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What is This?
Effects of Endoscopic Sinus Surgery and Nasal Surgery in Patients with Obstructive Sleep Apnea

Sreeya Yalamanchali, MD¹, Stephanie Cipta, MD¹, Jonathan Waxman, MD¹, Thomas Pott, MD¹, Ninos Joseph¹, and Michael Friedman, MD¹,²

Abstract

Objectives. To evaluate the impact of combined nasal surgery and endoscopic sinus surgery on the objective measurements of obstructive sleep apnea (OSA) and sleep architecture by comparing polysomnographic data before and after combined surgery in patients with OSA.

Study Design. Case series with chart review.

Setting. A single clinical site.

Subjects and Methods. Patients with OSA and chronic rhinosinusitis who underwent combined nasal surgery and endoscopic sinus surgery and preoperative and postoperative polysomnography were identified. Patient charts were reviewed and preoperative and postoperative body mass index, apnea-hypopnea index (AHI), mean and minimum oxygen saturation, sleep efficiency, and sleep staging were compared.

Results. Fifty-six patients were included in our study. Patients were divided into 3 groups on the basis of the severity of OSA: those with mild OSA (n = 9), those with moderate OSA (n = 23), and those with severe OSA (n = 24). After combined nasal and sinus surgery, the mean AHI significantly decreased from 33.5 ± 22.0 to 29.4 ± 20.8 (P = .009) in our overall population. Specifically, AHI improved significantly in patients with moderate OSA (from 22.3 ± 4.8 to 20.7 ± 8.2, P = .023) and severe OSA (from 52.3 ± 21.4 to 43.6 ± 23.9, P = .034), while patients with mild OSA did not have significant changes in AHI. Successful surgical procedures were achieved in only 2 of 56 patients.

Conclusion. Although combined nasal and sinus surgery may slightly improve AHI in a certain group of patients, it does not cure OSA or have a significant clinical impact.

Keywords
obstructive sleep apnea, nasal surgery, endoscopic sinus surgery

Introduction

An important component in the treatment of obstructive sleep apnea (OSA) is the correction of an obstructed nasal airway.¹,³ Nasal obstruction has been identified as an independent risk factor in the pathogenesis of OSA, and structural obstructions such as polyps, septal deviation, tumors, and nasal valve collapse increase nasal airway resistance and can worsen OSA and snoring.²,⁴-⁷ Moreover, nasal resistance further increases in a supine position, leading to destabilization of the pharynx as a consequence of increased pharyngeal airway negative pressure. This causes increased collapsibility of the airway and worsening symptoms of OSA.⁷ Even though nasal obstruction has been identified as an independent risk factor in the pathogenesis of OSA, multiple studies strongly suggest that objective measurements of OSA, such as the apnea-hypopnea index (AHI), are unlikely to improve after nasal surgery alone. However, nasal surgery has been shown to improve subjective symptoms such as daytime energy levels, snoring intensity, and overall quality of life.²,³,⁸-¹⁰ Furthermore, reports on the effects of nasal surgery on sleep architecture in patients with OSA have also been variable.¹¹-¹³

The nasal cross-sectional area may also further be reduced by nasal mucosal inflammation, which has been found to be present in patients with OSA.¹⁴,¹⁵ Secondary inflammatory processes such as chronic rhinosinusitis may also additionally increase upper airway resistance. Medical management with

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nasal saline irrigation, intranasal steroids, and antibiotics is the first-line treatment of chronic rhinosinusitis, while endoscopic sinus surgery (ESS) is reserved for patients who are refractory to medical therapy. Because elimination of chronic rhinosinusitis may increase the nasal cross-sectional area, the combination of nasal and sinus surgery may have a greater impact on reduction of OSA than nasal surgery alone.

However, no published studies have explored the impact of combined nasal surgery and ESS in patients with OSA. The use of ESS in patients with OSA may enhance the ventilation volume and symmetry of the nasal cavity as well as decrease resistance from continued inflammatory processes. The aims of this study were to explore the effects of combined nasal surgery and ESS on objective measurements of OSA as well as sleep architecture.

Methods

Patient Selection

This retrospective chart review received approval from the Advocate Health Care review board. The charts of 152 patients diagnosed with OSA and chronic rhinosinusitis were identified. Sixty-five of these patients had data available on a preoperative and postoperative polysomnography (PSG). Postoperative PSG was performed <12 months after combined nasal and sinus surgery. Patient demographics (age, sex) and physical examination findings (height, weight, body mass index [BMI]) were collected.

