Objective: To measure the efficacy of functional rhinoplasty techniques with a validated quality-of-life instrument.

Design: Prospective observational outcomes study of patients with severe nasal obstruction owing to septal deviation, internal or external valve collapse, and turbinate hypertrophy who subsequently underwent functional rhinoplasty. Preoperative and postoperative evaluations were performed using the Nasal Obstruction Symptoms Evaluation scale.

Results: Forty-one patients completed preoperative and postoperative evaluations. No complications occurred. There was a significant improvement in mean Nasal Obstruction Symptoms Evaluation score postoperatively for the entire cohort (P < .01). Nasal Obstruction Symptoms Evaluation scores were also examined based on the procedure performed, such as spreader grafting, septoplasty, external valve suspension, and turbinectomy. Each subgroup also demonstrated airway improvement.

Conclusions: Functional rhinoplasty techniques are effective in improving nasal airway function as measured by a patient-based, disease-specific, quality-of-life instrument. The specific techniques considered to treat nasal obstruction can be tailored to address the areas of concern, including septal deviation, internal or external valve collapse, and turbinate hypertrophy.

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NASAL OBSTRUCTION IS ONE of the most common patient reports in otolaryngology and facial plastic surgery practices. Septal deviation and turbinate hypertrophy are common findings; thus, septoplasty and turbinectomy modification are common procedures in this setting. In patients with mild to moderate septal deviation, standard septoplasty is often adequate to improve the nasal airway. In some instances, such as severe nasal obstruction or nasal obstruction refractory to standard septoplasty, more comprehensive evaluation and treatment are required.

Internal valve insufficiency is caused variably by a narrow angle between the upper lateral cartilage and the septum, deviation of the septum, or enlargement of the anterior portion of the inferior turbinate. The traditional technique used to address internal valve narrowing has been the spreader graft. External valve insufficiency is caused by a weakened vestibular nasal wall, which collapses on inspiration. Structures responsible include the lower lateral cartilage and fibrofatty or fibromuscular tissue complex of the ala. Techniques used to address external valve collapse include batten grafting, lateral crural strut grafts, and, more recently, suturing of the lower lateral cartilage to the orbital rim. Septoplasty and turbinectomy reduction are often used in conjunction with these procedures.

Several studies have attempted to measure outcome after septoplasty or rhinoplasty, or both, using quantitative techniques such as rhinomanometry.1 5 A more recent study has used patient-based outcome measures.13 In 2005, a prospective examination of a small group of patients demonstrated improved quality of life (QOL) after functional rhinoplasty.14 We prospectively examined a larger group of patients. Preoperative and postoperative characteristics of patients undergoing specific functional rhinoplasty procedures also were studied.

To evaluate the functional effectiveness of these surgical techniques, a prospective outcomes evaluation was performed. Functional outcomes were measured using the Nasal Obstructive Symptoms Evaluation (NOSE) scale, a validated and disease-specific QOL instrument designed for use in nasal obstruction.15,16

Methods

Study Design

The study was conducted at the University of Washington Cosmetic Surgery Center, Seattle, with approval of the university Human Subjects Committee. The study hypothesis
was that functional rhinoplasty improves disease-specific QOL (eg, nasal obstruction symptoms) measured postoperatively. As part of the same questionnaire, patients were asked to indicate the severity of their nasal obstruction on a visual, linear scale (Figure). This was then converted to a numerical score from 0 to 10, with 10 representing the most severe obstructive symptoms.

PATIENT SELECTION

Patients seen in consultation because of nasal obstruction were evaluated by me. Patients who had symptoms of nasal obstruction for at least 1 year that were the result of an identifiable anatomical cause such as septal deviation, turbinate hypertrophy, internal valve collapse, or external valve collapse were included in the study. Previous rhinoplasty or septoplasty did not exclude patients from consideration. Further inclusion criteria were failure of medical management, no history of nasal trauma or surgery within 1 year, and age 18 years or older.

STATISTICAL ANALYSIS

All patients completed the disease-specific QOL instrument for nasal obstruction, the NOSE scale, and the linear symptom evaluation scale. Patients were asked to be seen 1, 3, 6, and 12 months postoperatively; however, patients unable to attend on a specific date were seen at their convenience. Statistical analysis was undertaken using a 1- or 2-tailed t test, as required.

