

Staging of Obstructive Sleep Apnea/Hypopnea Syndrome: A Guide to Appropriate Treatment

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Objective: Early studies by Friedman et al. have demonstrated the value of staging obstructive sleep apnea/hypopnea syndrome (OSAHS) patients for the prediction of success for uvulopalatopharyngoplasty (UPPP) on the basis of short-term follow up. The goal of this study is to test the value of this staging system in a prospective study. **Study Design:** This is a prospective study of two cohorts of patients: one was treated with the benefit of a clinical staging system and the other without. **Methods:** Patients with symptoms of OSAHS were assessed by polysomnography and were staged according to a previously described staging system. The staging system is based on palate position, tonsil size, and body mass index (BMI). The control group was treated without the benefit of staging. All patients in the control group were treated with UPPP only. Patients in the experimental group were treated based on their clinical stage. Patients with stage I disease, regardless of the severity of disease, were treated with UPPP only. Selected patients with stage II and stage III disease were treated with UPPP in addition to a staged tongue-base reduction using a radiofrequency technique (TBRF). **Results:** Follow-up at 6 months showed significant improvement compared with a group of patients treated without the benefit of a staging system. Successful treatment of patients with stage II disease improved from 37.9% to 74.0%. The overall success rate improved from 40% to 59.1%. **Conclusion:** Clearly, patients with stage I disease had the best success rate, but a selective protocol based on clinical staging improves the overall success rate. In addition, it can eliminate as surgical candidates those patients with whom the procedure is likely to fail. **Key Words:** Sleep-disordered breathing, uvulopalatopharyngoplasty, palatal surgery, obstructive sleep apnea/hypopnea syndrome.

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INTRODUCTION

Uvulopalatopharyngoplasty (UPPP) remains the most commonly performed surgical procedure as treatment for obstructive sleep apnea/hypopnea syndrome (OSAHS). Many patients are not capable or willing to tolerate continuous positive airway pressure (CPAP) therapy and, therefore, seek surgical correction to alleviate the symptoms and sequelae of the disease. Although curative for many patients, the procedure has an extremely high overall failure rate, causing many to question its validity. The single study by Sher et al.¹ reviewing a meta-analysis of reported UPPP procedures revealed a success rate of only 40%. In an attempt to improve their surgical success rate, many clinicians limited the application of UPPP to patients with mild to moderate disease. Clinical experience, however, has shown that severity of disease cannot be used as a guide to select patients likely to succeed. In fact, Senior et al.² have shown that by using mild disease as a criteria, the success rate remains only 40%. We have shown in previous studies that a staging system based on palate position, tonsil size, and body mass index (BMI) is highly accurate in predicting success or failure of UPPP on the basis of a retrospective study.^{3,4} Stage I patients have an 80% success rate, stage II have a 40% success rate, and stage III patients have only an 8% success rate.⁴



The purpose of the present study was to validate this staging system in a prospective study. A valid staging system should direct treatment to those patients most likely to benefit and, therefore, improve overall success rates for surgical treatment. The subjective and objective results of the prospective group of patients were then compared with similar data collected in a previous study where patients with OSAHS were retrospectively staged after undergoing UPPP as a single corrective procedure.⁴

MATERIALS AND METHODS

Staging System

Earlier studies by Friedman et al.³⁻⁵ proposed a staging system based on three physical findings and unrelated to severity of disease. The staging system is based on Friedman Palate Position score, tonsil size, and BMI (Table I).³ The key points of the system are illustrated in Figures 1 and 2 and Table I. The staging system has been modified, and the number of stages has

TABLE I.
Modified Friedman Staging System for Patients with Obstructive Sleep Apnea/Hypopnea Syndrome.

	Friedman Palate Position	Tonsil Size	BMI
Stage I	1	3, 4	<40
	2	3, 4	<40
Stage II	1, 2	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.

BMI = Body Mass Index.

been expanded from three to four. The need for the expansion became evident once the system was used in a prospective manner because some patients should not be candidates for pharyngeal surgery.