Surgery

All patients underwent septoplasty with bilateral submucosal inferior turbinate reduction and concurrent ESS. Concurrent nasal valve repair and nasal polypectomy was performed depending on the patient’s pathology. All patients were admitted to the hospital for overnight observation and underwent routine postoperative care with removal of nasal packing on the first or second postoperative day and routine postoperative saline nasal irrigation and debridement.

PSG

All patients had reported 1-night formal laboratory polysomnographic evaluations in the same sleep laboratory before and after combined nasal and sinus surgery. AHI, minimum oxygen saturation, mean oxygen saturation, sleep efficiency, and sleep staging were reviewed and compared. Apnea was defined as a ≥90% decrease in airflow for ≥10 seconds relative to basal amplitude. Hypopnea was defined as a ≥50% decrease in the airflow amplitude relative to baseline value lasting ≥10 seconds with the presence of arousal or oxygen desaturation of ≥4%. Patients with AHIs of ≥5 and <15 were considered to have mild OSA, those with AHIs of ≥15 and <30 were considered to have moderate OSA, and those with AHIs of ≥30 were considered to have severe OSA (per American Academy of Sleep Medicine criteria). Sleep efficiency was the total sleep time divided by the total time in bed. The proportion of time spent in each sleep stage was expressed as a percentage of total sleep time.

Statistical Analysis

Statistical analysis was performed using SigmaStat version 3.24 (Systat Software, San Jose, California), and P values < .05 were accepted as statistically significant. Comparisons between preoperative and postoperative variables were conducted using Student’s paired t tests or Wilcoxon’s signed-rank tests (for data that failed normality or equivalence-of-variance tests). Pearson’s correlation coefficients were calculated to assess the relationships between preoperative BMI and preoperative AHI to change in AHI. Data are reported as either mean ± SD or median values.

Results

Of 65 patients with data available for review, 7 were excluded because they had concurrent base of tongue resection or uvulopalatopharyngoplasty during the same surgery. Two patients were excluded because their polysomnographic findings were not diagnostic, leaving 56 patients to be included in our review. Septoplasty and submucosal inferior turbinate reduction were performed on all patients. Thirty-seven patients had combined nasal surgery and bilateral pan-ESS, and 19 patients had combined nasal and limited sinus surgery. Thirty patients also had concurrent nasal polypectomy, and 7 patients underwent concurrent nasal valve repair.

The study group consisted of 48 men and 8 women (mean age, 43.6 ± 11.3). On average, there were 153.6 ± 147.7 days between the preoperative and postoperative sleep studies and 40.3 ± 32.5 days between surgery and the postoperative sleep study.

Sleep Quality and Architectural Parameters

After combined nasal surgery and ESS surgery, a significant increase in stage N1 sleep was observed in our overall group (P = .011). However, sleep efficiency and stages N2, N3, and REM sleep did not change significantly in our overall population.

Sleep-Disordered Breathing Parameters

Table 1 summarizes the mean preoperative and postoperative results of PSG for comparison. Using Wilcoxon’s signed-rank test, the median AHI decreased significantly from a preoperative value of 27.3 to a postoperative value of 23.5 (P = .009) in the collective group. Preoperative mean AHI was 33.5 ± 22.0, compared with a postoperative mean AHI of 29.4 ± 20.8. However, the mean lowest oxygen saturation and mean oxygen saturation did not improve significantly postoperatively.

We subdivided the total patient population on the basis of the severity of OSA. Of 56 patients, 9 had mild disease, 23 had moderate disease, and 24 had severe disease. After combined surgery, patients with moderate OSA had a significant reduction in median AHI from a preoperative value of 22.8 to a postoperative value of 17.7 (P = .023) using
Table 1. Summary of Results of PSG before and after Nasal Surgery and ESS.

