervals defined as early (1–3 months), middle (4–6 months), and late (≥10 months). Longitudinal analysis included repeated measures analysis of variance and adjustments for multiple comparisons.

Results: A total of 49 patients met inclusion criteria. For the total cohort, mean NOSE scores significantly improved between preoperative and early postoperative evaluations (71.4, standard deviation [SD] ± 17.0 vs. 24.2, SD ± 19.5; P < .001) but did not significantly change between early and middle (20.6, SD ± 19.1; P = .543) or middle and late (23.1, SD ± 24.9; P > .999) time intervals.

Conclusions: Patients with nasal obstruction who undergo functional septorhinoplasty can be expected to have significant improvement in self-reported nasal obstruction as early as 1 to 3 months postoperatively with a continued, durable, long-standing benefit lasting at least 10 months after surgery. Future studies can consider the 3-month time frame as a proxy for 1 year outcomes to help reduce survey burden.

Key Words: Rhinoplasty, patient outcome assessment, nasal septum, longitudinal studies, follow-up studies.

Level of Evidence: 2c

INTRODUCTION

The nasal airway plays a central role in air heating, humidification, olfaction, and most importantly, respiratory airflow. Nasal airway obstruction is a common complaint in otolaryngology and facial plastic surgery practices and can cause dramatic impacts on patient quality of life (QOL).1 A clinical diagnosis of nasal obstruction is based on patient symptoms and physical exam findings. Surgical treatment is focused on addressing the anatomic source of obstruction such as a deviated septum, inferior turbinate hypertrophy, or the upper and lower lateral cartilage (LLC) that make up the internal and external nasal valve. The combination of surgical techniques used to address the nasal septum and nasal valve are collectively referred to as functional septorhinoplasty.

Assessing success following functional septorhinoplasty is not standardized. Multiple objective measurements of the nasal airway such as acoustic rhinometry, rhinomanometry, and nasal airflow studies exist but weakly and inconsistently correlate with a patient's subjective assessment of airflow and patency.2 Because of the extra burden of collecting objective measures and their lack of strong correlation with patient symptoms, there has been a trend by physicians and researchers toward documenting patient-reported outcome measures (PROMs) as a primary outcome.3

The Nasal Obstruction Symptom Evaluation (NOSE) scale is a frequently used patient-reported QOL questionnaire specific to nasal obstruction.1 The NOSE scale is brief and has five questions with scores ranging from 0 to 100 that facilitate its use in a busy clinic setting. This scale has been validated for both septoplasty and functional septorhinoplasty.5 6 The NOSE scale allows for consistency in reporting PROMs among study populations with varying patient demographics and surgical interventions. However, the ideal follow-up duration after functional septorhinoplasty has not yet been determined. Previous literature utilizing NOSE scores report variable follow-up, ranging from 1 month to 4 years.7–33

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To assist with patient counseling, reduce survey time burden, and guide future research in the functional rhinoplasty population, the optimal study follow-up endpoint for NOSE scores needs to be determined. The purpose of this study was to evaluate longitudinal trends of NOSE scores over time and determine a time interval at which average NOSE scores stabilize after functional septorhinoplasty.

MATERIALS AND METHODS

Patient Population

Adult patients (age ≥ 18 years) presenting to the facial plastic and reconstructive surgery (FPSRS) clinic at Oregon Health and Science University (Portland, OR) for nasal obstruction were evaluated. Per our clinic’s standard protocol, patients with a clinical diagnosis of nasal obstruction based on symptoms and exam findings were given a NOSE scale questionnaire during their visit. After surgery, a NOSE scale questionnaire was given at each postoperative visit per standard protocol. After institutional review board approval (IRB00009971), a retrospective review of patients’ charts was conducted. Current Procedural Terminology codes 30465, 30420, 30400, 30410, 30430, 30435, and 30450 were used to identify patients who underwent septorhinoplasty between September 2013 and October 2016 by three FPSRS surgeons. These codes include the code for nasal valve repair. We reviewed patient records for NOSE scores, demographic data, and medical comorbidities including chronic rhinosinusitis, allergic rhinitis, and obstructive sleep apnea (OSA). History of prior septoplasty or rhinoplasty and motivation for surgery, either functional, cosmetic, or both, were recorded. Operative reports were reviewed for details of surgical techniques including: inferior turbinate reduction (ITR), use of butterfly graft, tip grafts (cap or shield), spreader grafts, nasal tip support grafts (columnar strut, caudal septal extension graft, or tongue-in-groove technique), septal transplant, osteotomies, cosmetic maneuvers (hump reduction, cephalic trim, dome division, or dorsal onlay graft), LLC grafts (lateral crural strut graft or cephalic turn in flap), alar base reduction, alar rim grafts, and/or use of other graft materials (auricular cartilage, autologous or irradiated rib, or Alloderm).

