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Improvement in Nasal Obstruction and Quality of Life After Septorhinoplasty and Turbinate Surgery

Alisa Yamasaki, MD; Patricia A. Levesque, BA; Benjamin S. Bleier, MD; Nicolas Y. Busaba, MD; Stacey T. Gray, MD; Eric H. Holbrook, MD; Ahmad R. Sedaghat, MD, PhD; Robin W. Lindsay, MD

Objective: To evaluate the long-term impact of functional septorhinoplasty (SRP) with and without inferior turbinate reduction (ITR) on disease-specific symptom severity and general health-related quality of life (QOL).

Study Design: Prospective cohort study at a tertiary referral center.

Methods: Patients undergoing functional SRP with and without ITR were administered the Nasal Obstruction Symptom Evaluation (NOSE) scale to assess severity of nasal obstruction and the EuroQol-5 Dimension Questionnaire Visual Analog Scale (EQ-5D VAS) to assess general health-related QOL preoperatively and at 2, 4, 6, 12, 24, and 36 months postoperatively. Patient demographics, surgical technique, symptom severity, and QOL outcomes were analyzed.

Results: A total of 567 patients were included, with 391 patients undergoing functional SRP alone (54.0% female; mean age 36.0 years [standard deviation (SD):16.2]) and 176 patients undergoing functional SRP with ITR (50.0% female; mean age 35.6 years [SD:13.6]). There was a significant decrease in NOSE and increase in EQ-5D VAS scores in both groups through at least 24 months postoperatively. Change in NOSE scores was negatively correlated with change in EQ-5D VAS (r = −0.38, P < 0.01). Compared to patients undergoing SRP, patients also undergoing ITR had a statistically but nonclinically significant improvement in NOSE, with similar trends for EQ-5D VAS that were not significant.

Conclusion: SRP results in a sustained, long-term improvement in nasal obstruction based on disease-specific and general health-related QOL measures, with incremental improvement in outcomes with addition of ITR. This study provides the foundation for defining health outcomes and the health utility value of surgical interventions that address nasal obstruction.

Key Words: Functional septorhinoplasty outcomes, turbinate surgery outcomes, inferior turbinate reduction, turbino-plasty, nasal obstruction, NOSE score, EQ-5D, general health-related QOL.

Level of Evidence: 2c

INTRODUCTION

Nasal obstruction is one of the most common complaints addressed by otolaryngologists and can result from a variety of structural or mucosal etiologies.1 Common anatomic causes are septal deviation, nasal valve compromise, and inferior turbinate hypertrophy (ITH). When medical management fails, functional septorhinoplasty (SRP) can be offered to correct both septal deviation and nasal valve compromise,2–4 whereas inferior turbinate reduction (ITR) may be performed for ITH.5–7

Although ITR is commonly used as an adjunct to functional SRP, controversy exists regarding the long-term efficacy of performing ITR with functional SRP. Some authors propose a prophylactic role for concomitant ITR with SRP, speculating that ITR may prevent postoperative nasal valve narrowing that can occur after rhinoplasty.8–10 Outcomes of septoplasty with or without ITR can be difficult to interpret because they are based on smaller scale studies, with limited longitudinal follow-up and significant variability in technique and outcome measures.3,11 Stewart et al. conducted one of the few studies examining septoplasty with or without partial turbinectomy using disease-specific outcomes, with postoperative improvement in Nasal Obstruction Symptom Evaluation Scale (NOSE) that was sustained at 6 months postoperatively. There was no significant difference between groups, although the authors acknowledge the limitations of this finding given the small sample size (n = 59).12 Larger comparisons of septoplasty with and without ITR suggest a lower revision surgery rate when septoplasty is performed with ITR (2.2%) as compared to septoplasty alone (5.1%), although revision rates can be significantly affected by appropriateness of initial diagnosis and treatment, surgeon reporting, and patient follow-up.13

In this study, we characterize the long-term impact of functional SRP with and without ITR when performed in a tertiary care setting involving facial plastic and reconstructive surgeons and rhinologists. The primary outcomes are postoperative nasal obstruction and general health quality of life (QOL) as defined by the validated

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Yamasaki et al.: Outcomes of Septorhinoplasty and ITR
TABLE I. Patient Demographic Characteristics and Comorbidities for Patients Undergoing Functional SRP Versus SRPt.

