Z-palatoplasty (ZPP): A technique for patients without tonsils

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OBJECTIVE: **Patients without tonsils and with Friedman tongue position (FTP) III and IV are poor candidates for uvulopalatopharyngoplasty (UP3). Even when combined with adjunctive hyopharyngeal techniques, results are poor. We assessed a modified uvulopalatoplasty based on a bilateral Z-plasty in treating patients without tonsils who have obstructive sleep apnea/hypopnea syndrome (OSAHS).**

METHODS: **25 patients treated with a modified technique were matched with 25 patients previously treated with classic UP3. All patients in both groups also had radiofrequency tongue base reduction. Preoperative vs. postoperative measures of objective treatment success and subjective symptoms were compared for the 2 groups. Morbidity, including pain levels, narcotic use, and return to solid diet and normal activity, as well as complications were studied.**

RESULTS: **Subjective improvement was good for both groups, but objective clinical improvement was significantly better for the experimental group. Morbidity and complications for the experimental group were comparable to the control group and to other published series on UP3.**

CONCLUSIONS: **A modified technique for patients without tonsils who have OSAHS is presented. The new technique is more successful with acceptable morbidity for patients with OSAHS than classical techniques.** (Otolaryngol Head Neck Surg 2004; 131:89-100.)

Uvulopalatopharyngoplasty (UP3) remains the most common surgical procedure performed as treatment for obstructive sleep apnea/hypopnea syndrome (OSAHS). In view of its limited success in curing OSAHS,[1-3] many adjunctive procedures have been proposed or performed concurrently or sequentially.[3-5] The UP3 technique was originally described by Fujito et al[6] in 1979, and, although many modifications have been published, the basic procedure involves palate shortening with closure of the mucosal incisions, hence encompassing "palatoplasty" component; classical tonsillectomy and pharyngeal closure comprise the "pharyngoplasty" component of the procedure.[7-9]

Several problems continue to exist: (1) No procedure has been studied for post-tonsillectomy patients. (2) Many patients, especially post-tonsillectomy patients, end up with an extremely narrow palatal arch further contributing to airway obstruction. (3) Post-tonsillectomy patients have poor results with classical UP3.[10,11] (4) A significant number of patients are not improved by UP3 but are actually made worse.[2]

Patients who have had a previous tonsillectomy have an altered palatal anatomy that requires specialized treatment. Often in these patients, the posterior tonsillar pillars have been resected or are scarred and the palate is pulled closer to the posterior pharyngeal wall. In an effort to achieve maximal airway enlargement in 3 areas, a new modified palatoplasty was developed. The goal was to widen the space between the palate and the postpharyngeal wall, between the palate and tongue base and to maintain or widen the lateral dimensions of the pharynx. The new technique will be described and essentially represents a double Z-plasty to change the scar contracture tension line to an anterolateral vector and to widen the anteroposterior and lateral oropharyngeal air spaces at the level of the palate, hence the term Z-palatoplasty (ZPP).

This retrospective/prospective study was designed to assess the safety and efficiency of this new procedure on 30 patients seeking surgical treatment for OSAHS and compare these results to a matched group of patients who previously underwent classical UP3. Of these 30 patients, 25 completed the study with a minimum of 6 months of follow-up.

MATERIALS AND METHODS

Institutional review board approval for the study protocol and appropriate informed consents were obtained from 30 patients without tonsils and positive history, physical examination, and conclusive polysomnographic evidence of OSAHS.

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Thirty patients who were deemed surgical candidates and fitting the inclusion criteria were invited to participate in the prospective (experimental) arm of the study and were scheduled to undergo a ZPP procedure. Prior to 2002, surgical treatment for patients with OSAHS consisted of UP3. A chart review identified a matching set of 25 patients previously treated with standard UP3 with minimum 6-month follow-up. These 25 patients represented the retrospective (control) arm of the study. All the patients in both groups underwent adjunctive tongue base reduction by radiofrequency (TBRF) to address the hyopharyngeal narrowing.

Inclusion Criteria

All prospective patients who underwent surgical treatment of OSAHS had fulfilled previously reported criteria by the authors.[10,11] In addition, selection criteria for the present study included: (1) no previous surgical treatment for OSAHS; (2) significant symptoms of snoring and/or daytime somnolence; (3) documented failure of continuous positive airway pressure trial; (4) documented failure of attempts at conservative measures, such dental appliances when appropriate, change in sleeping position, and sleep hygiene; (5) patient without tonsils or had underwent prior tonsillectomy; (6) Friedman OSA stages II or III;[10,11] (7) the appearance of obstruction at the level of the soft palate contributing to OSAHS (fiberoptic hypolaryngoscopy and Müller maneuver was performed on all patients); (8) proof of medical fitness adequate for surgery; and (9) a clear understanding and expectations of the risks, morbidity, and likely outcomes of surgery.

Preoperative Subjective and Quality-of-Life Evaluation

Candidates for surgical treatment of OSAHS were evaluated based on history. Patient histories included assessments of snoring level (0-10) described by the bed partner, Epworth Sleepiness Scale (0-24),[12] and the SF-36 v2 Quality-of-Life (QOL) score (0-100). The SF-36® v2 Health Survey (QualityMetric, Lincoln, RI) is a 36-item well-documented survey that has previously been used to evaluate patients with obstructive sleep apnea. The survey consists of 8 multiitem health domains: (1) physical functioning (PF); (2) role limitation as a result of physical health problems (RP); (3) bodily pain (BP); (4) general health (GH); (5) vitality (energy/fatigue) (VT); (6) social functioning (SF); (7) role limitation as a result of emotional problems (RE); and (8) mental health (psychological distress and psychological well-being) (MH). A score of 0 to 100 is calculated for each domain based on patient responses. A score of 100 represents the best possible health.

Table 1. Friedman staging system based on Friedman tongue position, tonsil size, and body mass index (BMI)

	Friedman tongue position	Tonsil size	BMI
Stage I	1	3, 4	<40
	2	3, 4	<40
Stage II	1, 2	0, 1, 2	<40
	3, 4	3, 4	<40
Stage III	3	0, 1, 2	<40
	4	0, 1, 2	<40
Stage IV	1, 2, 3, 4	0, 1, 2, 3, 4	>40
	All patients with significant craniofacial or other anatomic deformities		

From: Friedman M, Ibrahim I, Joseph NJ. Staging of obstructive sleep apnea/hypopnea syndrome: A guide to appropriate treatment. Laryngoscope (In Press).