Primary Patient-Reported Outcome Measure

Preoperative and postoperative nasal obstruction was assessed using the NOSE scale. The NOSE scale is composed of five questions concerning the severity of nasal obstruction. Each item is evaluated using a Likert scale from 0 = not a problem to 4 = severe problem, summarized, and then multiplied by 5, for a total final NOSE score range between 0 and 100. Higher NOSE scores reflect greater severity of self-reported nasal obstruction. Total NOSE scores have been categorized into previously described severity ranges including: mild (range, 5–25), moderate (range, 30–50), severe (range, 55–75), or extreme (range, 80–100).8 The completion of NOSE survey instruments was implemented during appointments per routine clinical practice. Electronic medical records were reviewed for records of preoperative and postoperative NOSE scores. If a postoperative NOSE score had not been obtained at the time of chart review, research staff contacted patients by phone or electronic mail for an updated NOSE score. Postoperative NOSE scores were then categorized into three groups based on time interval since surgery, which represent standard clinical appointment follow-up times for patients undergoing functional septorhinoplasty at our institution and time frames used in previous publications: early (range, 1–3 months), middle (range, 4–6 months), and late (≥10 months).

The minimal clinically important difference (MCID) of NOSE scores as reported by Stewart et al. is between 3.9 and 5.9 points.6 To conservatively estimate the prevalence of a MCID in this population, a postoperative difference of 6 points was used to calculate the percentage of patients with discernible minimal symptom improvement after septorhinoplasty.

Exclusion Criteria

Data were excluded from final analysis if study participants’ primary motivation for surgery was cosmetic rhinoplasty, even if they endorsed nasal obstruction. Additionally, patients who underwent concomitant endoscopic sinus surgery (ESS) at the time of septorhinoplasty were excluded to prevent potential confounding. Lastly, patients without documented preoperative NOSE scores or without all three postoperative NOSE scores were excluded.

Data Collection and Statistical Analysis

Protected health information was removed and study data safeguarded using unique study identification number assignment. Comparative analyses were completed using commercially available statistical software (SPSS version 24.0; IBM Corp., Armonk, NY). Descriptive analytics were completed for the final cohort data to confirm assumptions of normality for all scaled measures. Mean, standard deviation [±SD], and standard error [±SE] were reported when applicable. Between-subject differences in mean NOSE scores were evaluated using independent t test statistics, whereas bivariate within-subject differences over time were evaluated using paired-samples t testing. To evaluate within-subject changes in mean NOSE score responses over time, level IV repeated measures analyses of variance (ANOVA) and within-subjects F test statistics were utilized, with bivariate adjustments for multiple comparisons. All statistical comparisons assumed a standard .05 type I error probability.

RESULTS

Final Study Population

A total of 58 patients electing functional septorhinoplasty met preliminary inclusion–exclusion criteria and completed all preoperative and postoperative NOSE score evaluations. A total of nine (16%) study participants were excluded from final analyses due to either concomitant ESS (n = 6) or a primary indication of cosmetic rhinoplasty (n = 3).

Clinicodemographic characteristics of the final study cohort (n = 49) including surgical interventions are described in Table I. The majority of patients were female (n = 32, 65%). Many reported comorbidities contributing to nasal obstruction: allergic rhinitis (n = 30, 61%), OSA (n = 8, 16%), and/or sinusitis (n = 1, 2%). Several had prior nasal surgery (n = 15, 31%) or a cosmetic motivation for surgery in addition to functional reasons (n = 20, 41%). During surgery, all patients had a nasal tip support graft placed (n = 49, 100%) and the majority underwent inferior turbinate reduction (n = 47, 96%), had spreader grafts placed (n = 47, 96%), and/or had a septal transplant (n = 37, 76%). Other descriptors of surgical techniques and grafting types are outlined in Table I.
Longitudinal Differences in Nasal Obstruction Scores

Mean within-subjects longitudinal NOSE scores are described in Table II and graphically represented for the total cohort in Figure 1 and by preoperative NOSE score severity ranges in Figure 2. Mean NOSE scores were found to significantly improve from preoperative baseline (71.4, SD ± 17.0; 95% confidence interval [CI]: 66.5-76.3) as soon as the early time interval after surgery (P < .001). After adjustments for multiple comparisons, no statistically significant differences in average NOSE scores were reported between early and middle (20.6, SD ± 19.1; 95% CI: 15.1-26.1) follow-up NOSE scores (P = .543), early and late (23.1, SD ± 24.9; 95% CI: 15.9-30.2) NOSE scores (P > .999), or middle and late follow-up NOSE scores (P > .999).