<table>
<thead>
<tr>
<th>Demographic</th>
<th>SRP, n (%)</th>
<th>SRPt, n (%)</th>
<th>P Value [CI]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study participants</td>
<td>391</td>
<td>176</td>
<td>–</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>179 (45.8)</td>
<td>88 (50.0)</td>
<td>0.37</td>
</tr>
<tr>
<td>Female</td>
<td>211 (54.0)</td>
<td>88 (50.0)</td>
<td>[-0.05 to 0.13]</td>
</tr>
<tr>
<td>Unspecified</td>
<td>1 (0.2)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Age, mean in years</td>
<td>36.0 [16.2]</td>
<td>35.6 [13.6]</td>
<td>0.74</td>
</tr>
<tr>
<td>Seasonal allergies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>189 (48.3)</td>
<td>130 (73.9)</td>
<td>&lt;0.001***</td>
</tr>
<tr>
<td>No</td>
<td>193 (49.3)</td>
<td>44 (25.0%)</td>
<td>[0.17 to 0.33]</td>
</tr>
<tr>
<td>Unspecified</td>
<td>9 (2.3)</td>
<td>2 (1.1%)</td>
<td></td>
</tr>
<tr>
<td>Topical steroid use</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>255 (65.2)</td>
<td>153 (86.9)</td>
<td>&lt;0.01**</td>
</tr>
<tr>
<td>No</td>
<td>129 (33.0)</td>
<td>22 (12.5)</td>
<td>[0.14 to 0.28]</td>
</tr>
<tr>
<td>Unspecified</td>
<td>7 (1.8)</td>
<td>1 (0.6)</td>
<td></td>
</tr>
<tr>
<td>Improvement with steroids</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>6 (1.5)</td>
<td>10 (5.7)</td>
<td>0.06</td>
</tr>
<tr>
<td>No</td>
<td>246 (62.9)</td>
<td>140 (79.5)</td>
<td>[-0.002 to 0.09]</td>
</tr>
<tr>
<td>Unspecified</td>
<td>139 (35.5)</td>
<td>28 (14.8)</td>
<td></td>
</tr>
<tr>
<td>Sinus problems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>57 (14.6)</td>
<td>60 (34.1)</td>
<td>&lt;0.001***</td>
</tr>
<tr>
<td>No</td>
<td>326 (83.4)</td>
<td>113 (64.2)</td>
<td>[0.12 to 0.28]</td>
</tr>
<tr>
<td>Unspecified</td>
<td>8 (2.0)</td>
<td>3 (1.7)</td>
<td></td>
</tr>
<tr>
<td>Smoking</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Yes</td>
<td>11 (2.8)</td>
<td>3 (1.7)</td>
<td>0.23</td>
</tr>
<tr>
<td>No</td>
<td>213 (54.5)</td>
<td>119 (67.6)</td>
<td>[-0.06 to 0.02]</td>
</tr>
<tr>
<td>Unspecified</td>
<td>167 (42.7)</td>
<td>54 (30.7)</td>
<td></td>
</tr>
<tr>
<td>Snoring</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>192 (49.1)</td>
<td>92 (52.3)</td>
<td>0.41</td>
</tr>
<tr>
<td>No</td>
<td>185 (47.3)</td>
<td>76 (43.2)</td>
<td>[-0.05 to 0.13]</td>
</tr>
<tr>
<td>Unspecified</td>
<td>14 (3.6)</td>
<td>8 (4.5)</td>
<td></td>
</tr>
<tr>
<td>Obstructive sleep apnea</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>46 (11.8)</td>
<td>21 (11.9)</td>
<td>1.0</td>
</tr>
<tr>
<td>No</td>
<td>296 (75.7)</td>
<td>135 (76.7)</td>
<td>[-0.06 to 0.07]</td>
</tr>
<tr>
<td>Unspecified</td>
<td>49 (12.5)</td>
<td>20 (11.4)</td>
<td></td>
</tr>
<tr>
<td>CPAP use</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Using CPAP</td>
<td>17 (4.3)</td>
<td>10 (5.7)</td>
<td>0.49</td>
</tr>
<tr>
<td>Not Using CPAP</td>
<td>25 (6.4)</td>
<td>10 (5.7)</td>
<td>[-0.18 to 0.37]</td>
</tr>
<tr>
<td>Not specified</td>
<td>4 (1.0)</td>
<td>1 (0.6)</td>
<td></td>
</tr>
<tr>
<td>History of nasal surgery</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>157 (40.1)</td>
<td>35 (19.9)</td>
<td>&lt;0.001***</td>
</tr>
<tr>
<td>No</td>
<td>227 (58.1)</td>
<td>139 (79.0)</td>
<td>[-0.29 to -0.13]</td>
</tr>
<tr>
<td>Unspecified</td>
<td>7 (1.8)</td>
<td>2 (1.1)</td>
<td></td>
</tr>
<tr>
<td>History of nasal fracture</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>216 (55.2)</td>
<td>77 (43.8)</td>
<td>&lt;0.01**</td>
</tr>
<tr>
<td>No</td>
<td>166 (42.5)</td>
<td>97 (55.1)</td>
<td>[-0.21 to -0.03]</td>
</tr>
<tr>
<td>Unspecified</td>
<td>9 (2.3)</td>
<td>2 (1.1)</td>
<td></td>
</tr>
</tbody>
</table>


