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What is This?
Z-palatoplasty and Tongue Radiofrequency for Patients with Small Tonsils

Lin Wang, MD¹, Ji Xiang Liu, MD¹, Xiang Li Yang, MD¹, Chun Wei Yang, MD¹, and Yong Xin Qin, MD¹

No sponsorships or competing interests have been disclosed for this article.

Abstract

Objective. To explore the feasibility and efficacy of Z-palatoplasty for the management of severe obstructive sleep apnea-hypopnea syndrome in patients with tonsils.

Study Design. Case series and chart review.

Setting. University hospital.

Methods. Z-palatoplasty and coblation channeling of the tongue were performed in 36 patients with body mass index <40 kg/m² and size 1 or 2 tonsils. All patients’ tonsils were preserved. Follow-up continued for at least 1 year. Success was defined as a postoperative apnea-hypopnea index <15 events per hour and at least 50% less than the preoperative value.

Results. The surgical success rate was 58.3% (21/36 patients). Furthermore, 66.7% (24/36 patients) had a ≥50% reduction in the apnea-hypopnea index to less than 20 episodes per hour. There were statistically significant differences in preoperative nadir oxygen saturation, percentage of time with oxygen saturation less than 90%, microarousal index, and Friedman tongue position between those who responded to surgery and those who did not. Six patients had temporary velopharyngeal insufficiency. After 3 months, all the patients had normal deglutition. No major perioperative complications occurred.

Conclusion. Our findings suggest that Z-palatoplasty can improve disease-specific quality of life and sleep apnea symptoms in patients with obstructive sleep apnea-hypopnea syndrome and size 1 or 2 tonsils.

Keywords
snoring, sleep apnea, obstructive sleep apnea/hypopnea syndrome, Z-palatoplasty, surgical outcome

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following criteria: (1) no previous surgical treatment for OSAHS; (2) significant symptoms of snoring, daytime somnolence, or both; (3) respiratory disturbance index >30, as determined by polysomnography (PSG); (4) body mass index (BMI) <40 kg/m²; (5) tonsil size 1 or 2; (6) long-term continuous positive airway pressure (CPAP) refusal; and (7) the appearance of obstruction at the level of the soft palate contributing to OSAHS (assessed in all patients with fiber-optic hypolaryngoscopy and the Müller maneuver). The exclusion criteria were chronic pulmonary disease and poor general health. The patients included 31 men and 5 women with the following mean values: age, 44 years (range, 25-64 years); BMI, 29.2 kg/m² (range, 22.3-34.9 kg/m²); AHI, 65.1 events per hour (range, 31.6-92.4 events per hour) and nadir oxygen saturation (LSaO₂), 71.3% (range, 52.7%-86.4%).

Preoperative evaluation included clinical history, Epworth Sleepiness Scale (ESS) evaluation, physical examination, fiber-optic digital pharyngolaryngoscopy, and nocturnal PSG.

The patients underwent surgery under general anesthesia; all patients were reevaluated 1 year later. The procedure was considered successful if the postoperative PSG showed an AHI of <15 events per hour and a ≥50% decrease from value before the surgery and if the patient reported significant clinical improvement.

Sleep Evaluation

All-night PSG studies included an electroencephalogram, electrocugulum, nasal and oral airflow measurement, thoracic and abdominal movement determination, and continuous measurement of oxyhemoglobin saturation by using a pulse oximeter. Sleep stages were scored by using Alice 4 according to the criteria defined by Rechtschaffen and Kales. Obstructive apnea was defined as the absence of airflow with respiratory effort for at least 10 seconds. Hypopnea was defined as a >50% reduction in airflow accompanied by an oxygen desaturation of >4%, or arousal from sleep. The percentage of time with oxyhemoglobin saturation below 90% (CT90%) and LSAO₂ were also calculated. Apnea-hypopnea index was defined as the number of apnea and hypopnea events per hour. Microarousal index (MI) was determined according to the criteria of the American Sleep Disorders Association.

Subjective Evaluation

A comprehensive clinical history that encompassed the patients’ sleep habits and occurrence of sleep disturbance was evaluated. Excessive daytime sleepiness or hypersomnia was determined with the ESS. A score greater than 10 was considered indicative of hypersomnia. The extent of snoring was recorded by the sleeping partner on a standard 10-cm visual analog scale (VAS) where 0 represented no snoring noise and 10 represented extreme noise causing the partner to consider leaving the room.