A total of zero (0%) patients reported mild (NOSE score: ≤ 25) preoperative nasal obstruction, whereas eight (16%) reported moderate (NOSE score: 30–50), 19 (39%) reported severe (NOSE score: 55–75), and 22 (45%) patients reported extreme (NOSE score: ≥ 80) preoperative obstruction. In study participants with severe preoperative nasal obstruction, a total of 3/19 (16%) reported NOSE scores > 30 at late postoperative follow-up. Comparably, 2/8 (25%) of patients reported NOSE scores >30 in the preoperative moderate-severity group, whereas 9/22 (41%) patients reported NOSE scores >30 in the

**TABLE I.**
Patient Clinicodemographic Data of the Final Study Cohort

<table>
<thead>
<tr>
<th>Patient Characteristics, n = 49</th>
<th>Mean ± SD</th>
<th>Range</th>
<th>No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yr</td>
<td>43.6 ± 14.2</td>
<td>19–73</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>32 (65%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prior nasal surgery</td>
<td>15 (31%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comorbidity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Allergic rhinitis</td>
<td>30 (61%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obstructive sleep apnea</td>
<td>8 (16%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sinusitis</td>
<td>1 (2%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motivation for surgery</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Functional</td>
<td>49 (100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cosmetic</td>
<td>20 (41%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Intraoperative procedures**

| Nasal tip support graft       | 49 (100%)  |      |        |
| Inferior turbinate reduction  | 47 (96%)   |      |        |
| Spreader graft                | 47 (96%)   |      |        |
| Additional grafting material to sepal cartilage | 37 (76%)  |      |        |
| Septal transplant             | 37 (76%)   |      |        |
| Butterfly graft placement     | 36 (74%)   |      |        |
| Osteotomy                     | 24 (49%)   |      |        |
| LLC graft                     | 24 (49%)   |      |        |
| Tip graft                     | 12 (25%)   |      |        |
| Alar rim graft                | 8 (16%)    |      |        |
| Alar base reduction           | 3 (6%)     |      |        |

Tip grafts included both cap and shield graft. Nasal tip support grafts included columellar strut, caudal septal extension graft, and tongue-in-groove technique. Cosmetic maneuvers included hump reduction, cephalic trim, dorsal onlay graft, and dome division. LLC grafts included cephalic turn-in and lateral crural strut grafts. Grafting material in addition to septal cartilage included irradiated rib, autologous rib, AlloDerm, or auricular cartilage.

**LLC = lower lateral cartilage; SD = standard deviation.**

**Longitudinal Differences in Nasal Obstruction Scores**

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**TABLE II.**
Within-Subjects Comparison Between Preoperative and Postoperative NOSE Scores for the Total Cohort and for Preoperative Symptom Severity Subgroups

<table>
<thead>
<tr>
<th>Preoperative categories</th>
<th>Preoperative, Mean ± SE</th>
<th>Early Follow-up (1–3 Months), Mean ± SE</th>
<th>Middle Follow-up (4–6 Months), Mean ± SE</th>
<th>Late Follow-up (≥10 Months), Mean ± SE</th>
<th>Within-Subjects Effects F Test</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cohort (n = 49)</td>
<td>71.4 ± 2.4</td>
<td>24.2 ± 2.8</td>
<td>20.6 ± 2.7</td>
<td>23.1 ± 3.6</td>
<td>131.3</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Moderate nasal obstruction (n = 8)</td>
<td>42.5 ± 2.7</td>
<td>23.1 ± 8.4</td>
<td>16.9 ± 5.1</td>
<td>17.5 ± 6.2</td>
<td>6.9</td>
<td>.002</td>
</tr>
<tr>
<td>Severe nasal obstruction (n = 19)</td>
<td>66.6 ± 1.6</td>
<td>20.5 ± 3.2</td>
<td>14.2 ± 3.0</td>
<td>17.6 ± 5.1</td>
<td>69.4</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Extreme nasal obstruction (n = 22)</td>
<td>86.1 ± 1.2</td>
<td>27.7 ± 4.7</td>
<td>27.5 ± 4.9</td>
<td>29.8 ± 6.0</td>
<td>82.6</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

No patients had a preoperative NOSE score in the mild (<25) category. NOSE = Nasal Obstruction Symptom Evaluation; SE = standard error.
preoperative extreme-severity group. A total of 47/49 (95%) patients reported at least one MCID in NOSE scores in the early follow-up, whereas 45/49 (92%) of patients reported at least one MCID in the late follow-up.