RESULTS

Forty-one patients were enrolled in the study and completed the preoperative and at least 1 postoperative evaluation. All patients underwent preoperative evaluation for cause of anatomical obstruction (see the “Methods” section). The mean patient age was 41.5 years (age range, 18-66 years). Of these patients, 27 (66%) were men and 14 (34%) were women. Four procedures were revisions after previous rhinoplasty or septoplasty. No complications occurred.

The NOSE scale was used to assess disease-specific QOL and is scored from 0 to 100, with higher scores indicating more severe nasal obstruction. Baseline NOSE scores were obtained at a preoperative visit and follow-up NOSE scores were obtained at postoperative visits. In addition, each patient was asked at each visit to mark on a linear scale the severity of their nasal obstruction (Figure). Although patients were asked to return for follow-up at 1, 3, 6, and 12 months postoperatively, many deviated from this schedule; thus, follow-up is reported in days. Mean follow-up was 227 days. Mean NOSE scores decreased in all patients who underwent functional rhinoplasty (58.8 vs 15.7; P<.01; Table 1). Similar improvement was noted as measured by the linear symptom scale (7.6 vs 2.3; P<.01; Table 1). Evaluation of each of the 4 items on the NOSE scale individually revealed that patients experienced improvement in all areas (Table 2).

<table>
<thead>
<tr>
<th>Problem</th>
<th>Not a Problem</th>
<th>Very Mild Problem</th>
<th>Moderate Problem</th>
<th>Fairly Bad Problem</th>
<th>Severe Problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Nasal congestion or stuffiness</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>2. Nasal blockage or obstruction</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>3. Trouble breathing through my nose</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4. Trouble sleeping</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5. Unable to get enough air through my nose</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

To the Patient: Please help us to better understand the impact of nasal obstruction on your quality of life by completing the following survey. Thank you!

Over the past 1 month, how much of a problem were the following conditions for you?

Please Circle the Most Correct Response

1. Nasal congestion or stuffiness 0 1 2 3 4
2. Nasal blockage or obstruction 0 1 2 3 4
3. Trouble breathing through my nose 0 1 2 3 4
4. Trouble sleeping 0 1 2 3 4
5. Unable to get enough air through my nose during exercise or exertion 0 1 2 3 4

Figure. Nasal Obstructive Symptoms Evaluation scale. This questionnaire was given to patients preoperatively and postoperatively (see “Methods” section).

all patients who underwent functional rhinoplasty (58.8 vs 16.4; P<.01; Table 1). Similar improvement was noted as measured by the linear symptom scale (7.6 vs 2.3; P<.01; Table 1). Evaluation of each of the 4 items on the NOSE scale individually revealed that patients experienced improvement in all areas (Table 2).

To examine the possible effect of turbinate modification on the overall effectiveness of spreader grafting, the group of patients who underwent spreader grafting was further subdivided into those who underwent turbinate modification and those who did not. More patients underwent concomitant turbinate reduction (n=24) than those who did not (n=7). These groups of patients demonstrated similar preoperative symptom severity scores (Tables 1 and 2). Mean follow-up was slightly shorter in patients who underwent turbinate reduction (242 vs 338 days). Mean NOSE scores decreased similarly in both the patients who underwent turbinate reduction (57.8 vs 13.8; P<.01) and those who did not (62.3 vs 24.3; P<.01; Table 1). Similar improvement was noted as measured by the linear symptom scale for those who underwent turbinate reduction (7.6 vs 2.1; P<.01) compared with those who did not (7.6 vs 3.3; P<.001; Table 1). Evaluation of each of the 4 items on the NOSE scale individually revealed that patients experienced improvement in all areas (Table 2). While both NOSE scores and linear symptom scale values were lower postoperatively in patients who underwent turbinate modification than in those who did not, this was not statistically significant (P>.10).

Patients with external valve collapse were treated with bone-anchored sutures to the orbital rim. Seven patients underwent this procedure. In this group of patients, the mean follow-up was 110 days (range, 32-390 days). Average NOSE scores decreased in patients who underwent this procedure (66.3 vs 20.0; P<.01; Table 1). Similar improvement was noted as measured by the lin-
ear symptom scale (8.6 vs 2.6; P<.001; Table 1). Evaluation of each of the 4 items on the NOSE scale individually revealed that patients experienced improvement in all areas (Table 2).