Physical Examination Parameters

Patients underwent preoperative physical examinations included a full assessment of the upper airway with nasopharyngolaryngoscopy, Mueller maneuver, and standard examination. In addition, patients were staged according to the previously described Friedman staging system,[11] based on the Friedman tongue position (FTP, formerly the Friedman palate position), tonsil size, and body mass index (BMI) (Table 1). Weight and height were recorded at the initial visit and the BMI (kg/m^2) was calculated. Although originally named Friedman palate position (FPP), the term has been corrected and called Friedman tongue position (FTP) because the observation that describes the palate/tongue relationship is, in fact, predictive of the tongue position as it impacts the airway.

Stage I disease was defined as those patients with FTP I or II, tonsil size 3 or 4, and BMI of less than 40 kg/m^2 (Table 1). Stage II disease is defined as FTP I or II and tonsil sizes 0, 1, or 2, or FTP III and IV with tonsil sizes 3 or 4 and BMI of less than 40 kg/m^2. Stage III disease is defined as FTP III or IV, tonsil sizes 0, 1, or 2, and BMI less than 40 kg/m^2. All patients with a BMI greater than 40 kg/m^2, regardless of FTP or tonsil size, as well as those patients with significant cranio-

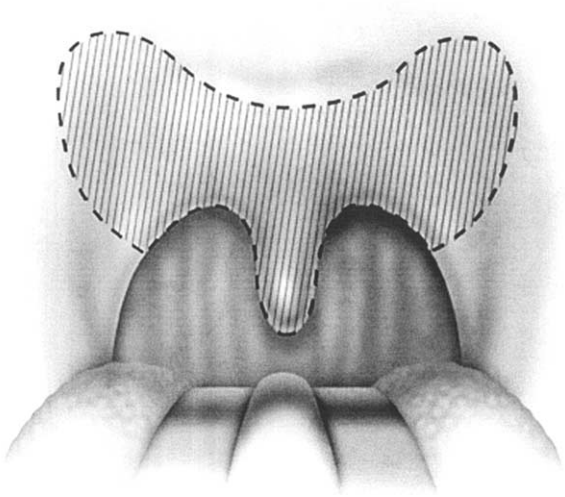

Fig 1. The incision of the palatal flap is marked.

facial or other anatomic abnormalities were designated as Stage IV (Table 1).

Polysomnography

An all-night attended, comprehensive sleep study was performed using a computerized polygraph to monitor electroencephalogram (C3-A2, C4-A1), left and right electrooculogram, electrocardiogram, chin and anterior tibialis electromyogram, abdominal and thoracic movement by inductive plethysmograph, nasal oral airflow, oxygen saturation by pulse oximetry (SaO_2), and throat sonogram. Hypopnea is measured via a thermistor placed in the path of airflow from the nose and mouth. Apnea was defined as cessation of breathing for at least 10 seconds. Hypopnea was a decreased effort to breathe at least 50% less than the baseline and with at least a 4% decrease in SaO_2. The apnea-hypopnea index (AHI) was calculated as the sum of total events (apneas and hypopneas) per hour. All patients were studied in the same sleep laboratory facility.

Surgical Technique

The surgical technique for the UP3 group has been previously described by the senior author.[13] The surgical technique for the modified ZPP group is illustrated in Figures 1-8. The key points of the surgical technique are as follows: (1) 2 adjacent flaps are outlined on the palate; (2) only mucosa of the anterior aspect of the 2 flaps is removed; (3) the 2 flaps are separated from each other by splitting the palatal segment down the midline; (4) 2-layer closure bringing the midline all the way to the anterolateral margin of the palate is accomplished; and (5) the final result creates 3 to 4 cm of distance between the posterior pharynx and the palate. In addition, the lateral dimension of the palate is usually doubled to approximately 4 cm. The exact dimensions of the flaps that extend in a butterfly pattern are illustrated in Figure 7. The anterior midline margin of the flap is halfway between the hard palate and the free edge of the soft palate. The distal margin is the free edge of the palate and uvula. The lateral extent is posterior to the midline and all the way the lateral extent of the palate.

Prior to discharge, all patients were prescribed acetaminophen with codeine elixir 12 mg/5 mL and directed to administer 15 cc q4 hr, as needed for pain. All patients also received postoperative antibiotics and steroids.

Adjunctive Surgical Procedures

All patients also underwent TBRF (Somnoplasty™ system, Gyrus, Inc., Memphis, TN). The patients received 3,000 joules distributed to 4 points along the midline of the tongue behind the circumvallate papillae. All patients also were asked to return to the office for monthly TBRF treatments. Each month, they received 1,500 joules distributed to 2 points along the midline. The total numbers of joules delivered are shown in Table 2. Patients were asked to return for treatments until symptoms resolved and until their polysomnogram indicated significant improvement of OSAHS. Not all patients complied with this request.

Postoperative Follow-up

Postoperatively, patients were seen in the office at 1 week, 2 weeks, at 1 month, monthly for follow-up TBRF treatments, and at 6 months. At each interval examination and interview, the patients were queried concerning any complications, other adverse effects, and complaints. A postoperative polysomnogram was scheduled at 6 months. At the 6-month follow-up or later, patients were reassessed for snoring level (0-10) as described by the bed partner, Epworth Sleepiness Scale (0-24), and the SF-36 v2 Quality-of-Life survey (0-100).

Statistical Analysis

All statistical analyses were performed using SPSS Version 11.0.1 (SPSS, Inc., Chicago, IL). Continuous data is displayed as means $\pm$ standard deviation (SD). Statistical significance was accepted when $P < 0.05$. The Student's t- and the Mann-Whitney U-tests were employed to evaluate significant differences between ZPP and standard UP3 treated patients. The Levine's Test for Equality of Variances was used to determine statistically significant variances. The paired Student's t-test was used to compare preoperative vs. postoperative mean values within each group. The chi-square test was used to test the association between categorical variables.

