The Nasal Obstruction Symptom Evaluation Survey as a Screening Tool for Obstructive Sleep Apnea

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Objective: To determine if clinical data and Nasal Obstruction Symptom Evaluation (NOSE) scores can be used to identify patients at risk for obstructive sleep apnea (OSA).

Design: Intake surveys using the NOSE, Epworth Sleepiness Scale (ESS), and Snore Outcomes Scale (SOS) were administered to new patients visiting a facial plastic surgery practice and a rhinology practice.

Setting: An academic facial plastic surgery practice and an academic rhinology practice.

Patients: New patients to both practices.

Main Outcome Measures: NOSE score and presence of septal deviation.

Results: The odds ratio (OR) for an ESS score higher than 10 was 2.98 (95% confidence interval [CI], 1.17-7.57) when snoring was present; 5.5 (95% CI, 1.35-22.58) when the NOSE score was 10 or higher; and 3.3 (95% CI, 0.98-11.0) when a deviated septum was found on clinical examination. The probability of an elevated ESS score was 88% when all 3 factors were present and 56% when the NOSE score was not elevated. Receiver operating characteristic analysis with predictors “snore” and NOSE score of 10 or higher had an area under the curve of 0.72. With a probability cutoff of 0.5, the sensitivity was 30%, and the specificity 90%.

Conclusions: Sinonasal surgery is among the most common outpatient procedures performed in the United States each year. Many patients undergoing sinonasal surgery have undiagnosed OSA or nasal obstruction, a known risk factor for OSA. Patients with OSA have unique perioperative needs. In patients with nasal obstruction, a deviated septum, and/or snoring, there is an association between the NOSE score and the ESS score. The NOSE survey may serve as a simple screening instrument instead of the ESS for patients at risk for undiagnosed OSA and special perioperative needs.


It has been estimated that 600,000 sinonasal procedures are performed in the United States each year, making them among the most commonly performed outpatient procedures in the United States. Nasal obstruction is a common symptom in patients undergoing sinonasal surgery. The surgeon contemplating surgical intervention must recognize that nasal obstruction is a known risk factor for sleep-disordered breathing, and patients with sleep-disordered breathing are at greater risk for perioperative complications. Sleep-disordered breathing, of which obstructive sleep apnea (OSA) is the most common type, has been reported to affect 17% of the adult population and is expected to increase in our aging and increasingly obese population. Patients with OSA have unique perioperative needs and increased perioperative morbidity and mortality. However, a significant percentage of patients have undiagnosed moderate to severe OSA at the time of elective surgical procedures.

The Nasal Obstruction Symptom Evaluation (NOSE) survey is a validated disease-specific instrument designed to measure nasal obstruction. It is commonly used in otolaryngology practices to provide an objective measure of nasal obstruction. The Epworth Sleepiness Scale (ESS) is a validated screening tool for excessive daytime sleepiness. Patients with elevated ESS scores are at increased risk for OSA and should be referred for further evaluation.

Given the increased risk of OSA in patients with nasal obstruction, the number of outpatient sinonasal surgical procedures performed each year, and the unique perioperative needs of patients with OSA, it would be helpful to have a screening tool for OSA that could be easily in-
was considered yes, and for patients who answered “most or all of the time,” the SOS score was considered no. The presence or absence of a deviated septum was determined by clinical examination. A cutoff of 10 was used for the NOSE score because this was just outside the mean (SD) of 8.9 (6.4) in this group (141 observations) and because in a logistic regression with NOSE as a continuous variable, 10 corresponded to a 50% probability of having and ESS score higher than 10. Models were sequentially built with elimination of nonsignificant variables and the addition of significant interaction terms. Significance was attributed to P < .05.