dSignificant differences between cohorts were found related to history of seasonal allergies, preoperative intranasal corticosteroid use, history of self-reported sinus disease, history of prior nasal surgery (including septoplasty, rhinoplasty, and/or closed nasal reduction), and history of nasal fracture.

\*P < 0.05; \**P < 0.01; \***P < 0.001. CI = 95% confidence interval; SRP = septorhinoplasty; SRPt = septorhinoplasty with inferior turbinate reduction.

TABLE II. Surgical Approach and Cartilage Grafting Techniques for Patients Undergoing Functional SRP Versus SRPt.

<table>
<thead>
<tr>
<th>Demographic</th>
<th>SRP, n (%)</th>
<th>SRPt, n (%)</th>
<th>P Value [CI]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study participants</td>
<td>391</td>
<td>176</td>
<td>–</td>
</tr>
<tr>
<td>Location of septal deviation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caudal septum</td>
<td>93 (23.8)</td>
<td>19 (10.8)</td>
<td>0.71 [-0.04 to 0.03]</td>
</tr>
<tr>
<td>Dorsal septal L-strut</td>
<td>153 (39.1)</td>
<td>44 (25.0)</td>
<td>0.61 [-0.03 to 0.06]</td>
</tr>
<tr>
<td>Maxillary crest</td>
<td>71 (18.2)</td>
<td>25 (14.2)</td>
<td>0.38 [-0.04 to 0.02]</td>
</tr>
<tr>
<td>Mid-septum</td>
<td>75 (19.2)</td>
<td>25 (14.2)</td>
<td>0.48 [-0.04 to 0.02]</td>
</tr>
<tr>
<td>Perpendicular plate</td>
<td>64 (16.4)</td>
<td>26 (14.8)</td>
<td>0.38 [-0.04 to 0.02]</td>
</tr>
<tr>
<td>Septoplasty technique</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open</td>
<td>389 (99.5)</td>
<td>160 (90.9)</td>
<td>&lt;0.001*** [-0.13 to -0.04]</td>
</tr>
<tr>
<td>Endoscopic</td>
<td>2 (0.5)</td>
<td>16 (9.1)</td>
<td>0.001*** [0.24 to 0.39]</td>
</tr>
<tr>
<td>Rhinoplasty technique</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Functional only</td>
<td>273 (68.8)</td>
<td>134 (76.1)</td>
<td>0.94 [-0.02 to 0.02]</td>
</tr>
<tr>
<td>Dual functional + cosmetic</td>
<td>111 (28.4)</td>
<td>39 (22.2)</td>
<td>0.79 [-0.05 to 0.06]</td>
</tr>
<tr>
<td>Unspecified functional + dual functional + cosmetic</td>
<td>7</td>
<td>3</td>
<td>0.94 [-0.03 to 0.02]</td>
</tr>
<tr>
<td>Graft source</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rib</td>
<td>54 (13.8)</td>
<td>8 (4.5)</td>
<td>&lt;0.001*** [0.05 to 0.14]</td>
</tr>
<tr>
<td>Septal</td>
<td>291 (74.4)</td>
<td>156 (88.6)</td>
<td>&lt;0.001*** [0.21 to -0.08]</td>
</tr>
<tr>
<td>PDS plate</td>
<td>90 (23.0)</td>
<td>27 (15.3)</td>
<td>0.03 [0.009 to 0.14]</td>
</tr>
<tr>
<td>Cadaveric rib</td>
<td>38 (9.7)</td>
<td>11 (6.3)</td>
<td>0.14 [-0.01 to 0.08]</td>
</tr>
<tr>
<td>Graft location</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Columellar strut</td>
<td>114 (29.2)</td>
<td>70 (39.8)</td>
<td>0.02 [-0.19 to -0.02]</td>
</tr>
<tr>
<td>Alar rim</td>
<td>59 (15.1)</td>
<td>28 (15.9)</td>
<td>0.80 [-0.07 to 0.06]</td>
</tr>
<tr>
<td>Lateral crural strut</td>
<td>64 (16.4)</td>
<td>45 (25.6)</td>
<td>0.16 [-0.02 to 0.01]</td>
</tr>
<tr>
<td>Lateral crural replacement</td>
<td>15 (3.8)</td>
<td>4 (2.3)</td>
<td>0.29 [-0.01 to 0.04]</td>
</tr>
</tbody>
</table>

