Sleep, 19(7):593–599

Short Report: Surgical Technique

A Reversible Uvulopalatal Flap for Snoring and Sleep Apnea Syndrome

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Summary: Velopharyngeal incompetence (VPI) is a recognized complication of uvulopalatopharyngoplasty (UPPP) for obstructive sleep apnea. A new uvulopalatal flap (UPF) technique that modifies the UPPP and reduces this risk is presented. The technique achieves the same anatomic results as the UPPP but is reversible. To evaluate clinical outcomes of this new procedure, selected variables were compared in patients who underwent UPPP and UPF procedures. Eighty patients were examined (59/80 UPF, 21/80 UPPP) in a prospective and consecutive manner. Subjects underwent polysomnography and extensive airway evaluations. The characteristics of all patients, at baseline, were evaluated. The study variables included age, sex, body mass index (BMI), palatal length (PNS-P) in millimeters, respiratory disturbance index (RDI), lowest oxygen saturation during sleep and a subjective snoring scale. Sixty-seven of the 80 patients underwent simultaneous hypopharyngeal surgery. Data were analyzed with a SAS program. No statistical difference existed between groups. The postoperative character of the palate and the change in snoring scores were the same in all patients ($p = 0.584$). A positive correlation existed between improvement in the snoring score and the amount of tissue removed or repositioned in the patients treated with UPF (correlation coefficient = 0.370, $p = 0.004$). In contrast, there was a negative correlation in the UPPP group for the same parameters (correlation coefficient = −0.195, $P = 0.409$). This suggests there was a difference between these two groups despite the fact that the baseline and postoperative lengths, as well as tissue removed or repositioned, were equivalent. This further suggests that the UPF may reduce snoring to a greater extent than the UPPP. No significant complications were seen in either group. There was no evidence of VPI, even in the early postoperative period. The new reported procedure is reversible and conservative and reduces the risk of VPI. Snoring is improved, which is consistent with a decrease in airway resistance or obstruction. **Key Words:** Uvulopalatopharyngoplasty (UPPP)—Uvulopalatal flap (UPF)—Velopharyngeal insufficiency (VPI)—Inferior sagittal osteotomy (ISO)—Hyoid myotomy and suspension (H).

It is well known that the treatment of palatal level obstruction in the obstructive sleep apnea syndrome (OSAS) by uvulopalatopharyngoplasty (UPPP) involves specific risks. These risks include pain, dysphagia, bleeding, dehiscence, scarring, and altered palatal function. Loss of complete palatal closure may result in voice changes and nasal regurgitation of fluid or food. This problem is caused by excessive surgical removal of the palatal tissues and is termed velopharyngeal incompetence (VPI). The severity of this VPI complication led to the development of a new surgical technique designed to minimize this risk.

Accepted for publication June 1996.
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Background

The traditional UPPP first described by Ikematsu (1) and then by Fujita et al. (2) has become the mainstay of surgical treatment in patients with snoring or OSAS. The procedure has varied results depending on whether other regions, which were not treated, continue to cause obstruction. However, this surgical procedure remains an excellent modality for treating specific anatomic obstruction at the palatal level.

Any surgery at the palatal level, with or without tonsillectomy, creates marked discomfort, pain, occasional bleeding, infection, and the risk of stenosis. Even more onerous and problematic is VPI from excessive tissue removal (3). The common goal of successful treatment, regardless of the technique used, is to achieve a wider airway without the consequences