Results

There were 158 patients who were administered the survey. Forty-six were excluded: 5 because they were children and 41 because they did not complete the survey. Of the 112 patients enrolled in the study, 90 were women (57%) and 68 were men (43%). The mean (SD) body mass index (BMI, calculated as weight in kilograms divided by height in meters squared) was 28.7 (6.16) (18.18-44.93). The mean (SD) NOSE score was 8.9 (6.4) (range, 0-20). The mean (SD) ESS score was 7.9 (5.4) (range, 0-24). Table 1 lists the factors that were found to be poor predictors of sleepiness as a function of sex and ESS score. A Hotelling T² test was performed to simultaneously compare age, height, weight, and blood pressure for the groups ESS score of 10 or lower and ESS score higher than 10 (F₉₀₁=0.5438, P = .74). This finding was not statistically significant, which suggests that these variables do not offer contrast between the high and low ESS groups. The degrees of freedom were lower than expected owing to missing data.

A limited stepwise logistic regression was performed with factors that were highly correlated with the ESS score. The only significant variables for predicting ESS were NOSE score and presence or absence of snoring. In addition, owing to its clinically significant association and despite its lack of statistical significance, we also included deviated septum. The other variables tested were removed from the model.

There were no significant interactions identified between predictive variables. The final logistic regression model included only NOSE score, presence or absence of snoring, and deviated septum (Table 2). The odds ratio (OR) for an ESS score higher than 10 was 2.98 (93% confidence interval [CI], 1.17-7.57) when snoring was present; 5.5 (95% CI, 1.35-22.58) when the NOSE score was 10 or higher; and 3.3 (95% CI, 0.98-11.0) when a
deviated septum was found on clinical examination. The probabilities of having an ESS score higher than 10 given the presence or absence of the different factors are listed in Table 3. Notably, the probability of having an elevated ESS score was 88% when all 3 factors were present (elevated NOSE score, positive snoring, and deviated septum) but only 56% when the NOSE score was not elevated. The probability of having an elevated ESS score was 70% when the NOSE score and only 1 of the other factors was elevated, highlighting the significance of nasal obstruction as a predictive variable for sleepiness. Based on these data, a receiver operating characteristic (ROC) analysis (Table 4) was performed using the predictors snore, NOSE score of 10 or higher, and presence of deviated septum; and the area under the curve was 0.72 (Figure).

**COMMENT**

Sinonasal surgery is among the most commonly performed of outpatient procedures in the United States, with a recent study estimating 600,000 cases per year.\(^1\)\(^2\) The vast majority of these are performed with general anesthesia.\(^1\) Nasal obstruction, a common complaint for many of the patients undergoing these procedures, may result from a number of causes including allergic rhinitis, deviated septum, nasal valve collapse, and nasal polyps. Of particular concern is that regardless of the cause of the obstruction, nasal obstruction has been identified as a risk factor for sleep-disordered breathing.\(^12\)

Sleep-disordered breathing is the most frequent medical cause of daytime sleepiness,\(^13\) and even in its most mild forms it has been associated with substantial morbidity. The true prevalence of sleep-disordered breathing is unknown, but it has been reported to be as high as 28% of the adult population.\(^11\) Obstructive sleep apnea has been independently associated with an increased likelihood of hypertension, cardiovascular disease, stroke, daytime sleepiness, and motor vehicle accidents.\(^15\) A case-control study confirmed that individuals with OSA, as defined by apnea-hypopnea index of 10 or higher, were 7.2 times more likely to have a motor vehicle accident than those without OSA.\(^14\) Of particular importance to surgeons is that patients with OSA have unique perioperative needs that should be addressed prior to surgical intervention.