Significantly worse average preoperative NOSE scores were reported by patients who received a butterfly graft compared to those who did not (74.7, SE ± 2.5 vs. 62.3, SE ± 5.2; P = .023). Similarly, study participants with comorbid allergic rhinitis reported significantly worse preoperative NOSE scores compared to participants without (78.7, SE ± 2.8 vs. 60.0, SE ± 3.1; P < .001). No significant difference in preoperative NOSE scores (P > .050) were found across independent surgical techniques, with the exception of worse average NOSE scores for patients requiring grafting material in addition to septal cartilage (74.7, SE ± 2.5) compared to those without (61.3, SE ± 5.5; P = .015).

Study covariates (Table II) were screened as significant between-subjects factors in ANOVA models. No significant mean NOSE score differences in effect were found over time for any independent subgroup or surgical technique including: gender (P = .240), prior surgery (P = .623), cosmetic indication (P = .912), comorbid sinusitis (P = .481), OSA (P = .347), use of butterfly graft (P = .062), ITR during surgery (P = .764), tip graft (P = .168), spreader graft (P = .354), septal transplant (P = .994), osteotomy (P = .208), cosmetic maneuver (P = .475), LLC graft (P = .236), alar rim graft (P = .208), alar base reduction (P = .904), or the need for grafting material in addition to septal cartilage (P = .105). The only cofactor associated with significantly worse NOSE scores at each evaluation was allergic rhinitis (P = 4.59, P = .037) (Fig. 3). Study participants with comorbid allergic rhinitis reported worse (higher) postoperative mean NOSE scores compared to those without allergic rhinitis at each postoperative time interval, although none of the mean bivariate postoperative differences were statistically significant (P > .100).

DISCUSSION

The NOSE score is currently the most commonly used PROM for reporting outcomes after functional septorhinoplasty. The optimal duration needed to follow and measure postoperative nasal obstruction severity has not been established. In February 2017, the first clinical practice guidelines regarding rhinoplasty were published and included recommendations for further research examining long-term outcomes data following functional rhinoplasty. Establishing an optimal postoperative follow-up duration at which average NOSE scores are reflective of true and durable treatment effect would provide guidelines for research design and help standardize the nasal obstruction severity measures, such as the NOSE instrument, in future research studies.

Previously published studies have described patient populations with a relatively high prevalence of differential loss to follow-up or with heterogeneous trends in NOSE scores. A recent systematic review and meta-analysis of 16 studies using NOSE score outcomes after functional rhinoplasty by Floyd et al. showed significant and sustained improvement of NOSE scores at 3 to 6 month (n = 6 studies), 6 to 12 months (n = 7 studies), and greater than 12 months (n = 4 studies). Their analysis required pooling of data samples with different lengths of follow-up and different intervals of reporting, prohibiting drawing definitive conclusions regarding the trend of NOSE scores longitudinally. For example, San Nicolo et al. performed polylactic acid copolymer implants within the nasal wall for lateral cartilage support on 30 patients and reported outcomes 12 months after surgery. Baser et al. performed septorhinoplasty on 45 patients and reported a single outcome measurement at a time ranging from 6 to 30 months after surgery with an average of 12.89 months. When only one postoperative time point was reported per patient, longitudinal trends in average NOSE scores were not assessed. Fuller et al. performed septorhinoplasty with use of polydioxanone plates on 88 patients and reported postoperative NOSE scores at 2, 4, 6, and 12 months. Seventy-five significant mean NOSE score differences in effect were found over time for any independent subgroup or surgical technique including: gender (P = .240), prior surgery (P = .623), cosmetic indication (P = .912), comorbid sinusitis (P = .481), OSA (P = .347), use of butterfly graft (P = .062), ITR during surgery (P = .764), tip graft (P = .168), spreader graft (P = .354), septal transplant (P = .994), osteotomy (P = .208), cosmetic maneuver (P = .475), LLC graft (P = .236), alar rim graft (P = .208), alar base reduction (P = .904), or the need for grafting material in addition to septal cartilage (P = .105). The one cofactor associated with significantly worse NOSE scores at each evaluation was allergic rhinitis (P = 4.59, P = .037) (Fig. 3). Study participants with comorbid allergic rhinitis reported worse (higher) postoperative mean NOSE scores compared to those without allergic rhinitis at each postoperative time interval, although none of the mean bivariate postoperative differences were statistically significant (P > .100).