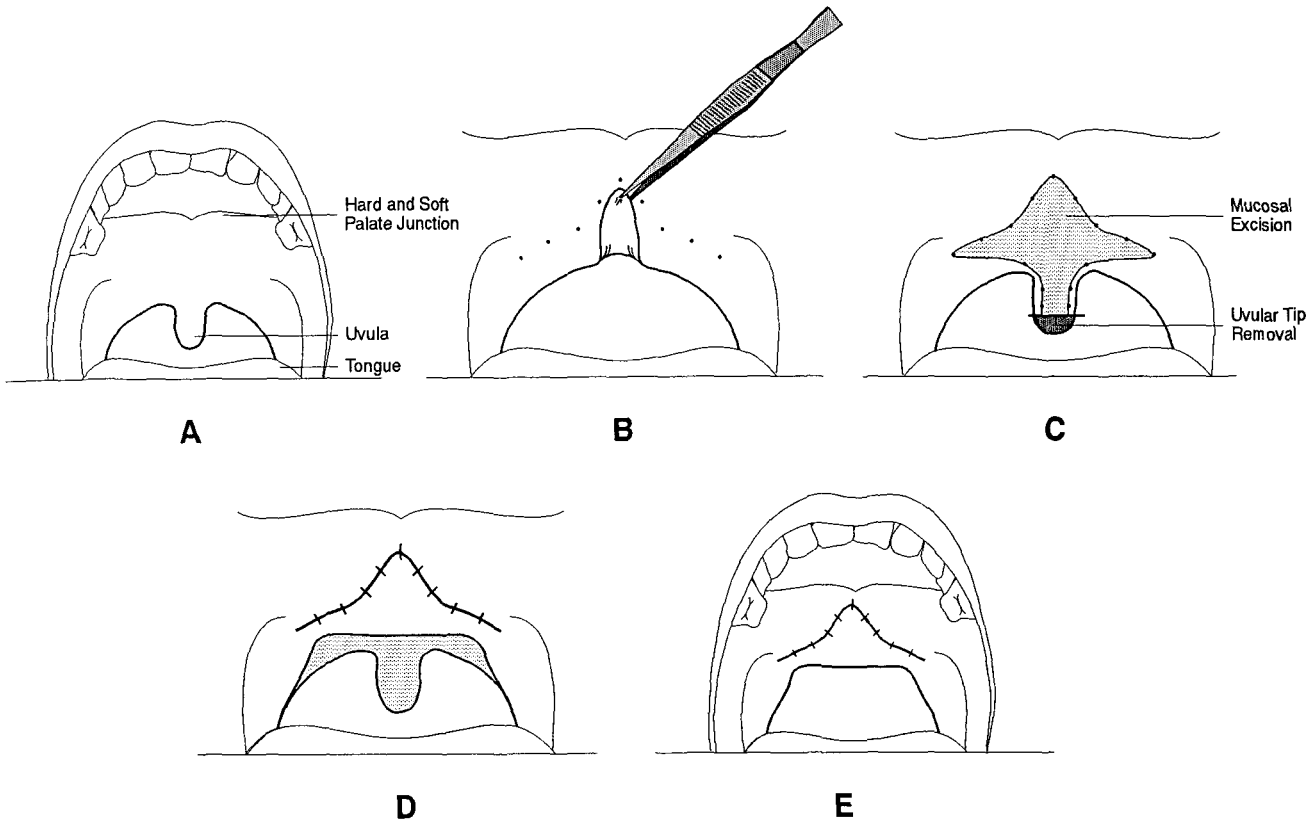

FIG. 1. Techniques used for UPF surgery (see text).

of excessive tissue removal. Hence, a procedure that would reduce the risks of VPI while still achieving the same anatomic results as seen with the traditional UPPP was developed.

To achieve this goal, a technique was devised utilizing the uvular muscle along with minimal resection of soft palatal tissues. It was speculated that the uvular muscle may play a role in palatal dynamics, similar to that of the levator palati muscle, in that it appears to raise the uvula and lift the midpalatal edge during swallowing and breathing (4). The uvular muscle retracts toward its origin, the posterior nasal spine and palatine aponeurosis. If the uvular tip could be repositioned and stabilized toward the hard palate, the retraction of this muscle against this anchored position might further assist in keeping the midpalate region open during breathing. To gain the same postoperative anatomic configuration of the palate as with a traditional UPPP, an advancement of the lateral free edges of the soft palate was combined with a conservative palatal mucosal resection and uvular advancement. This is described as a uvulopalatal flap (UPF) or "flap" procedure.