Nasal obstruction has been identified as a modifiable risk factor for OSA and is a common complaint in patients with OSA.\(^15\) The upper airway has been described as resembling a Starling resistor with a collapsible segment in the oropharynx where upper airway narrowing is induced by subatmospheric nasal pressure.\(^16\) Multiple observational and cross-sectional studies have documented a relationship between chronic nasal obstruction, snoring, and OSA.\(^3,17,19\) Based on these data, it is reasonable to assume that nasal obstruction plays a role in the pathogenesis of snoring and sleep apnea and that improving nasal patency may alleviate sleep-disordered breathing. It is thought that OSA is underdiagnosed in the population at large. By one estimate, in the adult white population in the BMI range of 25 to 28, the prevalence of mild OSA is 1 in 5, and the prevalence of at least moderate OSA is 1 in 5.\(^11\) Given the association between nasal obstruction, snoring, and OSA, it is likely that there is a significant subpopulation of patients presenting to otolaryngologists for treatment of nasal obstruction who also have undiagnosed OSA. It would be beneficial for otolaryngologists to have a practical method to screen for OSA in this population.

The importance of identifying these patients, even in practices not focused on sleep, cannot be overemphasized and is based in part on surgical risk. A large proportion of patients with nasal obstruction would benefit from a surgical intervention. Patients with OSA have different needs from an anesthesia standpoint because they are at increased risk for hypoxemia, hypercapnia, and cardiac arrhythmias postoperatively than are patients without OSA.\(^5,6\) Patients with OSA should undergo preparation with continuous positive airway pressure prior to undergoing general anesthesia to prevent cardiac complications. Because such patients are at greater risk for respiratory depression from opiate analgesics, their postoperative pain management may need to be uniquely tailored, and they may benefit from sedation or regional anesthesia vs general anesthesia when possible. Additionally, patients with OSA may also benefit from surgery on the palate, tonsils, or base of tongue, which may be performed simultaneously or sequentially with nasal surgery. Given the association of OSA with comorbidities like depression, cardiovascular disease, and increased motor vehicle accidents, it is reasonable to expect our patients to have better outcomes from nasal surgery if this element of their quality of life is improved as well.

The NOSE survey is a brief, validated, disease-specific instrument designed to measure nasal obstruction. Many otolaryngologists already use it to objectively evaluate nasal obstruction. The results of the present study show that in patients who snore and have a deviated septum, there is an association between elevated NOSE scores and elevated ESS scores. The probability of having an elevated ESS score when all 3 factors (snoring, elevated NOSE score, and deviated septum) were present was 88%, and when the NOSE score was elevated with either of the other 2 factors, the probability was 70%. Patients with elevated ESS scores should have further evaluation by a sleep specialist and should possibly undergo polysomnography. We propose that there exists a subpopulation of patients with nasal obstruction who also have undiagnosed OSA. With our simple standard survey tool, the NOSE instrument, knowledge of snoring status, and clinical examination, we may be able to predict those at risk for OSA and refer them for further treat-

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**Table 2. Logistic Regression Results by Predictor**

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Odds Ratio (95% Confidence Interval)</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snore most or all of the time</td>
<td>2.98 (1.17-7.57)</td>
<td>.02</td>
</tr>
<tr>
<td>NOSE score ≥10</td>
<td>5.5 (1.35-22.58)</td>
<td>.02</td>
</tr>
<tr>
<td>Deviated septum</td>
<td>3.3 (0.96-11.0)</td>
<td>.054</td>
</tr>
</tbody>
</table>

Abbreviation: NOSE, Nasal Obstruction Symptom Evaluation.\(^8\)
In addition, based on the high specificity of this screening method (90%), a physician can be fairly confident that if a patient does not snore, have a deviated septum, or an elevated NOSE score, the likelihood of an elevated ESS is extremely low, and therefore the risk of OSA may be low.

The incorporation of these screening instruments into clinical practice requires a minimum amount of effort. For practices already using the NOSE survey, this information is already available, and the only additional data item would be snoring status. Our data suggest that the use of these simple screening tools aid in the identification of patients at high risk for OSA, who can be referred for further evaluation preoperatively to minimize perioperative morbidity and mortality. For those who do not already use these tools, a minimum amount of effort would be required to do so.