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patients had a baseline preoperative NOSE score, but only 18 patients had follow-up at 1 year. One of the studies with the best follow-up is by Yeung et al.,27 which is a prospective multicenter cohort study for functional rhinoplasty. In their study, 79 patients who underwent functional rhinoplasty were enrolled, and NOSE scores were collected at baseline and 3, 6, and 12 months postoperatively. Only eight patients were lost to follow-up, for a total of 71 patients included in their analysis. Although all patients had a preoperative and 3-month NOSE score, not all patients included in the study had a 6- and 12-month postoperative score. Therefore, it is not clear how many patients included in the analysis had a 3-, 6-, and 12-month postoperative score.

Compared to previously published studies that looked at NOSE score trends over time, our study data appear to be externally consistent. Like Yeung et al. and Fuller et al.,26,28 we found that NOSE scores improve at the earliest time point (1–3 months) and remain improved at the later follow-up time point (≥10 months.)

In our review comparing preoperative and postoperative NOSE scores at three postoperative time intervals (early, middle, and late) we found significant and durable improvement in nasal obstructive severity scores reported as early as the 1- to 3-month time interval, on average. This suggests that the early NOSE scores could be representative of stable, longer-term nasal obstruction severity, and the average magnitude of early improvement experienced by patients following functional septorhinoplasty could be used as a proxy for 1-year outcomes.

Our subgroup analysis based on categories of nasal obstruction severity revealed patients with preoperative NOSE scores in the extreme category (NOSE > 80) improved postoperatively, but did so to a lesser extent than patients in less-severe categories. This information can be used to better counsel patients with extreme patient-reported nasal obstruction regarding their expected outcomes following septorhinoplasty. Additionally, we found that patients with comorbid allergic rhinitis reported significantly worse preoperative mean NOSE scores and reported worse mean NOSE scores at each postoperative time interval (Fig. 3). This highlights the importance of continuing appropriate medical management for allergic rhinitis postoperatively. These findings can also be used to improve counseling regarding expectations after surgery in these patient subgroups. In terms of the analysis of our surgical techniques, the finding that patients who underwent butterfly graft placement had a higher preoperative NOSE score than those who did not may reflect the use of this graft in patients with more severe collapse in our practice.

There are a number of caveats to consider when interpreting our study findings. Only patients who completed preoperative NOSE surveys, and all three postoperative NOSE scores were considered for final analysis. Study participants were sampled from a larger surgical population who did not complete all follow-up time points, resulting in a reduced sample size and decreased power to detect significant postoperative within-subject or between-subject differences. This may also introduce selection or misclassification bias in this final study population. This longitudinal, single-arm cohort study design is also limited in terms of causal association due to the lack of a well-defined control population for comparison and calculation of relative risk. However, this investigation provides evidence of consistent treatment effect across comorbid subgroups, biological plausibility, strong statistical associations, and temporal associations between functional septorhinoplasty and improvements in nasal obstruction. We did find some indication of NOSE survey score floor effects, suggesting this tool does not adequately capture the full range of nasal obstruction severity in this patient population.

Although the NOSE instrument is the most widely used PROM for functional septorhinoplasty to date, several other validated scales may provide for more comprehensive evaluation. Other examples of PROMs used in outcomes research for rhinoplasty include the FACE-Q,38 Rhinoplasty Outcome Evaluation questionnaire,39 the Functional Rhinoplasty Outcomes Inventory 17,40 the Rhinoplasty Health Inventory and Nasal Outcomes scale,41 the 22-item Sino-Nasal Outcome Test,42 visual analog scales,43 and the most recently proposed Standardized Cosmesis and Health Nasal Outcomes Survey.44 Additional research comparing these different scales may provide more insight into the strengths and weaknesses of these tools. Inferior turbinate reduction was performed in the vast majority of patients (96%) at the time of septorhinoplasty, and this concomitant procedure may reflect near-perfect confounding in the reported effect estimates of mean NOSE scores. Further comparative research may be warranted to determine the influence of each surgical procedure on postoperative outcomes. Lastly, findings should not be interpreted outside of the reported postoperative time intervals and may not be externally valid with patient populations in alternative settings.

CONCLUSION

In patients undergoing functional septorhinoplasty for nasal obstruction, average nasal obstruction severity significantly improves as early as 1 to 3 months after surgery. This early average improvement appears to remain durable across most patient subgroups and does not significantly change at least 10 months postoperatively. Future studies focusing on PROMs after functional septorhinoplasty using the NOSE score should consider the 3-month time frame as a proxy for 1-year outcomes to help reduce survey burden.

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