Technique used for UPF surgery

The patient is positioned for adequate exposure (Fig. 1A). The uvula is grasped with a toothed forcep and reflected back toward the soft–hard palate junction. The opening into the nasopharynx is examined and the uvula retracted sufficiently to allow this reflection to reveal a crease between the mucosa of the palatal edge and corresponding muscle. This same crease identifies the extent of resection at the base of the uvula in a routine UPPP. Further pulling will only indent the palatal edge on either side of the uvula. If further advancement is desired, a releasing incision can be made at the apex of the anterior pillars, both right and left. This is seldom necessary because the palatal mucosal flap design will assist in elevating the entire segment along its leading edge and laterally to the apex of the anterior pillars.

An outline of the uvular flap is made on the palatal mucosa with a pinpoint bovie. This outline will identify the uvula's final position once it is retracted and the flap is sutured (Fig. 1B). As needed, the outline is carried out laterally, in a flair, to accommodate the lateral palatal advancement. None of the lines of incision is brought onto or near the edge of the palate. Also, it is best to avoid connecting this incision with those created by removal of redundant lateral pharyngeal tissues or tonsils. A portion of the tip of the uvula is amputated to remove the excess mucosa and thus expose muscle. The mucosa is then carefully removed inside this outline with a scalpel (Fig. 1C). This allows

the surgeon to reflect the uvula forward, covering the denuded area with the mucosa of the soft palate edge and the nasopharyngeal side of the uvular muscle and mucosa. A half-buried mattress suture is used, starting and ending at the junction of the hard and soft palate and passing through the tip of the uvular muscle. With this suture placement, tension can be varied to allow adjustment in elevating the soft palate edge. The remaining mucosa edges are then sutured. Trimming adjustments are made to the mucosa on the lateral palate or uvular mucosa during suturing. Figure 1D illustrates the trimmed and sutured flap. The shaded area indicates the location of the tissue before it is repositioned. Figure 1E depicts the completed surgical procedure.

Should the patient experience voice changes, or other VPI symptoms such as nasal reflux, this flap is reversible and can be taken down if not yet completely healed. Because only mucosa and a small amount of uvular muscle have been removed, the area will remucosalize rapidly with little or no deformity. In the early postoperative stage, a fullness may persist at the site that will flatten as it heals. In addition, the mucosa is pink in color because it came from the nasopharyngeal side. After healing, it will be difficult to distinguish this technique from the UPPP in appearance except for the color. It should be the surgeon's preference as to which procedure is done first during surgery, with respect to tonsillectomy or lateral tissue removal. We prefer to outline the flap, do the tonsillar area, and then finish the flap.

Anatomical contraindications

This flap design can be used in most palatal surgeries with the following exceptions. In patients with excessively thick palates, the doubling over of the muscular uvula may interfere with palatal function and occasionally create a foreign body sensation at the site of surgery. Additionally, the very long and/or redundant palate or lateral pharyngeal mucosa may be difficult to advance without involving most of the soft palate and creating the possibility of connecting the lateral wall incision line with that of the UPF. Therefore, we avoid the use of this flap procedure in this group of patients.

METHODS

A modification of a well-established surgery (UPPP) was investigated utilizing a new flap technique as opposed to removal of these tissues. No attempt was made to modify the tonsillar portion of the UPPP. When indicated in our group of patients, the removal of tonsils or lateral redundancy was accomplished in the traditional manner. This technique does not deviate significantly from previously accepted UPPP surgeries other than in its more conservative and reversible approach. The study was prospective and included 80 consecutive patients. The UPF procedure was not used with any patient who presented with one of the following clinical findings: an excessively long and/or bulky soft palate/uvula and/or markedly redundant lateral pharyngeal wall mucosa. Those who were excluded from treatment with the UPF procedure were treated with the traditional UPPP. The patients in this smaller UPPP group were compared with those who underwent the UPF.