In this cohort of 41 patients, only 5 underwent septoplasty without spreader grafting or external valve treatment. Partial turbinectomy was performed in all 5 patients. In this group of patients, the mean follow-up was 166 days. Mean NOSE scores decreased in patients in this group (44.0 vs 16.8; P<.05; Table 1). Similar improvement was noted as measured by the linear symptom scale (6.2 vs 1.8; P<.05; Table 1). Evaluation of each of the 4 items on the NOSE scale individually revealed that, while patients experienced improvement in all areas, this reached statistical significance only in the first 2 query fields (Table 2). Overall, preoperative symptoms were lower in patients who underwent septoplasty with turbinectomy compared with patients who underwent the more extensive procedures (scaled NOSE scores, 44.0±17.2 vs 60.4±11.8, respectively; P<.01).

### Table 1. Scores on Disease-Specific Quality-of-Life Instrument (NOSE) and Linear Scales Preoperatively (Baseline) and Postoperatively*

<table>
<thead>
<tr>
<th>Time of Evaluation</th>
<th>All Patients (N = 41)</th>
<th>Spread Grating (All-Inclusive) (n = 31)</th>
<th>Spread Grating, Septoplasty, and Turbinate Modification (n = 24)</th>
<th>Spread Grating Without Turbinate Reduction (n = 7)</th>
<th>External Valve Suspension (n = 7)</th>
<th>Septoplasty With Turbinate Reduction (n = 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NOSE Scale</td>
<td>Linear Scale</td>
<td>NOSE Scale</td>
<td>Linear Scale</td>
<td>NOSE Scale</td>
<td>Linear Scale</td>
</tr>
<tr>
<td>Preoperative</td>
<td>58.4 (13.4)</td>
<td>7.6 (1.7)</td>
<td>58.8 (11.9)</td>
<td>7.6 (1.7)</td>
<td>57.8 (11.9)</td>
<td>7.6 (1.4)</td>
</tr>
<tr>
<td>Postoperative</td>
<td>15.7 (16.3)</td>
<td>2.2 (2.1)</td>
<td>16.4 (15.4)</td>
<td>2.3 (2.0)</td>
<td>13.8 (14.3)</td>
<td>2.1 (1.8)</td>
</tr>
<tr>
<td>Follow-up, d</td>
<td>227 NA</td>
<td>264 NA</td>
<td>242 NA</td>
<td>338 NA</td>
<td>110 NA</td>
<td>166 NA</td>
</tr>
</tbody>
</table>

### Table 2. Scores on Disease-Specific, Quality-of-Life Instrument (NOSE) Preoperatively (Baseline) and Postoperatively*

<table>
<thead>
<tr>
<th>NOSE Scale Query†</th>
<th>All Patients (N = 41)</th>
<th>Spread Grating (All-Inclusive) (n = 31)</th>
<th>Spread Grating, Septoplasty, and Turbinate Modification (n = 24)</th>
<th>Spread Grating Without Turbinate Reduction (n = 7)</th>
<th>External Valve Suspension (n = 7)</th>
<th>Septoplasty With Turbinate Reduction (n = 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nasal congestion or stuffiness</td>
<td>55 (18)</td>
<td>21 (19)†</td>
<td>54 (18)</td>
<td>22 (17)†</td>
<td>54 (18)</td>
<td>20 (18)†</td>
</tr>
<tr>
<td>Nasal blockage or obstruction</td>
<td>62 (17)</td>
<td>14 (18)‡</td>
<td>62 (16)</td>
<td>14 (17)‡</td>
<td>63 (15)</td>
<td>14 (16)‡</td>
</tr>
<tr>
<td>Trouble breathing through my nose</td>
<td>64 (16)</td>
<td>15 (19)‡</td>
<td>65 (14)</td>
<td>17 (21)‡</td>
<td>66 (14)</td>
<td>14 (19)‡</td>
</tr>
<tr>
<td>Trouble sleeping</td>
<td>51 (24)</td>
<td>14 (20)‡</td>
<td>51 (24)</td>
<td>12 (19)‡</td>
<td>45 (22)</td>
<td>8 (14)‡</td>
</tr>
<tr>
<td>Unable to get enough air through my nose during exercise or exertion</td>
<td>60 (18)</td>
<td>14 (21)‡</td>
<td>61 (17)</td>
<td>15 (20)‡</td>
<td>62 (17)</td>
<td>13 (19)‡</td>
</tr>
<tr>
<td>Follow-up, d</td>
<td>227 NA</td>
<td>264 NA</td>
<td>242 NA</td>
<td>338 NA</td>
<td>110 NA</td>
<td>166 NA</td>
</tr>
</tbody>
</table>