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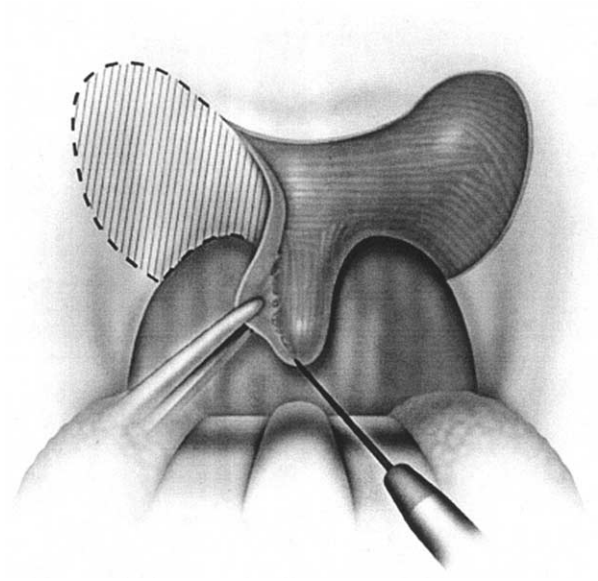

Fig 2. The mucosa over the palatal flap is removed, exposing the palatal musculature.

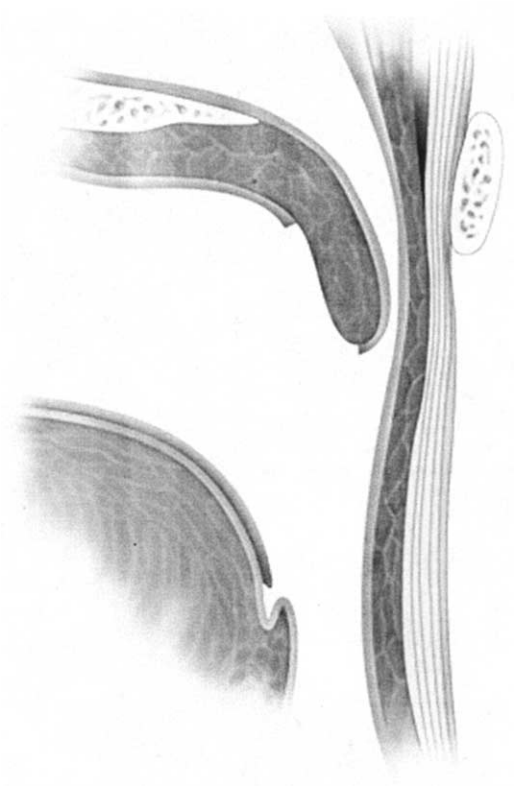

Fig 3. Lateral view of the soft palate and the uvula after the mucosa is excised. Note the uvula and palate are hanging close to the posterior pharyngeal wall, narrowing the retropharyngeal space.

RESULTS

Twenty-five patients ZPP patients were studied and matched with an additional 25 patients who had previously undergone UP3 for the treatment of OSAHS. Table 2 compares demographic data, including mean age, gender distribution, mean preoperative BMI, Friedman OSAHS stage as described by Friedman et al,[11] OSAHS disease severity based on preoperative AHI (AHI $<$ 15 = mild, AHI 15-45 = moderate, AHI $>$ 45 = severe), and treatment of tongue base via radiofrequency (total number of Joules delivered). There were no statistical differences between the 2 groups with regard to mean age, gender distribution, Friedman stage distribution, OSAHS severity, mean preoperative BMI, or TBRF joules delivered.

Adjunctive Treatment

All patients in both groups received intraoperative and follow-up treatments to the tongue base with radiofrequency reduction. The total energy delivered was 4510 $\pm$ 1874 joules in ZPP patients and 3840 $\pm$ 1067.7 joules in UP3 patients. These values were not different from each other (Table 2).

Morbidity

Postoperative. The number of days of narcotic pain medication usage and return to normal diet were used as indices of short-term morbidity from surgery. Patients undergoing ZPP used narcotic pain medication for 6.4 $\pm$ 3.6 days and required 6.4 $\pm$ 1.9 days to return to a normal diet as compared with 9.4 $\pm$ 2.7 days and 10.3 $\pm$ 3.6 days, respectively in UP3 patients. These

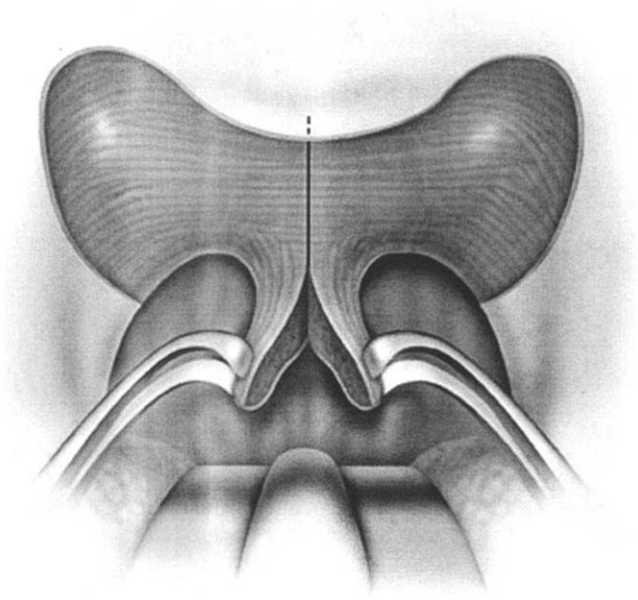

Fig 4. The uvula and palate are split in the midline with a cold knife.

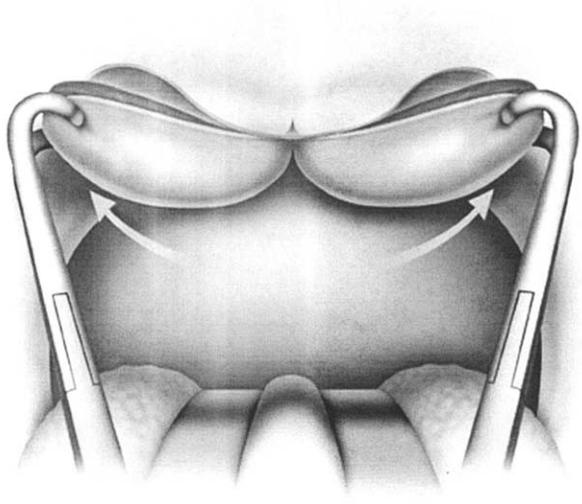

Fig 5. The uvular flaps along with the soft palate are reflected back laterally over the soft palate.

mean values for narcotic medication usage and return to normal diet were significantly different from each other (Table 3).