All patients had clinical evaluations, and lateral cephalometric head films were used to document the length of the palate by measurements (in mm) of posterior nasal spine to palate (PNS-P) pre- and postoperatively. All patients underwent fiberoptic nasopharyngoscopy to confirm and evaluate anatomic airway characteristics. Pre- and postoperative weights were attained and nocturnal polysomnography was performed in all subjects to document the presence of OSAS and objective changes in polygraphic variables. A simple snoring scale was also used, with grading from 0 to 10. Zero to 3 was classified as mild, 4–7 as moderate and 8–10 as severe. Zero was considered to be no snoring at all, 1–3 was soft snoring that did not interrupt the bed partner's sleep (social snoring), 4–7 was loud enough to be bothersome to the partner, and 8–10 was very intense snoring that was annoying to anyone near. The bed partner of all subjects, when available, was used to help establish this scale. Ten was used when the bed partner moved out of the bedroom or avoided sleeping near the patient.

Most patients (67/80) in this study also underwent hypopharyngeal surgery, as outlined in our protocol for phase I upper airway reconstruction (5,6,7). Patients were followed weekly for the first 2 weeks, then the time interval was individually adjusted. The last follow-up visit was used to determine snoring levels and complications. Snoring was evaluated during brief periods of noncompliance for those patients using continuous positive airway pressure (CPAP). All patients were evaluated, as mentioned, with polysomnography to establish phase I clinical outcomes. This aspect of follow-up was not included in this report because multiple procedures were performed.

Reports of excessive daytime somnolence (EDS) and pain were not included in this study because the use of CPAP perioperatively in most patients substantially masked or altered both of these subjective characteristics. All complications were carefully documented.

TABLE 1. *Baseline characteristics*

Variable	All patients (n = 80)	UPPP group (n = 21)	Flap group (n = 59)	p-value[a]	Statistical test
Age	45.0 ± 11.8	47.2 ± 12.5	44.3 ± 11.6	0.338	*t* test
Male gender	67/80 = 83.8%	49/59 = 83.1%	18/21 = 85.7%	0.776	χ^2
BMI	30.6 ± 6.4	31.7 ± 7.8	30.2 ± 5.9	0.364	*t* test
Palate length (mm)	46.6 ± 4.8	47.5 ± 5.2	46.3 ± 4.6	0.333	*t* test
Snoring score	7.8 ± 1.6	8.1 ± 1.5	7.7 ± 1.7	0.331	*t* test
Min oxygen saturation	83.6 ± 9.4	83.9 ± 9.9	83.5 ± 9.4	0.880	*t* test
RDI	30.5 ± 28.5	35.7 ± 32.0	28.7 ± 27.3	0.400	Wilcoxon's

Abbreviations used: BMI, body mass index (kg/m²); Min oxygen saturation, lowest oxygen saturation during nocturnal polysomnography (%); RDI, respiratory disturbance index (number of apnea and hypopneas per hour of sleep).

[a] Compares UPPP group with Flap group. Based on χ^2 for gender and *t* test for all other variables except Wilcoxon's test used for the RDI comparison because of skewed data.

Statistical analysis

Data were analyzed using the SAS computer program (8), and results are presented as mean ± standard deviation. We used *t*-tests for between-group comparisons of continuous variables. Wilcoxon's rank sign test was used as an alternative when the data were skewed or when the equal variance assumption of the *t*-test was violated. Chi square tests provided between-group comparisons of categorical variables. Analyses of covariance were used to see if key relationships existed after adjusting for important covariates. Also, the interaction term in another analysis of covariance provided a test of the hypothesis that the relationship between the improvement in snoring score and the amount of tissue removed or repositioned was the same in the UPPP and the Flap groups.

RESULTS

Table 1 contains baseline characteristics of all patients, together and separately, by procedure. Patients were 45.0 ± 11.8 years old and were 83.8% male. There were no significant differences between groups and no trends toward a difference in any of the baseline variables contained in Table 1.