\*P < 0.05; \**P < 0.01; \***P < 0.001. CI = 95% confidence interval; SRP = septorhinoplasty; SRPt = septorhinoplasty with inferior turbinate reduction.

NOSE\textsuperscript{14} and EuroQol 5-Dimension Health Assessment Visual Analog Scale (EQ-5D VAS) instruments.\textsuperscript{15}

**MATERIALS AND METHODS**

**Patient Selection and Treatment**

This prospective study at a single tertiary care referral center was approved by the Human Subjects Research Committee at Massachusetts Eye and Ear (Boston, MA). A total of 567 patients was included, aged 18 years or older and presenting between January 2013 and October 2018. All participants provided study consent and underwent functional SRP with correction of septal deformity and nasal valve compromise with or without ITR. Patients’ preoperative evaluations followed one of two pathways depending on the needs and referral patterns of the patient: 1) evaluation by a facial plastic surgeon alone, or 2) evaluation by a facial plastic surgeon and rhinologist. Patients undergoing cosmetic rhinoplasty in addition to functional SRP were included. Patients undergoing concomitant sinus surgery
or those with chronic rhinosinusitis, as defined by consensus guideline criteria, were excluded. Prior diagnosis of allergic rhinitis was tracked and included in a demographic comparison of the patient cohorts. Functional SRP was performed by one facial plastic surgeon (R.W.L.), and ITR was performed by either the same surgeon or by a rhinologist, depending upon the patient’s chief complaint and the ease of facilitating a collaborative procedure. Presence of ITH was diagnosed via anterior rhinoscopy and/or nasal endoscopy, and ITR was performed for exam findings of ITH and clinical history including alternating nasal obstruction, worsened obstruction at night or when lying down, and/or improvement in nasal congestion with topical nasal decongestants. ITR techniques were at the discretion of the surgeon(s) and included medial flap inferior turbinoplasty (creation of a medial mucosal flap after removal of inferior turbinate bone and lateral mucosa) and submucous resection using microdebrider, electrocautery, or coblation.