Abbreviations: NA, not applicable; NOSE, Nasal Obstructive Symptoms Evaluation.

*Data are given as mean (SD) score unless otherwise indicated.

†P<.01.
‡P<.001.
§P<.05.

**Note:** Over the past 1 month, how much of a problem were the following conditions for you?": 0 indicates not a problem; 1, very mild problem; 2, moderate problem; 3, fairly bad problem; and 4, severe problem.

### COMMENT

Treatment of nasal obstruction is a challenge to the rhinoplasty surgeon. In some cases, the cause may be an obvious anatomical deformity. More often, however, the cause of nasal obstruction is multifactorial. Nonsurgical causes of nasal obstruction must first be ruled out and treated. An understanding of nasal anatomy and the dynamics of nasal airflow are paramount to undertaking a surgical procedure to correct nasal obstruction. Recognition of the importance of the internal and external nasal valve areas in nasal airflow has led to numerous techniques for surgical...
correction of anatomical narrowing of these areas. While retrospective analyses of functional rhinoplasty have shown some beneficial effects, the efficacy of these techniques has not been examined prospectively with a disease-specific QOL instrument. Miman et al have attempted prospective studies to measure changes in nasal airflow with quantitative techniques. These studies are useful because they measure volumetric changes in the nasal cavity, but they do little to measure the subjective sensation of nasal obstruction or airflow in patients.

The NOSE scale is a validated, disease-specific, QOL instrument that has been used to measure the effectiveness of septoplasty and turbinate reduction. The NOSE scale has been designed for use in measuring nasal obstruction, providing an ideal instrument for use in measuring the effectiveness of functional rhinoplasty techniques. Recently, the NOSE scale was used to prospectively examine the efficacy of a specific nasal reconstructive technique. Rhee et al studied the efficacy of some functional rhinoplasty techniques using the NOSE instrument in 20 patients. I performed a prospective examination of a larger group of patients to further delineate the efficacy of specific functional rhinoplasty techniques using this QOL instrument. Patients in each subgroup in my study demonstrated improved QOL scores. While the number of patients in some of the treatment groups examined was small, the strengths of the present study are its prospective design, use of a validated instrument, and use of a patient-based outcome assessment. Furthermore, because I performed all of the surgical procedures, intersurgeon technique variability was minimized.

The study was performed at a tertiary medical facility, which may have resulted in a patient population skewed toward more severe or refractory nasal obstruction than that observed in the community. This is reflected in the small number of primary septoplasties performed without need for anterior septal reconstruction, spreader grafting, or external valve treatment. The overall preoperative symptom scores observed were similar to those observed in a study using the same QOL instrument to examine the efficacy of septoplasty.

The internal nasal valve is affected primarily by 3 components: the angle between the upper lateral cartilage and the septum, the septum itself, and the anterior portion of the inferior turbinate. Each of these is examined individually in forming a plan to address internal valve insufficiency. The current study demonstrates a trend toward lower QOL scores, and, hence, improved breathing in patients who underwent turbinate reduction in conjunction with spreader grafting compared with those who did not, although this was not statistically significant. The statistical power of this portion of the study was hampered by the low number of patients who did not undergo turbinate reduction in conjunction with spreader grafting. This may indicate that, even in cases in which the turbinate may be deemed within normal limits, turbinate reduction would increase cross-sectional area and improve the airway. Examination of a larger number of patients may confirm this. The use of prospectively designed studies to analyze functional rhinoplasty techniques, such as this study, should ultimately benefit both patients undergoing rhinoplasty and their surgeons.

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REFERENCES