Table 2 presents postsurgery data, along with changes over time in snoring score and in body mass index (BMI; expressed as kg/m²) for all patients. Data are also presented separately for the UPPP and Flap groups. The decrease in snoring score in the UPPP group was not different from the decrease reported in the Flap group (p = 0.584). Changes in BMI, the rate at which tonsils were removed, and the use of postsurgery CPAP were also similar in the two groups. However, there was a highly significant between-group difference (p = 0.005) by χ^2 test in the patterns of use of additional procedures, with the difference reflecting the much greater use of inferior sagittal osteotomy–hyoid myotomy and suspension (ISO-H) in the Flap group (50.8% vs. 14.3%) and the less frequent use of ISO alone in this same group (39.0% vs. 52.4%). Also, Wilcoxon's test (used because of unequal standard deviations) showed that follow-up du-

TABLE 2. *Postsurgery data and changes over time*

Variable	All patients (n = 80)	UPPP group (n = 21)	Flap group (n = 59)	p-value
Change in snoring score	−5.1 ± 2.4	−5.3 ± 2.4	−5.0 ± 2.4	0.584[a]
Change in BMI	−0.67 ± 1.22	30.8 ± 7.6	29.6 ± 5.7	0.446[a]
Weeks of follow-up	13.0 ± 8.4	9.0 ± 4.8	14.5 ± 8.9	0.010[b]
Amount of tissue removed	9.8 ± 2.3	10.5 ± 2.8	9.5 ± 2.1	0.058[b]
Tonsils removed	39/80 = 48.8%	11/21 = 52.4%	28/59 = 47.5%	0.698[c]
Postsurgery CPAP	51/80 = 63.8%	12/21 = 57.1%	39/59 = 66.1%	0.463[c]
Additional procedures				
ISO	n = 34 (42.5%)	n = 11 (52.4%)	n = 23 (39.0%)	
ISO-H	n = 33 (41.3%)	n = 3 (14.3%)	n = 30 (50.8%)	0.005[d]
Other	n = 3 (3.8%)	n = 2 (9.5%)	n = 1 (1.7%)	
None	n = 10 (12.5%)	n = 5 (23.8%)	n = 5 (8.5%)	

[a] *t* test. Note that because follow-up time and the amount of tissue removed were different in the two groups, the "between-group" comparison of the change in the snoring score (the key outcome measure) was evaluated by analysis of covariance, which was adjusted for follow-up time and amount of tissue that was removed. The nonsignificant result (p = 0.946) means that if follow-up times and the amount of tissue removed were identical, we would still expect the change in snoring scores to be essentially the same in the two groups.

[b] Wilcoxon's rank sign test results.

[c] χ^2. Based on χ^2 test.

[d] χ^2. Note patients in the "no surgery" and the "other" categories are collapsed into a single group.

TABLE 3. *Within-group associations with baseline snoring score and with pre- to postsurgery changes in snoring score*

Variable	UPPP (n = 21)		Flap (n = 59)	
	Baseline snoring score	Improvement in snoring score	Baseline snoring score	Improvement in snoring score
Age	Corr = 0.075	Corr = −0.296	Corr = −0.114	Corr = 0.082
	ns (p = 0.748)	ns (p = 0.192)	ns (p = 0.390)	ns (p = 0.539)
Gender	8.2 ± 1.5	5.2 ± 2.5	7.7 ± 1.7	5.0 ± 2.4
Male	7.3 ± 1.2	6.3 ± 1.5	7.8 ± 1.4	5.1 ± 2.3
Female	ns (p = 0.213)	ns (p = 0.475)	ns (p = 0.828)	ns (p = 0.886)
Baseline BMI	Corr = 0.279	Corr = 0.080	Corr = 0.275	Corr = 0.087
	ns (p = 0.221)	ns (p = 0.732)	p = 0.035	ns (p = 0.512)
Baseline minimum oxygen saturation	Corr = −0.331	Corr = 0.236	Corr = −0.028	Corr = 0.099
	ns (p = 0.143)	ns (p = 0.303)	ns (p = 0.736)	ns (p = 0.455)
Baseline RDI	Corr = 0.252	Corr = −0.322	Corr = 0.178	Corr = 0.174
	ns (p = 0.272)	ns (p = 0.155)	ns (p = 0.178)	ns (p = 0.188)
Decrease in BMI	Corr = 0.066	Corr = −0.028	Corr = −0.022	Corr = −0.126
	ns (p = 0.776)	ns (p = 0.905)	ns (p = 0.868)	ns (p = 0.340)
Weeks of follow-up	Corr = 0.141	Corr = −0.194	Corr = 0.045	Corr = 0.102
	ns (p = 0.543)	ns (p = 0.401)	ns (p = 0.736)	ns (p = 0.444)
Amount of tissue removed	Corr = 0.061	Corr = −0.195	Corr = 0.276	Corr = 0.370
	ns (p = 0.798)	ns (p = 0.409)	p = 0.035	p = 0.004
Tonsils removed	7.9 ± 1.8	4.4 ± 2.8	7.7 ± 1.5	5.0 ± 1.6
Yes	8.3 ± 1.1	6.4 ± 1.3	7.7 ± 1.8	5.0 ± 2.9
No	ns (p = 0.559)	p = 0.053	ns (p = 0.933)	ns (p = 0.717)
Postop CPAP	8.5 ± 1.6	4.7 ± 2.8	7.8 ± 1.6	4.9 ± 2.4
Yes	7.5 ± 1.1	6.1 ± 1.6	7.4 ± 1.7	5.1 ± 2.5
No	ns (p = 0.153)	ns (p = 0.219)	ns (p = 0.331)	ns (p = 0.733)
Additional procedures	7.5 ± 1.7	4.8 ± 2.2	8.2 ± 1.4	5.0 ± 2.4
ISO	8.3 ± 1.2	5.7 ± 1.2	7.2 ± 1.8	4.7 ± 2.4
ISO-H	8.9 ± 0.9	6.0 ± 3.1	8.2 ± 1.6	6.3 ± 2.3
Other	ns (p = 0.202)	ns (p = 0.426)	p = 0.091	ns (p = 0.330)