Complications and Long-Term Morbidity. Perioperative complications were rare in both groups. Tongue base infections, secondary to TBRF treatments that required antibiotic treatment were found in 1 ZPP patient and 2 UP3 patients. None of these patients had airway obstruction or abscess formation that required surgical drainage. Temporary postoperative velopharyngeal insufficiency (VPI) was reported in the 12 ZPP and 7 UP3 patients. In all these patients, the VPI lasted between 2 and 60 days, and completely resolved by the fifth postoperative visit (3 months after surgery). All patients that complained of VPI noted occasional or rare problem when drinking quickly. In no patient did the VPI significantly affect their ability to eat a normal diet in social situations nor did it significantly affect their voice. No cases of permanent VPI were encountered in either group. The majority of complications encountered were related to postoperative throat discomfort, including globus sensation, mild dysphagia, dry throat, and inability to clear the throat. Eleven ZPP and 17 UP3 patients reported such complaints (Table 3).

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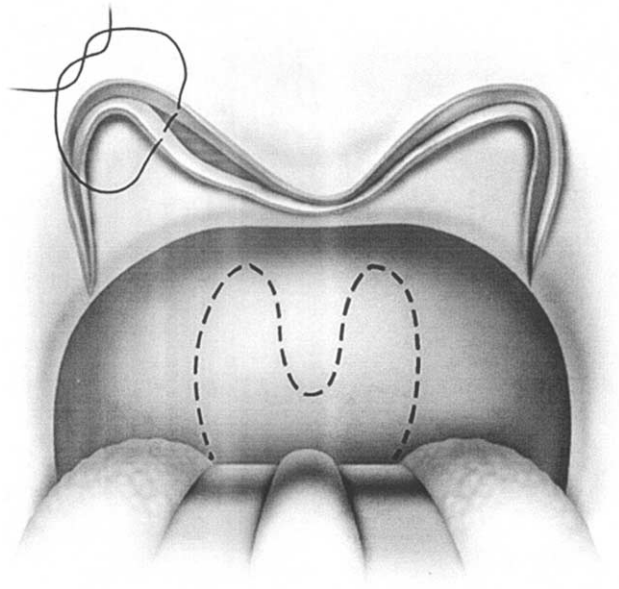

Fig 6. Two-layered closure of the palatal flaps. The submucosal layer is approximated first with 2-0 Vicryl (polyglactin 910, Ethicon, Inc,, Somerville, NJ).

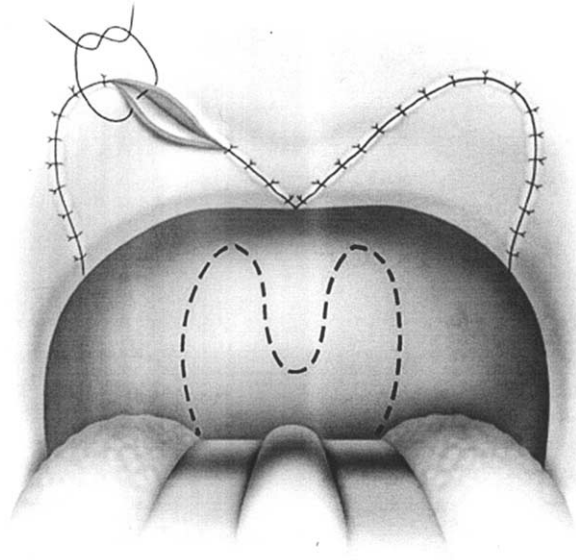

Fig 7. Two-layered closure of the palatal flaps—the mucosal closure with 3-0 chromic suture.

Subjective Symptom Elimination

Patients' and bed-partners' subjective assessment of disease severity (snoring level and ESS) were collected preoperatively and at the time of the 6-month postoperative follow-up examination. Only preoperative level of snoring level differed, either preoperatively or postoperatively, between the two groups (Table 3). However, postoperative values for both snoring level and ESS were significantly lower than their respective preoperative values (Table 3). To more easily compare subjective assessments of improvement in symptom severity between the 2 groups, the percent change in snoring level and ESS was calculated using the following formula:

$$\left[\%\ \text{Change} = \left(\frac{(\text{Postop} - \text{Preop})}{\text{Preop}}\right) \times 100\right]$$

There were no differences in % change snoring level or ESS between patients treated with ZPP or UP3 (Fig 9).

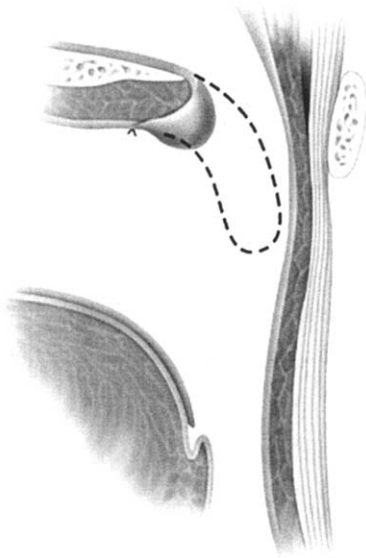

Fig 8. Lateral view showing the widening of the nasopharynx after midline palatoplasty.

Table 2. Demographic data 50 patients who underwent either Z-palatoplasty (ZPP) or uvulopalatopharyngoplasty (UP3) for the treatment of obstructive sleep apnea/hypopnea syndrome (OSAHS)

	ZPP (n = 25)	UP3 (n = 25)	Sig. (*P*-value)
Age (yrs)	49.7 ± 12.6	50.4 ± 9.6	NS
Gender			NS
Male	19	16	
Female	6	9	
Friedman OSAHS stage			NS
II	2	23	
III	3	22	
OSA severity			NS
Mild	3	7	
Moderate	11	10	
Severe	10	8	
BMI (kg/m^2)	30.8 ± 3.6	29.5 ± 4.2	NS
TBRF (total Joules delivered)	4510.0 ± 1874.3	3840.0 ± 1067.7	NS

*Staging system for grading OSAHS as previously described by Friedman et al.[8] OSA severity based on AHI (AHI < 15 = mild; AHI 15–45 = mild; AHI > 45 = severe). *BMI*, body mass index; *TBRF*, base of tongue reduction by radiofrequency. Statistical significance accepted when $P < 0.05$. NS, not significant.