<table>
<thead>
<tr>
<th>Group</th>
<th>Preoperative AHI, Mean ± SD</th>
<th>Postoperative AHI, Mean ± SD</th>
<th>Preoperative Lowest SaO2, %, Mean ± SD</th>
<th>Postoperative Lowest SaO2, %, Mean ± SD</th>
<th>Preoperative Mean SaO2, %, Mean ± SD</th>
<th>Postoperative Mean SaO2, %, Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>All patients (n = 56)</td>
<td>33.5 ± 22.0</td>
<td>29.4 ± 20.8</td>
<td>83.5 ± 8.9</td>
<td>83.4 ± 7.6</td>
<td>94.4 ± 2.0</td>
<td>94.7 ± 1.8</td>
</tr>
<tr>
<td>Severe OSA (n = 24)</td>
<td>52.3 ± 21.4</td>
<td>43.6 ± 23.9</td>
<td>79.3 ± 9.5</td>
<td>80.3 ± 7.9</td>
<td>93.6 ± 2.2</td>
<td>94.3 ± 2.2</td>
</tr>
<tr>
<td>Moderate OSA (n = 23)</td>
<td>22.3 ± 4.8</td>
<td>20.7 ± 8.2</td>
<td>85.1 ± 7.5</td>
<td>84.4 ± 7.1</td>
<td>94.9 ± 1.7</td>
<td>94.8 ± 1.6</td>
</tr>
<tr>
<td>Mild OSA (n = 9)</td>
<td>12.0 ± 2.8</td>
<td>14.0 ± 8.0</td>
<td>90.7 ± 2.4</td>
<td>89.3 ± 2.3</td>
<td>95.4 ± 1.4</td>
<td>95.4 ± 0.9</td>
</tr>
<tr>
<td>Polyps (n = 30)</td>
<td>37.3 ± 25.5</td>
<td>33.2 ± 22.9</td>
<td>84.8 ± 8.1</td>
<td>83.9 ± 7.8</td>
<td>94.6 ± 2.3</td>
<td>95.0 ± 1.7</td>
</tr>
<tr>
<td>No polyps (n = 26)</td>
<td>29.2 ± 16.5</td>
<td>25.1 ± 17.6</td>
<td>82.0 ± 0.10</td>
<td>82.8 ± 0.07</td>
<td>94.2 ± 0.02</td>
<td>94.3 ± 0.02</td>
</tr>
</tbody>
</table>

Abbreviations: AHI, apnea-hypopnea index; ESS, endoscopic sinus surgery; OSA, obstructive sleep apnea; PSG, polysomnography; SaO2, oxygen saturation.

Wilcoxon’s signed-rank test. Preoperative mean AHI was 22.3 ± 4.8, compared with a postoperative value of 20.7 ± 8.2. Patients with severe disease had a significant reduction in mean AHI from 52.3 ± 21.4 to a postoperative value of 43.6 ± 23.9 (P = .034). Median preoperative AHI was 41.9, compared with a median postoperative AHI of 37.4. Patients with mild disease did not have significant changes in AHI (P = .48) (Figure 1).

We also looked at the change in AHI in patients with preoperative nasal polyps and patients without nasal polyps. There was no statistically significant difference in preoperative BMI (P = .780), AHI (P = .349), and follow-up time (P = .189) between patients with and without polyps. The 30 patients with nasal polyps did not have a statistically significant reduction in AHI (P = .241) (Table 1), whereas patients without nasal polyps did have a statistically significant reduction in AHI from 29.2 ± 16.5 to 25.1 ± 17 (P = .007). However, there was no significant difference in the change in AHI between the 2 groups (P = .593).

In this study, success was defined as a decrease in baseline AHI by 50% and an AHI < 20.19 Even though there was a statistically significant decrease in AHI in our overall population, successful surgery was achieved in only 2 of 56 patients (3.6%). Both of these patients had severe OSA and did not have nasal polyps.

For our overall population, we failed to show a significant correlation between change in AHI after surgery and preoperative BMI. On the other hand, there was a moderately positive relationship between preoperative AHI and change in AHI (r = 0.401, P = .002) (Figure 2).

Discussion

Nasal obstruction is a commonly encountered risk factor and contributor to snoring and OSA. A study by Friedman et al20 showed that postoperative nasal packing (which artificially induced nasal obstruction) increased respiratory disturbance index, oxygen desaturation index, and snoring in patients with mild OSA but not in patients with moderate to severe OSA. Logically, we might assume that nasal obstruction prevents airflow and aggravates OSA and that correcting this obstruction would improve OSA. However, published studies have reported mixed results on the effectiveness of nasal surgery alone on OSA. A recent systematic review concluded that nasal surgery is very unlikely to
improve AHI and has a variable success rate in treating most other objective sleep indices, such as oxygen saturation, arousal index, sleep efficiency, and sleep architecture. In their meta-analysis, Li et al calculated a pooled success rate of 16.7%, even though the definitions of success varied widely among the included studies. Even though studies consistently fail to show an improvement in objective OSA parameters after nasal surgery, most studies have shown improvements in subjective outcomes of OSA symptoms (e.g., daytime somnolence, snoring) and overall quality of life. Therefore, because of the clinical subjective impact on individual patients, correcting nasal obstruction is still considered an important component of treating OSA.