Corr, correlation coefficient.

ration was significantly greater in the Flap group than in the UPPP group (p = 0.010), whereas the amount of tissue removed (in millimeters) was of borderline significance by Wilcoxon's test in the UPPP group (p = 0.058).

Table 3 summarizes the results of within-group associations. Thus, within both the UPPP and Flap groups, the table demonstrates the association between the baseline snoring score and a set of baseline variables, postoperative variables, and variables that measure change. Similar data are also presented using the improvement in the snoring score rather than the baseline score. Results in the left half of Table 3 indicate that, among UPPP patients, none of the associations with the baseline snoring score was statistically significant. When we evaluated associations with the improvement in snoring score among UPPP patients, the Wilcoxon's test indicated a trend (p = 0.053), suggesting that the improvement in snoring score was less in the 11 subjects who had their tonsils removed (4.4 ± 2.8) than in the 10 subjects who did not have their tonsils removed (6.4 ± 1.3). Note that this result should be interpreted cautiously because the decision to remove the tonsils was not random, so the tonsil patients may have had characteristics that would mitigate against an improvement in snoring. Note also that, because of the small number of UPPP patients and the associated limitations on statistical power, the nonsignificant results in Table 3 should not be interpreted to mean that relationships do not exist. For example, the correlation of −0.322 between baseline respiratory disturbance index (RDI) and the improvement in snoring score is a reasonably substantial correlation, which indicates that a high baseline RDI may be associated with less improvement in the snoring score of UPPP patients. But because of the small sample size, the p-value is a nonsignificant 0.155, so no conclusion can be reached. If the sample size is doubled, statistical power is increased, and the same correlation coefficient turns out to be significant.

The right half of Table 3 repeats the analysis on the left side using the Flap patients. Results indicate that the baseline snoring score was positively and significantly associated with both baseline BMI (correlation coefficient = 0.275, p = 0.035) and the amount of tissue that was removed/repositioned (correlation coefficient = 0.276, p = 0.035). Thus, Flap patients with a high baseline snoring score tend to be obese and tend to have a lot of tissue repositioned. Also, the improvement in the snoring score was significantly and positively associated with the repositioning of increased amounts of tissue (correlation coefficient = 0.370, p = 0.004). There is another inter-

esting feature shown in Table 3: the correlation between the improvement in the snoring score and the amount of tissue repositioned/removed was positive in the Flap patients (0.370) and negative in the UPPP patients (−0.195). To address the possibility that these correlations may be significantly different, an analysis of covariance with the change in the snoring score as the dependent variable was performed. The result was a statistically significant interaction between the procedure performed (UPPP or FLAP) and the amount of tissue removed ($p = 0.014$). This suggests that the relationship between improved snoring and tissue removal/repositioning is different in UPPP and Flap patients.