Outcomes Measures

The primary outcomes measures were longitudinal postoperative change in nasal obstruction and general health-related QOL based on validated surveys consisting of NOSE and EQ-5D VAS, respectively. The NOSE instrument measures nasal obstruction based on five questions that are scaled on a 5-point Likert scale, with a total score converted to a scale from 0 (no nasal obstruction) to 100 (severe nasal obstruction). The EQ-5D measures QOL based on five different health domains of mobility, self-care, usual activity, pain/discomfort, and anxiety/depression using a Likert scale and a general health VAS (EQ-5D VAS) that ranges from 0 (worst health imaginable) to 100 (best health imaginable). Survey data was collected preoperatively and at 2, 4, 6, 12, 24, and 36 months postoperatively using an electronic questionnaire completed at each of the above time points. Data were compiled in the Research Electronic Data Capture system (REDCap), a prospective and longitudinal data management platform used for patients with nasal obstruction undergoing functional rhinoplasty at our institution. Patient demographics (e.g., prior history of topical steroid use, effect of topical steroids, smoking, nasal surgery, nasal fracture) and self-reported patient comorbidities (e.g., seasonal allergies, sinus problems, snoring and/or obstructive sleep apnea with and without continuous positive airway pressure use) were also tracked prospectively in the REDCap data repository.

Statistical Analysis

All analyses were performed with the statistical software package R (www.r-project.org). Standard descriptive analyses were performed. Welch’s two-sided t test and Fisher exact test were performed to compare differences in continuous variables and binary variables, respectively, between participants undergoing SRP alone (SRP) versus SRP with ITR (SRPt). Linear regressions were used to determine associations between change in NOSE or EQ-5D VAS (as dependent variables) and completion of ITR (as independent variable). Because data from multiple follow-up time points were incorporated for each participant, mixed-effects linear regression models with random intercepts and random slopes over time for participants were created using the lmer package. Bivariate and multivariable models—controlling for age, gender, history of seasonal allergies, history of topical intranasal steroid use, history of sinus problems, history of nasal surgery, and history of nasal fracture—were used. P values less than 0.05 were considered significant.

Fig. 1. Pre- and postoperative NOSE score for nasal obstruction outcomes for functional SRP versus SRPt. (A) Table of mean pre- and postoperative NOSE scores. (B) Graphical representation of mean pre- and postoperative NOSE scores. Circles denote SRP group, and triangles denote SRPt group. Error bars reflect full range of data for each time point. CI = confidence interval; NOSE = Nasal Obstruction Symptom Evaluation; SRP Only = septorhinoplasty; SRPt = septorhinoplasty with inferior turbinate reduction. [Color figure can be viewed in the online issue, which is available at www.laryngoscope.com.]
RESULTS

Study Participants

Of the 567 patients enrolled in the study, 391 patients underwent functional SRP alone (SRP) and 176 patients underwent functional SRP with ITR (SRPt). There was no significant difference in age or gender between the two cohorts, with a mean age of 36.0 years and 54.0% females in the SRP group and mean age of 36.0 years and 50.0% females in the SRPt group (Table I). Additional demographic factors are presented in Table I. Location of septal deviation, SRP technique, and grafting sources are detailed in Table II. Location of septal deviation varied but was not significantly different between cohorts. The majority of septoplasties were performed using an open technique (99.5% SRP, 90.9% of SRPt), with the predominant graft source being septal cartilage for both groups (74.4% for SRP, 88.6% for SRPt).

Postoperative Outcomes After SRP With and Without ITR

Outcomes were analyzed by comparing the total NOSE and EQ-5D VAS scores between the SRP and SRPt groups at each measured time point. There was an immediate and sustained improvement in both NOSE (Fig. 1) and EQ-5D VAS (Fig. 2) for both cohorts beginning at 2 months postoperatively. Preoperatively, mean NOSE score was 61.5 for the SRP group (95% confidence interval [CI]: 59.9 to 62.4, n = 347) and 66.6 for the SRPt group (95% CI: 65.1 to 68.1, n = 166), which decreased to 24.7 for the SRP group (95% CI: 23.4 to 26.0, n = 286) and 18.5 for the SRPt group (95% CI: 17.1 to 20.0, 143) at 2-month follow-up. This postoperative change in NOSE score was sustained through at least 24 months postoperatively for both cohorts (mean 26.7 for SRP, 95% CI: 21.6 to 31.7, n = 30; mean 16.8 for SRPt, 95% CI: 13.4 to 20.29, n = 28) (Fig. 1). Mean EQ-5D VAS scores demonstrated similar postoperative improvement. Mean preoperative EQ-5D VAS was 75.7 for the SRP group (95% CI: 74.6 to 76.8, n = 292) and 74.6 for the SRPt group (95% CI: 73.1 to 76.2, n = 137). By 2-month follow-up, mean EQ-5D VAS scores had increased to 82.0 for the SRP group (95% CI: 81.1 to 82.8, n = 259) and 82.1 for the SRPt group (95% CI: 80.9 to 83.4, n = 126) (Fig. 2). Change in NOSE score was negatively correlated with change in EQ-5D VAS ($r = -0.38, P < 0.01, 95% CI: -0.42 to −0.33$).