Physical Examination

Patients underwent a preoperative physical examination that included a full assessment of the upper airway with nasopharyngolaryngoscopy, the Müller maneuver, and a standard examination. In all patients, the extent of retropalatal contraction brought on by the Müller maneuver exceeded 90%. Finkelstein and colleagues previously described the anatomy of the velopharynx as being either flat or deep; the patients were divided into 2 groups based on this classification. In addition, the patients were grouped according to modified Mallampati position (MMP).

Surgical Procedure

After undergoing nasal CPAP for 5 to 7 days, all patients further underwent ZPP and coblation channeling of the tongue (CCT). Z-palatoplasty was performed according to the technique described by Friedman et al. and CCT was performed using the Reflexs5 (Arthrocare Corporation, Sunnyvale, California) according to the technique described by Zhang and colleagues. The first lesion was made 1 cm in front of the foramen cecum of the tongue. The 2 subsequent lesions were made anterior to the first lesion along the midline and 1 cm apart. Two additional lesions were made parallel to the back of the tongue and 1 cm apart on both sides near the base of the tongue. Each lesion was 15 seconds in duration and not more than 1.5 cm deep. The tonsils were preserved in all patients. Postoperative care was provided in the surgical intensive care unit for the first 24 hours after surgery. All patients received postoperative antibiotics and steroids but not CPAP.

Statistical Analysis

All statistical analyses were performed using SAS version 9.0 (SAS, Inc, Cary, North Carolina). Continuous data are reported as means with standard deviations (SD). Statistical significance was set at P < .05. Paired Student t test was used to compare preoperative and postoperative mean values. Unpaired Student t test and Fisher exact probability test were used to evaluate differences between responders and nonresponders. Pearson correlation analysis was used to compare changes in AHI and ESS score.

Results

Symptom Severity

Thirty-six patients were followed up at 1 year. Subjective improvement was achieved in all patients. The mean (SD) postoperative BMI was 28.9 (2.8) kg/m² and was not significantly different from preoperative BMI. Patients’ and their partners’ subjective assessments of disease severity were recorded preoperatively and at the 1-year postoperative follow-up. The ESS score improved from a mean (SD) of 12.2 (5.8) to 5.5 (3.6), and snoring level improved from 7.3 (2.3) to 3.0 (2.1); the postoperative values for both parameters were significantly lower than the respective preoperative values (Table 1).

Table 1

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Preoperative</th>
<th>Postoperative</th>
</tr>
</thead>
<tbody>
<tr>
<td>AHI</td>
<td>59.8 (20.5)</td>
<td>12.4 (19.5)</td>
</tr>
<tr>
<td>MI</td>
<td>40.8 (19.5)</td>
<td>14.0 (19.5)</td>
</tr>
<tr>
<td>LSaO₂</td>
<td>70.5% (12.4%)</td>
<td>91.5% (12.4%)</td>
</tr>
</tbody>
</table>

The mean (SD) baseline PSG parameters showed high AHI (59.8 [20.5]) and MI (40.8 [19.5]), with severe oxygen desaturation (CT90%, 32.3% [19.9%]; LSAO₂, 70.5% [12.4%]). Postoperative sleep studies showed a significant reduction in AHI, MI, and CT90% and a significant improvement in LSaO₂ (Table 1). Nearly 60% of the patients met the definition of successful surgical treatment
Table 1. Preoperative and postoperative characteristics (N = 36).