Complications

Complications were confined to minor bleeding (two), wound separation (one), superficial infections (one) and a transient band sensation (one). Postoperative bleeding was limited to the resected tonsil sites and was seen in one patient from each procedure group. Both patients required admission for management, and neither had further bleeding. One partial wound separation, which resolved spontaneously, was seen in the lateral portion of a UPF site. One patient complained of a bandlike sensation at the palate edge after UPF, which totally resolved in the follow-up period.

The most heuristic complication was seen in one patient at the UPF site. This was in a 49 year old male with ankylosing spondylitis for whom withdrawal of antiinflammatory medications was medically contraindicated. He was treated with an isolated UPF. Over 48 hours, he developed a hematoma at the tip of the flap that was too small to aspirate. It showed signs of infection at 8 days even though the patient was on oral antibiotics. At 10 days, the flap totally unraveled and came down. Local wound care and continued oral antibiotics for one additional week resolved the infection. At 4 weeks postsurgery, the mucosa had regenerated, and only a minor shortening of the uvula was noted. After 12 weeks of healing, the procedure was redone without difficulty, and the patient is now fully healed.

DISCUSSION

The UPF is designed to minimize the possible risk for VPI. When it is fully healed, the Flap is anatomically and clinically equivalent to the traditional UPPP. Although not fully explored in this study, the UPF is expected to achieve clinical outcomes equivalent to those of the original UPPP or the many other modifications that have been reported previously reported (9). Postoperative snoring determined by subjective measurement is similar in both groups. A positive correlation between improved snoring and the repositioned tissue (correlation coefficient = 0.370, $p = 0.004$) is evident in the UPF group. This is in contrast to a negative correlation in the UPPP group (correlation coefficient = −0.195, $p = 0.409$). In examination of the pre- and postoperative palatal length ($p = 0.333$; Table 1) and the amount of tissue removed or repositioned ($p = 0.058$; Table 2), there is little significant difference. This may suggest that the repositioning and stabilization of the uvular muscle may be responsible for a wider opening and hence less snoring than is seen in the UPPP group.

The potential advantages of UPF are as follow. This technique can be done as an outpatient procedure for simple snoring. It may also be considered as a single-step office procedure for snoring in those patients who have been objectively studied to rule out OSAS. This is in direct contrast to the laser-assisted uvulopalatopharyngoplasty (LAUP) technique, which requires multiple office procedures (10) to achieve results similar to the UPPP. There was no evidence of VPI (reflux or voice changes) even in the early postoperative period in the UPF procedure. In contrast, early transient VPI is frequently seen with the traditional UPPP. The reversible nature of the UPF technique will also give a sense of confidence to those who are concerned with VPI. This may be especially important to those who depend on their voice character. Other advantages may include reduced pain and a decreased risk of contracture because sutures are not placed on the free edge of the palate.

The disadvantages of the UPF technique include a slightly longer operating time because meticulous hemostasis and closure are required. It is also not appropriate for all patients, as discussed previously. To further assess the questions of pain, bleeding, infection, stenosis, and reduction of disordered breathing, additional long-term studies are needed. As with any new or modified procedure, prudent choices in patient selection and a conservative surgical approach are recommended.

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APPENDIX: DEFINITIONS OF TERMINOLOGY USED

Uvulopalatopharyngoplasty (UPPP): removal of soft tissue from the palate and/or lateral pharyngeal wall.

Uvulopalatal flap (UPF): repositioning of palatal soft tissue that does not include the lateral pharyngeal wall.

Velopharyngeal insufficiency (VPI): loss of complete palatal closure causing voice changes and/or nasal regurgitation of fluids or food.

Inferior sagittal osteotomy (ISO): an osteotomy of the anterior mandible which includes the attachment of the genioglossus muscle.

Phase I surgery: surgery of the palate and/or base of tongue, dependent on the site of obstruction.