Association Between Improved Postoperative Outcomes and ITR

A mixed-effects linear regression model was used to evaluate for association between change in NOSE and EQ-5D VAS scores (as dependent variables) and performing ITR (as independent variable). On bivariate analysis, NOSE score improved by an additional 8.14 points when an ITR was also performed ($\beta = 8.14, 95% CI: 5.59 to 10.69, P < 0.01$). This statistically significant relationship was confirmed with a multivariable model (controlling for age, gender, history of seasonal allergies, history of topical intranasal steroid use, history of sinus problems, history of nasal surgery, and history of nasal fracture), which found
that performing an ITR was associated with a 5.98-point greater improvement in NOSE score ($\beta = 5.98$, 95% CI: 1.73 to 10.2, $P < 0.01$). By contrast, EQ-5D VAS score improved by an additional 2.63 points when an ITR was also performed, but this difference was not statistically significant ($\beta = -2.63$, 95% CI: −6.30 to 1.04, $P > 0.1$). The lack of a statistically-significant association between ITR and greater improvement in EQ-5D VAS was confirmed using our multivariable model ($\beta = -1.00$, 95% CI: −4.59 to 2.59, $P > 0.1$).

**Effect of ITR Technique on Postoperative Outcomes**

Subgroup analyses were also performed to examine trends in NOSE and EQ-5D VAS scores across different ITR techniques within the SRPt cohort. Subgroups were categorized by the most commonly used techniques at our institution, which are medial flap inferior turbinoplasty (baseline group) and SRP with microdebrider-assisted submucous resection. SRP with other methods of ITR (e.g., submucosal electrocautery, coblation) were aggregated as a third group. No significant differences in outcome were detected by ITR technique through 12 months. When comparing NOSE scores for medial flap turbinoplasty versus microdebrider-assisted ITR versus other methods of ITR, there was no significant difference in score improvement (vs. microdebrider, bivariate regression: $\beta = 0.58$, 95% CI: −4.16 to 5.32, $P > 0.1$; multivariate regression: $\beta = 0.03$, 95% CI: −4.87 to 4.93, $P > 0.1$) (vs. all other, bivariate regression: $\beta = 5.49$, 95% CI: −4.88 to 15.70, $P > 0.1$; multivariate regression: $\beta = 6.53$, 95% CI: −4.11 to 17.17, $P > 0.1$) (Fig. 3A). Similarly, EQ-5D VAS scores did not improve any differently when ITR was performed with medial flap turbinoplasty versus microdebrider-assisted ITR (bivariate regression: $\beta = -2.09$, 95% CI: −4.83 to 0.65, $P > 0.1$; multivariate regression: $\beta = -1.14$, 95% CI: −3.90 to 1.62, $P > 0.1$) versus all other methods of ITR (bivariate regression: $\beta = 2.51$, 95% CI: −3.72 to 8.74, $P > 0.1$; multivariate regression: $\beta = 3.00$, 95% CI: −3.27 to 9.27, $P > 0.1$) (Fig. 3B).