<table>
<thead>
<tr>
<th></th>
<th>Preoperative, Mean (SD)</th>
<th>Postoperative, Mean (SD)</th>
<th>Mean Difference (95% CI)</th>
<th>t Test</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI, kg/m²</td>
<td>29.2 (2.9)</td>
<td>28.9 (2.8)</td>
<td>−0.3 (−0.5 to −0.2)</td>
<td>−0.87</td>
<td>.36</td>
</tr>
<tr>
<td>Snoring level</td>
<td>7.3 (2.3)</td>
<td>3.0 (2.1)</td>
<td>−4.5 (−6.5 to −2.2)</td>
<td>−6.02</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>ESS</td>
<td>12.2 (5.8)</td>
<td>5.5 (3.6)</td>
<td>−6.8 (−8.9 to −4.6)</td>
<td>−5.46</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>AHI, events/h</td>
<td>59.8 (20.5)</td>
<td>23.2 (18.4)</td>
<td>−36.6 (−48.1 to −24.2)</td>
<td>−5.74</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>LSaO₂, %</td>
<td>70.5 (12.4)</td>
<td>85.6 (10.0)</td>
<td>15.2 (6.9 to 23.8)</td>
<td>5.86</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>CT90%, %</td>
<td>32.3 (19.9)</td>
<td>14.6 (13.3)</td>
<td>−17.7 (−22.9 to −12.6)</td>
<td>−3.62</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>MI, events/h</td>
<td>40.8 (19.5)</td>
<td>15.1 (8.6)</td>
<td>−25.7 (−37.8 to −15.7)</td>
<td>−5.94</td>
<td>&lt;.01</td>
</tr>
</tbody>
</table>

Abbreviations: AHI, apnea-hypopnea index; BMI, body mass index; CI, confidence interval; CT90%, percentage of time with oxygen saturation <90%; ESS, Epworth Sleepiness Scale; LSaO₂, nadir oxygen saturation; MI, microarousal index.

Table 2. Baseline physical parameters and sleep evaluation for 21 responders and 15 nonresponders.

<table>
<thead>
<tr>
<th></th>
<th>Responders, mean (SD)</th>
<th>Nonresponders, mean (SD)</th>
<th>t Test (P value)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI, kg/m²</td>
<td>28.1 (3.0)</td>
<td>29.4 (2.5)</td>
<td>−1.06 (.33)</td>
<td>−.36</td>
</tr>
<tr>
<td>AHI, Events/h</td>
<td>50.1 (15.9)</td>
<td>61.8 (14.1)</td>
<td>−1.34 (.16)</td>
<td>−.13</td>
</tr>
<tr>
<td>LSaO₂, %</td>
<td>79.2 (11.4)</td>
<td>64.8 (9.2)</td>
<td>2.36 (.03)</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>CT90%, %</td>
<td>23.2 (15.8)</td>
<td>44.9 (20.2)</td>
<td>−2.45 (.02)</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>MI, events/h</td>
<td>30.3 (21.7)</td>
<td>54.7 (18.6)</td>
<td>−2.42 (.02)</td>
<td>&lt;.01</td>
</tr>
</tbody>
</table>

Abbreviations: AHI, apnea-hypopnea index; BMI, body mass index; LSaO₂, lowest oxygen saturation; CT90%, percentage of time with oxygen saturation <90%; MI, microarousal index.

for OSAHS—namely, a postoperative AHI of <15 and a ≥50% reduction from the baseline AHI. Nonresponders were advised to continue treatment with CPAP.

Complications and Morbidity

There were no incidences of perioperative airway obstruction or hemorrhage. Temporary postoperative velopharyngeal insufficiency (VPI) occurred in 6 patients and completely resolved within 6 months in each case. A majority of the complications encountered were related to postoperative throat discomfort, including globus sensation, dry throat, and inability to clear the throat.

Factors Predicting Positive Outcome

There were significant differences in CT90%, LSaO₂, and MI between responders and nonresponders, whereas no significant differences were observed with regard to AHI and BMI (Table 2). Subjects with MMP I or II were significantly more likely to have a positive outcome than those with MMP III or IV (90.9% vs 44.0%, respectively). Tonsil size did not predict outcome: surgical success rates were 60.0% and 57.7% for tonsil sizes 1 and 2, respectively; this was not a statistically significant difference. The anatomical structure of the velopharynx also appeared not to influence outcome, as there was no significant difference in success rate between subjects with the deep structure (56.5%) and those with the flat structure (61.5%) (Table 3).

Correlation Analysis of the Changes in AHI and ESS

There was a positive relationship between reduction in AHI and reduction in ESS score ($r = 0.635, P < .01$).