Because nearly all the patients originally sought treatment for loud snoring, we also determined subjective improvement of the patients' symptoms using a strict criteria, which required a 50% decrease in snoring level postoperatively and a postoperative snoring level of 5 or less. Table 4 compares the subjective improvement in OSAHS symptoms following surgical treatment of OSAHS with ZPP versus UP3. Subjective improvement based on snoring scale was encountered in 25 (100%) of ZPP patients and 24 (96%) of UP3 patients. There was no significant difference between the 2 groups in subjective improvement of symptoms.

Although mean postoperative ESSs were significantly lower in both the experimental and control groups as compared with preoperative scores (Table 3), the percent changes in ESS for both groups were considerably less than the percent change in snoring level (Fig 9). Cross-tabulation analysis of the raw data showed that, particularly in the ZPP patients, a sizable number of patients (12 ZPP and 6 UP3) showed no improvement in their subjective ESSs following surgery.

SF-36 v2 Quality of Life Health Survey

Twenty-five patients belonging to the experimental group had completed the SF-36 v2 Health Survey both pre- and postoperatively, totaling 50 surveys. Scores from 0 to 100 (100 being the best health) were calculated for all 25 patients in each of the 8 domains both pre- and postoperatively. Figure 10 displays the preoperative vs. postoperative mean scores (±SD) for each of the 8 domains for the experimental group. In addition, the difference in mean score (±SE), postoperative vs. preoperative, for each of the eight health domains were calculated (Fig 11). A positive mean difference in mean score represents improvement, whereas a negative mean difference in mean score represents deterioration in quality of life.

The postoperative improvement in mean scores was statistically significant ($P < 0.05$) for 6 of the 8 domains (Figs 10 and 11). Only PF (physical function) and BP (bodily pain) were not significantly improved. The greatest degrees of improvement were seen in the RE (emotional role), MH (mental health), SF (social functioning), and VT (vitality/energy) domains with mean percent increases equal to 13.0 ± 20.1, 15.4 ± 17.4, 11.2 ± 17.5, and 14.1 ± 16.2, respectively. In addition, positive mean differences were also seen in the RP and GH domains (Fig 11).

Objective Surgical Success

Objective measure of clinical improvement of OSAHS was based on data collected during polysomnography. Specific indicators included the apnea index (AI), the apnea/hypopnea index (AHI), and the minimum recorded arterial oxygen saturation (Min SaO_2). Table 5 compares mean (±SD) preoperative vs. postoperative values for the ZPP patients and UP3 patients. In both ZPP and UP3 patients, mean AI and AHI values decreased and mean Min SaO_2 increased postoperatively as compared with their preoperative values. Ex-

Table 3. Comparison of subjective indices of disease severity (snoring level and Epworth sleepiness scale) and postoperative course (narcotic medication days, return to normal diet, and morbidity) in patients undergoing Z-palatoplasty (ZPP) and uvulopalatopharyngoplasty (UP3)

	ZPP (n = 25)	UP3 (n = 25)	Sig. (*P*-value)
Snoring level (1–10)			
Preoperative	9.6 ± 0.6	7.4 ± 1.0	$P < 0.001$
Postoperative	2.6 ± 2.1*	2.4 ± 2.3*	NS
Epworth sleepiness scale (1–24)			
Preoperative	12.5 ± 6.2	14.2 ± 3.6	NS
Postoperative	8.3 ± 4.0*	8.7 ± 4.3*	NS
Narcotic pain meds use (days)			
Postoperative	6.4 ± 3.6	9.4 ± 2.7	$P < 0.005$
Return to normal diet (days)			
Postoperative	6.4 ± 1.9	10.3 ± 3.6	$P < 0.002$
Tongue base infection			
Postoperative	1 (4%)	2 (8%)	NS
Bleeding			
Postoperative	0 (0%)	0 (0%)	NS
Postnasal drip			
Postoperative	3 (12%)	4 (16%)	NS
Dysphagia			
Postoperative	1 (4%)	11 (44%)	$P < 0.001$
Foreign body sensation			
Postoperative	11 (44%)	17 (68%)	NS
Temporary velopharyngeal insufficiency			
Postoperative	12 (48%)	7 (28%)	NS
Permanent velopharyngeal insufficiency			
Postoperative	0 (0%)	0 (0%)	NS

Statistical significance accepted when $P < 0.05$.
*Statistical significance from the preoperative value.

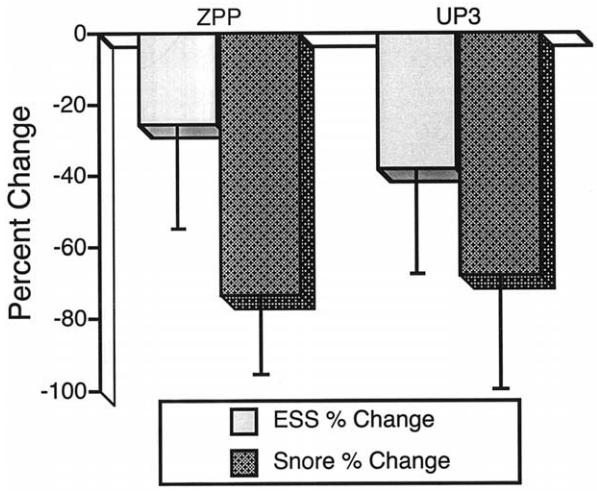

Fig 9. Comparison of Z-palatoplasty (ZPP) vs. uvulopalatopharyngoplasty (UP3) for the treatment of obstructive sleep apnea/hypopnea syndrome on % change of postoperative vs. preoperative values in snoring level and Epworth Sleepiness Scale (ESS). Both snoring level and ESS decreased significantly postoperatively in both groups, however, the % change in each group were not different from each other.