**DISCUSSION**

Nasal obstruction is a common complaint among otolaryngology patients, with the septum, inferior turbinates, and nasal valve frequently identified as anatomic etiologies. Septoplasty, functional SRP with nasal valve correction, and ITR are commonly used to treat nasal obstruction. However, long-term outcomes for these techniques are not well-established given limited sample sizes, diversity of procedures, ongoing standardization of outcomes, and relatively recent recognition of the role of nasal valve compromise in nasal obstruction. In this study, we focus on Patient-Reported Outcome Measures (PROMs) to evaluate patients with nasal valve insufficiency who were candidates for functional SRP and, in some cases, ITR.

Our prospective study of 567 patients examined long-term outcomes of functional SRP with and without ITR using the disease-specific NOSE and EQ-5D VAS general health QOL instruments. Drawing on a longitudinal data repository of functional SRP patients developed at our institution, we demonstrate postoperative improvement in nasal obstruction and general health QOL in both cohorts. Prior work has demonstrated the minimum clinically important difference (MCID) to be 30 points for NOSE$^1$, and 9.5 points for EQ-5D VAS$^2$, reflecting the smallest patient-detected differences in score to have adequate benefit to warrant intervention. Both the SRP and SRPt cohorts achieved a greater than 30-point improvement in NOSE scores through 24-month follow-up. These findings are comparable to pre- and postoperative NOSE scores reported after functional nasal airway surgery, with one systematic review reporting a weighted mean NOSE of 65 ± 22 points preoperatively and 23 ± 20 points at various postoperative times for a
we demonstrate one specific than others, although some authors describe a preferen-
tial resection. The current literature has not de-
ferred turbinoplasty and microdebrider-assisted submu-
most common ITR techniques at our institution: medial

general health-related QOL outcomes when comparing the

ection in patient-determined nasal obstruction compared to

decreased nasal airway resistance, and greater improve-
section report increased rhinomanometric nasal air-

mean improvement of 42 points. In our study, the SRPt
cohort had lower mean postoperative NOSE scores than
SRP at all measured time points from 2 to 36 months
follow-up, with an 8.14-point greater improvement in
NOSE score for the SRPt group compared to SRP. This
difference may reflect an incremental increase in nasal
airway volume and restoration of nasal mucociliary func-
tion with ITR or represent undertreatment of turbinate
hypertrophy in the SRP group.22 Grymer et al. utilized
acoustic rhinometry to demonstrate decreased nasal vol-
ume after rhinoplasty and osteotomies, providing a ratio-

e for concurrent ITR to restore losses in nasal volume.9,10 However, volumetric measurements have not
been demonstrated to correlate with symptoms of nasal
obstruction, 23–26 although the subsequent development of
the NOSE instrument has allowed researchers to corre-
late patient-reported symptoms of nasal obstruction with
objective measurements. In this study, both SRP and
SRPt cohorts improved, demonstrating that ITR is not
required in all patients to achieve a significant clinical
improvement. The clinical significance of the 8.14-point
greater decrease in NOSE score for the SRPt cohort will
require further characterization and an understanding of
the underlying physiologic explanation.

EQ-5D VAS scores also trended toward higher QOL
outcomes after SRP with ITR compared to SRP alone.
Preoperative EQ-5D VAS scores were not appreciably dif-
ferent between the groups. Both experienced significant
postoperative improvements in EQ-5D VAS that ap-
proach or exceed the 9.5-point MCID threshold for EQ-5D
VAS in SRP20 (SRP at 24 months: 5.1 points; SRPt: 10.1
points). Although the change in NOSE score was signifi-
cantly higher for the SRPt group, the greater improve-
ment in EQ-5D VAS score for the SRPt group was not
statistically significant. Given the multifactorial nature of
general health-related QOL, there may be idiosyncratic
aspects of ITR-related nasal obstruction or social determi-
nants, such as family status, occupational status, and
income, that may impact general health QOL despite
improved nasal obstruction.21 These were not specifically
examined but are areas of future inquiry.