Discussion

In an effort to achieve maximal airway enlargement, Friedman et al.4 developed a modified palatoplasty technique, known as Z-palatoplasty, in 2004. Friedman compared 25 patients who underwent ZPP and tongue-base reduction by using radiofrequency ablation with a matched group of patients who had previously undergone classic UPPP.4 The rate of objective clinical improvement was significantly better for the group who underwent ZPP (68% vs 28%), with no apparent increase in morbidity or complications. Recently, Friedman and colleagues studied the effectiveness of ZPP in patients with persistent OSAHS who had previously undergone classic UPPP.11 Thirty-one patients completed the study, all of whom underwent revision ZPP, radiofrequency tongue-base reduction. At follow-up, no patient showed clinically significant postoperative VPI after 14 weeks, and no major perioperative complications occurred. Subjective improvement was achieved in all patients, and objective cure was achieved in 21 (67.7%). The Z-palatopharyngoplasty (ZPPP) technique was conceived and modified from the Z-palatoplasty procedure and pharyngoplasty, and it appears to be effective for the management of severe OSAHS in patients with tonsils.4

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postoperative AHI <20 and a 50% decrease from the preoperative value.

We studied 36 patients with size 1 or 2 tonsils who underwent ZPP and CCT by radiofrequency ablation. The tonsils were preserved in all patients. Our surgical success rate was similar to that reported for ZPPP\textsuperscript{11,12}; however, preserving the tonsils reduces the size of the wound and the operating time. For patients with tonsil size 1 or 2, tonsillectomy does not substantially widen the lateral dimensions of the pharynx. On the contrary, further narrowing of the pharyngeal isthmus could result from scarring caused by resection of the posterior tonsillar pillars, which may further affect long-term efficacy. Generally, patients with a higher tongue are more likely to develop an obstruction in the hypopharynx. The surgical success rate was significantly better in subjects with MMP I or II (90.9%) than in those with MMP III or IV (44.0%). This observation indicates that tongue position was an important factor affecting surgical efficacy. The differing anatomical structure of the velopharynx, as described by Finkelstein and colleagues,\textsuperscript{8} is based on the relative contribution of the pharyngeal walls to the closing of the velopharyngeal valve or isthmus during airway collapse. A deep velopharynx is closed by the movement of the velum and medial movement of the lateral pharyngeal walls forming a circular or sagittal closing pattern. A flat velopharynx is closed by the antero-posterior movement of the velum forming a coronal closure pattern with or without marked medial movement of the lateral pharyngeal walls. In our study, there was no significant difference between the groups of subjects classified on the basis of this anatomical distinction, leading us to conclude that ZPP can partially reduce medial movement of the lateral pharyngeal walls.

There was a positive relationship between reduction in AHI and reduction in ESS score: those who had greater improvement in AHI also had greater improvement in ESS score. Although some patients were not completely cured, they did show some improvement in AHI, MI, and oxygen saturation. Because this was not a placebo-controlled trial, we cannot rule out the possibility of the surgical placebo effect.

Our findings suggest that ZPP combined with CCT has the potential to improve disease-specific quality of life and sleep apnea symptoms in patients with OSAHS and size 1 or 2 tonsils and that it has results similar to those reported for ZPP and tongue radiofrequency in patients who have previously undergone tonsillectomy. Further studies with larger samples are needed to confirm these findings.

**Table 3. Relationship between surgical success rate and MMP, tonsil size, and Finkelstein velopharynx type.**

<table>
<thead>
<tr>
<th>MMP</th>
<th>Success Rate, %</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I and II (n = 11)</td>
<td>90.9</td>
<td>.009</td>
</tr>
<tr>
<td>III and IV (n = 25)</td>
<td>44.0</td>
<td></td>
</tr>
<tr>
<td>Tonsil size</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I (n = 10)</td>
<td>60.0</td>
<td>.291</td>
</tr>
<tr>
<td>2 (n = 26)</td>
<td>57.7</td>
<td></td>
</tr>
<tr>
<td>Finkelstein velopharynx type</td>
<td>Success Rate, %</td>
<td>P Value</td>
</tr>
<tr>
<td>Deep (n = 23)</td>
<td>56.5</td>
<td>.264</td>
</tr>
<tr>
<td>Flat (n = 13)</td>
<td>61.5</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviation: MMP, modified Mallampati position.

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**Author Contributions**

Lin Wang, conception, design, acquisition of data, analysis and interpretation of data, drafting and revision of article, final approval; Ji Xiang Liu, acquisition of data, analysis and interpretation of data, drafting and revision of article, final approval; Xiang Li Yang, acquisition of data, analysis and interpretation of data, drafting and revision of article, final approval; Chun Wei Yang, acquisition of data, final approval; Yong Xin Qin, acquisition of data, final approval.

**Disclosures**

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**References**