Table 4. Comparison of successful surgical treatment and improvement of symptoms of OSAHS between Z-palatoplasty (ZPP) and uvulopalatopharyngoplasty (UP3) in selected patients

	ZPP (n = 25)	UP3 (n = 25)	Sig. (*P*-value)
Objective success	17 (68.0%)	7 (28.0%)	$P = 0.005$
Subjective improvement	25 (100%)	24 (96%)	NS

Statistical significance accepted when $P < 0.05$.

cept for preoperative AI, other preoperative or all postoperative polysomnogram data did not differ between the 2 groups (Table 5).

Using the classic definition of successful surgical treatment of OSAHS, which requires a 50% or greater reduction in postoperative AHI as compared with the preoperative value and a postoperative AHI of less than 20, we determined the success or failure of ZPP or UP3 in each patient (Table 4). Surgical treatment of OSAHS with ZPP combined with TBRF resulted in successful treatment in 17 (68%) as compared with 7 (28%) success in patients treated with UP3 combined with TBRF.

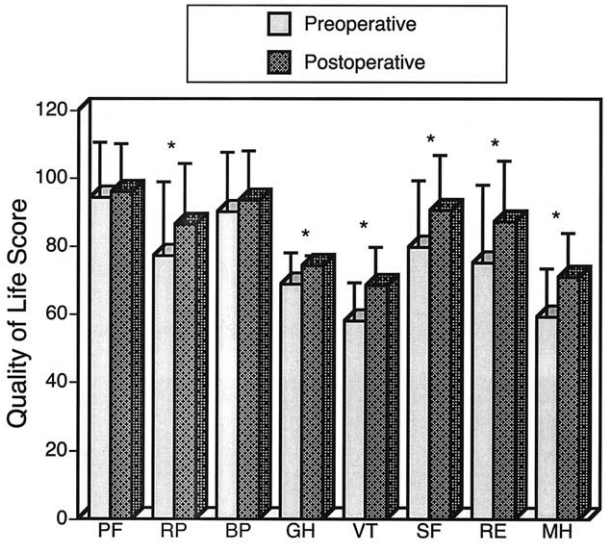

Fig 10. Comparison postoperative vs. preoperative quality-of-life values for each of the 8 SF-36 v2 health domains in 25 patients treated with Z-palatoplasty (ZPP) for the treatment of obstructive sleep apnea/hypopnea syndrome. Statistical significance accepted when $P < .05$. *Denotes significant difference between preoperative and postoperative values. PF = physical function, RP = physical role, BP = bodily pain, GH = general health, VT = vitality/energy, SF = social functioning, RE = emotional role, and MH = mental health. A score of 0-100 is calculated for each domain based on patient responses. A score of 100 represents the best possible health.

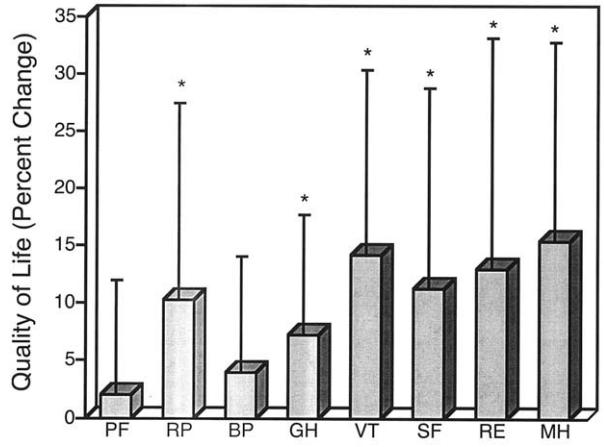

Fig 11. Percent change of postoperative vs. preoperative quality-of-life values for each of the 8 SF-36 v2 health domains in 25 patients treated with Z-palatoplasty (ZPP) for the treatment of obstructive sleep apnea/hypopnea syndrome. A positive mean difference in mean score represents improvement, whereas a negative mean difference in mean score represents deterioration in quality of life. Statistical significance accepted when $P < .05$. *Denotes significant difference between mean preoperative and postoperative scores. PF = physical function, RP = physical role, BP = bodily pain, GH = general health, VT = vitality/energy, SF = social functioning, RE = emotional role, and MH = mental health.

These values were significantly different from each other (Table 4).

DISCUSSION

The value of UP3 as an isolated procedure for treatment of OSAHS has been questioned by many studies because of variable results.[1-3,5,11] Its role as part of a comprehensive treatment plan that includes adjunctive procedures, however, remains solidly accepted in most situations in which the palate is contributing to airway turbulence and obstruction. The goal of this study was to focus only on the palatal component, and keep adjunctive treatment "standard" in both the experimental and control groups. We treated tongue base with radiofrequency reduction, but any other treatment of the hypopharynx could have been used as a "standard" for both groups. Our hypothesis was that by designing a better palatoplasty we could improve subjective and objective results without increasing morbidity.

The goal of UP3 is to widen the airspace in 3 areas: (1) the retropalatal space, (2) the space between tongue base and palate, and (3) the lateral dimensions. The results however often fall short of this goal in all 3 areas. Patients who have had a previous tonsillectomy are the most difficult in whom to achieve a "squared off" wide palatal area with the standard technique. The nature of standard UP3 brings the posterior palatal mucosal forward, narrowing the oropharyngeal inlet at

Table 5. Comparison of polysomnographic data before and after Z-palatoplasty (ZPP) or uvulopalatopharyngoplasty (UP3) in 50 patients treated for sleep apnea/hypopnea syndrome

	ZPP (n = 25)	UP3 (n = 25)	Sig. (*P*-value)
BMI (kg/m^2)			
Preoperative	31.0 ± 3.1	29.6 ± 4.2	NS
Postoperative	31.4 ± 3.5	29.8 ± 4.5	NS
AI			
Preoperative	14.8 ± 18.6	4.6 ± 8.8	P <0.017
Postoperative	3.5 ± 8.2*	2.8 ± 5.4	NS
AHI			
Preoperative	41.8 ± 26.4	33.4 ± 13.9	NS
Postoperative	20.9 ± 19.3*	25.2 ± 16.6*	NS
Min SaO_2 (%)			
Preoperative	81.3 ± 10.6	84.4 ± 8.9	NS
Postoperative	87.8 ± 8.4*	86.6 ± 7.4	NS

BMI, body mass index; *AI*, apnea index; *AHI*, apnea/hypopnea index; *Min SaO_2*, minimum arterial oxygen saturation.
Statistical significance accepted when $P < 0.05$.
*Statistical significance from the preoperative value.