There was no overall difference in disease-specific or
general health-related QOL outcomes when comparing the
most common ITR techniques at our institution: medial flap
inferior turbinoplasty and microdebrider-assisted submu-
cosal resection. The current literature has not definitively
demonstrated one specific ITR technique to be more effica-
cious than others, although some authors describe a prefer-
ence for mucosa-sparing techniques to facilitate turbinate
volume reduction while preserving mucociliary function.6,28
Existing studies of microdebrider-assisted submucosal re-
section report increased rhinomanometric nasal airflow,
decreased nasal airway resistance, and greater improve-
ment in patient-determined nasal obstruction compared to
preoperative or healthy controls.29–31 Other studies suggest
longer efficacy for medial flap turbinoplasty beginning
between 12 and 24 months, with lower reported revision
rates (12%) compared to electrocautery (54%) or powered
submucosal resection (i.e., microdebrider; 40%) during
60-month follow-up (n = 100).32 These studies are limited
by the lack of standardized outcomes, with measures based
on rhinomanometry and acoustic rhinometry of unclear clin-
ical significance given the lack of established correlation
with PROMs.23–25 Ongoing analyses in large studies will be
required to continue probing longitudinal, clinically signifi-
cant differences between ITR techniques.

We recognize that patient selection for ITR is a poten-
tial study bias. It is theoretically possible that patients
who would benefit from ITR did not have it performed.
Postoperative outcomes would therefore be expected to
skew toward worse outcomes for the SRP group if some of
these patients had ITH but did not undergo ITR. At our
institution, decision to perform ITR was based on diverse
criteria (see “Materials and Methods”) that were applied
consistently across subspecialties to minimize bias. How-
ever, given the multifactorial nature of nasal obstruction
and the broad indications for ITR, some degree of variabil-
ity in diagnosis and treatment could occur between differ-
ent subspecialities in a tertiary care setting or, when
applied more broadly, between general and subspecialty
practice. Given the large overall variability in the diagno-
sis and management of ITH, this study provides insight
into patient QOL outcomes in the context of current man-
agement practices. Although ITH scaling systems exist,
these are not widely adopted in clinical practice.30 Pro-
viders may perform ITR with all septoplasty or SRP sur-
geries, whereas others may rarely perform ITR. These
differences in practice patterns may be explained by differ-
ences in subspecialty training, although this was not
directly examined in this study. Improved algorithms for
diagnosis and treatment of ITH have been suggested in
existing clinical practice guidelines but continue to be an
area of future work.7

Decreased patient numbers at 12-, 24-, and 36-month
follow-up times is another limitation of this study. With
some of the participants, adequate time had not yet
elapsed to allow for analyses at these time points. Patients
were asked to complete surveys at all postoperative visits
and were given every opportunity to complete surveys,
either in person or electronically via links sent by e-mail.

Our study is the largest to examine long-term out-
comes after SRP with and without ITR using validated
instruments to quantify changes in nasal obstruction and
general health-related QOL. Our work is a collaboration
between facial plastic surgeons and rhinologists to deter-
mine the optimal management for nasal obstruction,
which can be a complex medical problem with many etiol-
ogies. Studies focusing on the combination of septal,
inferior turbinate, and nasal valve etiologies of nasal
obstruction are limited in the literature but are all
addressed here.

This study provides a foundation for general otolaryn-
gologists as well as collaborating subspecialists to examine
differences in nasal airway surgery outcomes among differ-
ent subpopulations of patients—segmented by variables
such as medical comorbidities, laterality and location of sep-
tal deviation, and degree of ITH—to quantify the incremen-
tal impact and duration of different types of septoplasty,
rhinoplasty/nasal valve correction, and ITR techniques. Our
work contributes to the growing literature that establishes
disease-specific and patient-centered QOL outcomes for
functional nasal surgery. Using standardized outcomes, further
projects to understand resource utilization and cost will enable providers to fully characterize the value of these procedures and ensure that high-value surgical care is accessible for the patient populations for whom procedures are clinically indicated.

CONCLUSION

Functional SRP performed as a standalone procedure or in conjunction with ITR results in significant, sustained postoperative improvement in nasal obstruction and general health-related QOL through at least 24 months postoperatively. Greater improvement in NOSE and EQ-5D VAS scores was demonstrated when ITR is performed with SRP. In the appropriately-selected patient populations, ITR can be combined with SRP for effective long-term treatment of structural nasal obstruction.

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BIBLIOGRAPHY