In addition to nasal obstruction, inflammation of the nasal airway mucosa from conditions such as rhinosinusitis might further exacerbate sleep-disordered breathing. Even in the absence of clinical symptoms of rhinitis, patients with moderate to severe OSA may have increased nasal inflammation, which may play a role in upper airway obstruction. A study by Rubinstein showed that patients with OSA had higher concentrations of neutrophils and Bradykinin-like and vasoactive intestinal peptide–like immunoreactivity cells in their nasal lavage fluid after sleep in comparison with a control population without OSA. This may be due to a local inflammatory response triggered by mechanical trauma to the airway from airflow vibrations combined with the forceful suction collapse of the airway during apneic episodes. By opening the nasal cavity and paranasal sinuses symmetrically, the nasal resistance and upper airway obstruction may be relieved while expanding and enhancing the ventilation volume of the nasal cavity. Because the elimination of chronic rhinosinusitis may increase nasal cross-sectional area, the combination of nasal and sinus surgery may have a greater impact on reducing signs and symptoms of OSA in comparison with nasal surgery alone.

Our results show a statistically significant reduction in AHI after combined nasal surgery and ESS in our overall study population, in patients with moderate to severe sleep apnea and in patients without nasal polyps. Clinically, the reduction in AHI in each of these groups is minimal, with no improvement in OSA severity, and only 2 patients meeting the criteria for successful surgery. Although the reductions in AHI reached statistical significance in these groups, these changes were often small and did not reach a level that is clinically important.

Consequently, these results suggest that the nasal airway is not the sole or a dominant contributor to the development of OSA. OSA is recognized as a disease that results from multilevel obstruction in the nasal airway, hypopharynx, and pharynx. Combined with obstruction at other anatomic levels, obstruction of the nasal airway and sinuses may influence the severity of OSA. Nasal surgery alone, or combined nasal and sinus surgery, treats only the nasal airway, and the objectively measured benefits may be limited by the presence of additional areas of obstruction. Combined nasal and sinus surgery may therefore be most effectively used with treatments aimed at relieving multiple levels of airway obstruction, depending on the specific patient’s anatomy.

Patients with higher preoperative AHIs had greater reductions in postoperative AHI, suggesting that relieving nasal obstruction may help improve OSA. However, this moderately positive relationship between preoperative AHI and change in AHI may represent a regression to the mean and may not reflect a true treatment effect. There were also no significant changes in oxygen saturation, sleep efficiency, or sleep parameters, demonstrating that the preoperative and postoperative results of PSG were otherwise comparable.

In this study, patients did not undergo identical procedures, which may limit the true clinical impact of combined nasal and sinus surgery. Most patients underwent pan-ESS, while a subgroup underwent subtotal ESS along with nasal valve repair and polypectomy when indicated. Thus, our population is heterogeneous, and our results may not be an accurate representation of the true clinical impact of combined nasal and sinus surgery. Furthermore, patients with mild OSA disease did not have statistically significant changes in their AHIs after combined nasal and sinus surgery. However, this group consisted of only 9 patients and may have been underpowered.

Conclusions

The results of this study show a small, statistically significant reduction in the AHI after combined nasal and sinus surgery in patients with moderate to severe sleep apnea and in patients without nasal polyps. Combined surgery, however, did not improve the quality of sleep. Because of only minor reductions in AHI and a low success rate, the clinical efficacy of combined surgery in treating OSA is limited. Because OSA is a disease caused by multiple levels of obstruction, combined nasal and sinus surgery may have a role in improving OSA if used with further treatments aimed at relieving multiple levels of airway obstruction.

Author Contributions

Sreeya Yalamanchali, acquisition of data, analysis and interpretation of data, drafting and revising for critically important intellectual content, final approval of version to be published; Stephanie Cipta, acquisition of data, analysis and interpretation of data, final approval of version to be published; Jonathan Waxman, acquisition of data, analysis and interpretation of data, drafting and revising for critically important intellectual content, final approval of version to be published; Thomas Pott, acquisition of data, analysis and interpretation of data, drafting and revising for critically important intellectual content, final approval of version to be published; Ninos Joseph, acquisition of data, analysis and interpretation of data, final approval of version to be published; Michael Friedman, study design and concept, statistical analysis, drafting/revision, final approval of the version to be published.

Disclosures

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References