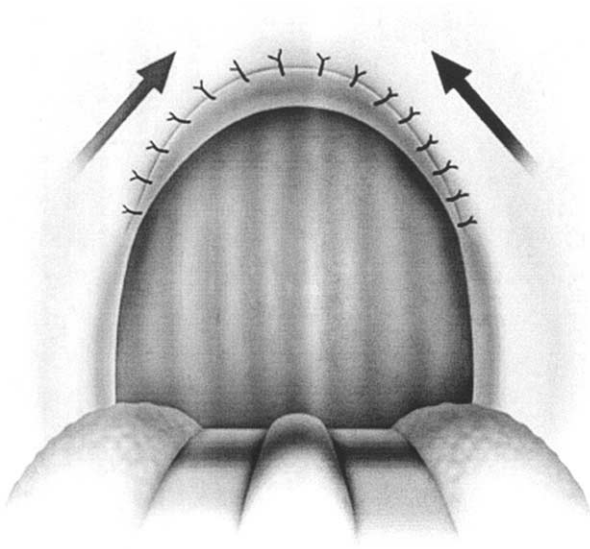

Fig 12. Traditional uvulopalatopharyngoplasty. The direction of pull is anteromedial, eventually narrowing the retropharyngeal airway in the midline.

the level of the new free edge of the palate with a resulting triangular shape of the palate rather than the originally desired "squared shape." As further contraction occurs, additional narrowing further adversely affects long-term results (Fig 12). The Z-palatoplasty technique changes the direction of contracture from superior-medial to superior-lateral (Fig 12).

Our experience shows that patients without tonsils having OSAHS are found to be poor candidates for UP3. It may be because of the damage caused to the posterior pillar by previous tonsillectomies, which resulted in scarring and thereby pulling the soft palate toward the posterior pharyngeal wall and thus, often do not have redundant pharyngeal folds. The "pharyngoplasty" component of UP3 is designed to increase pharyngeal space by first removing hypertrophied tonsils and secondly by eliminating redundant pharyngeal folds. Including a pharyngeal component for these patients usually only adds morbidity without any benefit. Most surgeons already limit surgery on these patients to a uvulopalatoplasty and eliminate the "pharyngeal" component. Fairbanks[14] has contributed significantly to improved results by recommending that the posterior tonsillar pillar be advanced lateral cephalad. When patients have had previous tonsillectomy with resection or scarring of the posterior tonsillar pillar, this important step is not possible.

Various modifications of the UP3 have been previously proposed.[7-9] The reversible uvulopalatal flap described by Powell et al[8] and its modification, the uvulopalatal flap,[8] involve reflecting back the uvula back toward the soft–hard palate junction. First, a portion of the tip of the uvula is amputated to remove the excess mucosa and expose muscle. The mucosa over the uvula and some of the soft palate are removed with a scalpel. Finally, the uvula is reflected back toward the soft palate and sutured. This procedure was designed to treat snoring while minimizing the possible risk for VPI. It was not specifically designed as a treatment for OSAHS. The concept, however, of preservation of the palate and using it as a flap was the basis of our modified technique.

A thorough review of the international literature identified an article by Mauro B. M. Vieira et al[7] entitled Zetapalatoplasty. The technique describes a form of Z-plasty that requires intact anterior and posterior pillars and is meant for patients with intact tonsils. In this modified technique, tonsillectomy is first performed, followed by a lateral posterior incision made on the soft palate from the superior point of the tonsil site to create a triangular flap. A second incision is made on the middle part of posterior tonsillar pillar directed upward and medially, creating a superomedial-based triangular flap. The tip of the superomedial-based flap is then pulled and sutured on the soft palate incision. The same procedure is repeated on the other side. Finally, subtotal uvulectomy is done. The procedure was designed mainly to prevent VPI following classical UP3. Because the tonsillar pillars are often partially sacrificed in previous tonsillectomies, this technique was not suitable for our group of patients. This article was identified after completion of our series. The principle of changing the direction scar contracture by Z-plasty is similar to our concept. Our procedure, however, is far more aggressive and is designed for maximal improvement.

Fairbanks,[14] in his extensive study of UP3 reported that the palatal incompetence was attributed to excessive resection of the palate, particularly in the midline. Palatal closure depends on the central mounding action of the musculus uvulae and on the lifting action of the levator palati muscles, which course from the eustachian tube downward (posteriorly) and medially to enter diagonally in the midline. Hence, our procedure was modified in such a way that all muscles are preserved and distortion of midline tissue is minimized.

In our modified technique, the midline of the soft palate is retracted anterolaterally, which results in a widened retropalatal area. The uvula is split in midline and sutured laterally along with the adjacent soft palate, thereby creating an effective anterolateral pull on the soft palate and thus widening the retropalatal area. Additionally, because the muscles of soft palate are preserved, risks of complications such as permanent VPI are minimized. This is crucial because the technique results in a more anterior position of the palate

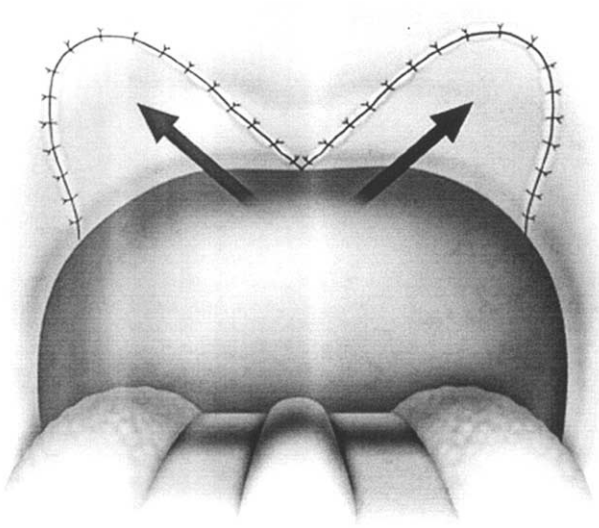

Fig 13. Z-palatoplasty. Note the anterolateral direction of pull on the soft palate that widens the retropharyngeal space.

and VPI is a major concern. Our modified technique results in a dramatically improved postoperative appearance of the pharynx. The anteroposterior and lateral space is significantly larger than comparable areas with the classic UP3. The line of healing and contracture is anterolateral (an oblique vector with some vertical but predominantly horizontal components), so that long-term healing and contracture will continue to widen the airway rather than narrow it, as can occur with the classical UP3 (Figs 12 and 13).