In conclusion, sinonasal procedures are among the most common outpatient procedures performed each year, and most of them are performed with general anesthesia. Nasal obstruction, a symptom present in most patients undergoing sinonasal surgery, is common in otolaryngology practices and is a known risk factor for OSA. In patients with a deviated septum who snore and report nasal obstruction, there is an association between the NOSE score and the ESS score. Thus, when these data are available, one can determine if a patient is at increased risk for OSA without administering a separate survey, namely the ESS. The NOSE survey may serve as a simple, practical instrument for screening for patients at risk for undiagnosed OSA preoperatively, who may benefit from special perioperative management.

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Author Contributions: Dr L. Ishii had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: L. Ishii, Godoy, and M. Ishii.

Table 3. Probability of ESS Score Being Higher Than 10 in the Presence of Various NOSE Scores, Septum Deviation, and Snoring Characteristics

<table>
<thead>
<tr>
<th>Cut Point</th>
<th>NOSE Score</th>
<th>Snoring Present</th>
<th>Deviated Septum</th>
<th>Probability, %</th>
<th>Patients, No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&lt;10</td>
<td>No</td>
<td>No</td>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td>2</td>
<td>&lt;10</td>
<td>No</td>
<td>Yes</td>
<td>29</td>
<td>15</td>
</tr>
<tr>
<td>3</td>
<td>&lt;10</td>
<td>Yes</td>
<td>No</td>
<td>30</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>&gt;10</td>
<td>No</td>
<td>No</td>
<td>42</td>
<td>16</td>
</tr>
<tr>
<td>5</td>
<td>&lt;10</td>
<td>Yes</td>
<td>Yes</td>
<td>56</td>
<td>9</td>
</tr>
<tr>
<td>6</td>
<td>&gt;10</td>
<td>No</td>
<td>Yes</td>
<td>70</td>
<td>19</td>
</tr>
<tr>
<td>7</td>
<td>&gt;10</td>
<td>Yes</td>
<td>No</td>
<td>70</td>
<td>12</td>
</tr>
<tr>
<td>8</td>
<td>&gt;10</td>
<td>Yes</td>
<td>Yes</td>
<td>88</td>
<td>18</td>
</tr>
</tbody>
</table>

Table 4. Important Characteristics Found at Each Cut Pointa

<table>
<thead>
<tr>
<th>Cut Point</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Positive Predictive Value</th>
<th>Negative Predictive Value</th>
</tr>
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<tbody>
<tr>
<td>≥1</td>
<td>100</td>
<td>0.0</td>
<td>26.8</td>
<td>NA</td>
</tr>
<tr>
<td>≥2</td>
<td>96.7</td>
<td>17.1</td>
<td>29.9</td>
<td>93.3</td>
</tr>
<tr>
<td>≥3</td>
<td>96.7</td>
<td>35.4</td>
<td>35.4</td>
<td>96.7</td>
</tr>
<tr>
<td>≥4</td>
<td>86.7</td>
<td>41.5</td>
<td>35.1</td>
<td>89.5</td>
</tr>
<tr>
<td>≥5</td>
<td>73.3</td>
<td>56.1</td>
<td>37.9</td>
<td>85.2</td>
</tr>
<tr>
<td>≥6</td>
<td>63.3</td>
<td>63.4</td>
<td>38.8</td>
<td>82.5</td>
</tr>
<tr>
<td>≥7</td>
<td>43.3</td>
<td>79.3</td>
<td>43.3</td>
<td>79.3</td>
</tr>
<tr>
<td>≥8</td>
<td>36.7</td>
<td>91.5</td>
<td>61.1</td>
<td>79.8</td>
</tr>
<tr>
<td>&gt;8</td>
<td>0.0</td>
<td>100</td>
<td>NA</td>
<td>73.2</td>
</tr>
</tbody>
</table>

Abbreviations: ESS, Epworth Sleepiness Scale; NOSE, Nasal Obstruction Symptom Evaluation.

a All data are reported as percentages.

Figure. Area under the receiver operating characteristic curve is 0.72, with predictors Nasal Obstruction Symptom Evaluation score of 10 or higher, snoring present, and deviated septum present.

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