We measured the results of surgical treatment by categorizing patients according to subjective and objective improvement. The subjective success was based on comparative improvement on snoring level, Epworth Sleepiness Scale, and quality-of-life questionnaires, pre- and postoperatively in each group. Previously, we have shown that UP3 with adjunctive TBRF has excellent subjective results.[5] Thus, it is not surprising that ZPP treatment with adjunctive TBRF could not improve on these results. Our results were excellent for improving snoring and qualty-of-life data. Many of our patients, however, did not improve when ESS was used as a guide. We suspect that many of these patients were seeking relief from snoring, and were unaware of daytime somnolence. Their preoperative ESS scores were therefore relatively low. The assessment (ESS) is based on subjective information and is subject to the patient's awareness of his or her daytime function and his or her willingness to identify problems. If the preoperative score is low, it is not surprising that a postoperative score will show no improvement. This is reflected in relatively low percent changes in ESS in both groups (Fig 9). However, when objective success was examined, our modified ZPP technique showed considerable improvement over classical UP3. Objective success was based on improvement in postoperative versus preoperative polysomnograms. Seventeen of 25 (68%) of ZPP patients were classified as clinically successful based on a minimum 50% reduction in AHI and a postoperative AHI of less than 20. The UP3 group had a success rate of 28% that is consistent with previous studies (Table 4).[5]

The modified ZPP technique also resulted in significantly less postoperative morbidity as compared to UP3. Modified ZPP patients used pain medications for fewer days (6.4 $\pm$ 3.6) and required fewer days to return to normal diet (6.4 $\pm$ 1.9) than those patients treated with UP3 (9.4 $\pm$ 2.7 and 10.3 $\pm$ 3.6 days, respectively). This may be explained by the fact that the palatal mucosa was only partially excised, sparing the musculature and no pharyngeal muscle was exposed.

The options available for evaluating quality of life in patients with OSAHS include disease-specific tools, such as the Calgary Sleep Apnea Quality of Life Index (SAQLI), and generic tools, such as the SF-36 v2. Lacasse et al[15] demonstrated that although the SAQLI has strong content and construct validity and is more responsive to changes in quality of life than the SF-36 v2, it must be administered by an interviewer, is time-consuming, and demonstrates redundancy. We have found the SF-36 v2 Health Survey to be a reliable survey that is shorter, generic self-completed questionnaire with well-documented validity and has been previously used in patients with OSAHS.[16-18]

The SF-36 v2 is designed to evaluate patients' quality of life in 8 domains of health. Using a scale of 0 to 100, patients with high scores in a particular domain have a better quality of life in that domain. The SF-36 v2 is designed so that raw scores can be used in isolation and/or be compared to national norms.[19] In our study, we used the raw scores alone, because each patient was compared pre- and postoperatively against him or herself. Using the raw data to compute scores in each of the 8 domains, we were able to compare quality of life preoperatively and postoperatively (in each of the 8 domains) within the experimental group. Because the control group was taken from the charts retrospectively, we were unable to compare between the 2 groups

The experimental group showed a significant degree of improvement in the postoperative quality of life. Specifically, patients reported greater improvement in VT (vitality/energy), which correlates with the improvement in snoring and OSAHS. The improvement in SF (social functioning) correlates with their ability to sleep well with their bed partners. Both these factors indirectly led to an improvement on the emotional and

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psychological well-being as shown by the improvement in RE (role emotional) and MH (psychological distress and psychological well-being).

The modified technique however suffers from many limitations. It is a more aggressive change of the palate, despite the fact that only mucosa is removed. Preservation of the palatal musculature probably contributes to the absence of permanent VPI in our patients. It does not mean, however, that the procedure is reversible if VPI should occur. The more aggressive treatment clearly resulted in a higher incidence of temporary VPI in our study group.

A very significant limitation is the absence of any clear landmark to describe the size of the flaps. The extent of mucosal removal at the midline is half way between the hard palate and the limit or resection in a classical UP3. The lateral component of the flap extends further back and all the way laterally as illustrated. These are guidelines and the technique clearly requires operator judgment. The procedure is technically more difficult and takes longer than the classic UP3. This technique, like the classical one, results in the absence of a uvula and many patients complain of a "foreign body" sensation in the throat.

This study also suffers from limitations. It is a relatively small group with short follow-up. It is extremely difficult to obtain postoperative polysomnograms on successfully treated patients. The longer the time interval from surgery, the more difficult that tasks becomes. Therefore, the 6-month cutoff was used as a compromise to be able to capture a reasonable sample of patients. After 6 months, usually only the patients whose treatment failed are willing to undergo additional testing. Although some of the patients may ultimately relapse, the study was designed to compare two procedures both at 6 months. It clearly shows the benefit of the modified technique.

Finally, an ideal study would have been entirely prospective and randomized. After the initial pilot studies with the technique, however, it became obvious that it was far superior to the classical technique. It was therefore felt it was wrong to design a study that would not allow half of our patients to benefit from the improved technique.

CONCLUSIONS

Obviously, no single procedure would be effective in treating all OSAHS patients. Treatment should to be tailored according to the anatomy of each patient, as demonstrated in the present study. We conclude that rerouting the uvula and soft palate laterally can more effectively enlarge the retropharyngeal space and improve the airway characteristics as compared with the traditional UP3. Our modification appears effective (both subjectively and objectively) in treating the palatal level obstruction in OSAHS patients without tonsils. We suggest that Z-palatoplasty might serve as a potential alternative to the traditional UP3 in treating the palatal level obstruction in patients without tonsils. As with any new procedure, a learning curve will lead to improved results. Additional studies are needed to examine the efficacy of Z-palatoplasty in the treatment of patients with tonsils.

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