Exclusion Criteria

For this study, 140 patients were selected for combined treatment with UPPP + tongue-base reduction using a radiofrequency technique (TBRF). In theory, most of this group would have been treated by only classical UPPP in the past. Only patients who were willing to actually use CPAP at home for a reasonable trial were considered for surgery. Patients with stage

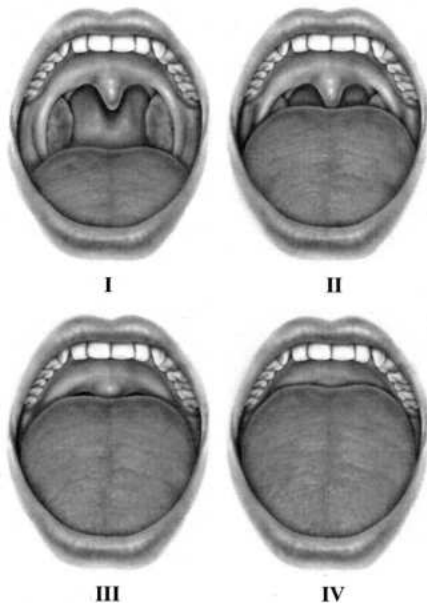


Fig. 1. The Friedman Palate Position is based on visualization of structures in the mouth with the mouth open widely without protrusion of the tongue. Palate grade I allows the observer to visualize the entire uvula and tonsils. Grade II allows visualization of the uvula but not the tonsils. Grade III allows visualization of the soft palate but not the uvula. Grade IV allows visualization of the hard palate only.

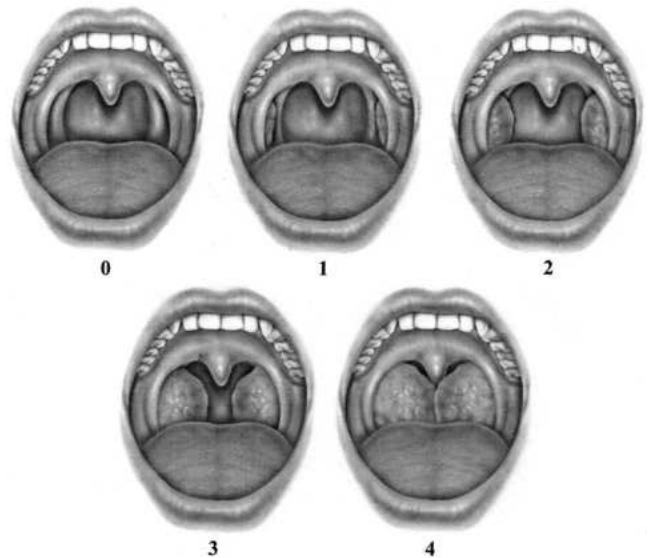


Fig. 2. Tonsil size is graded from 0 to 4. Tonsil size 0 denotes surgically removed tonsils. Size 1 implies tonsils hidden within the pillars. Tonsil size 2 implies the tonsils extending to the pillars. Size 3 tonsils are beyond the pillars but not to the midline. Tonsil size 4 implies tonsils extend to the midline.

I disease were excluded from combined treatment because our earlier study⁴ had demonstrated that UPPP alone offers greater than 80% success for these patients. Therefore, only stage II and stage III patients were included for combined treatment. Some patients with stage II or III disease had thin, small palates and were judged to have neither palatal snoring nor a palatal source of obstruction on classical clinical examination, nasopharyngoscopy, and hypopharyngoscopy with Müller maneuver. Included in this examination was observation of the palate with the patient recreating a snoring sound. These patients consisted of a very small group of patients, and no rigid criteria were created to incorporate them into the staging system. Patients who had previous UPPP were excluded from combined treatment. These patients were treated with TBRF alone. The goal of this staging system was to target those patients who need treatment directed to the tongue base with or without palatal surgery. Stage IV patients were excluded on the basis of two criteria. Exclusion of patients with BMI > 40 kg/m² was based on a clinical sense that these patients cannot be treated with localized enlargement of the airway but must have either bariatric treatment or tracheotomy. The BMI of 40 kg/m² was a somewhat arbitrary limit and has not been studied or proven. Finally, several patients that were defined as having "obvious micrognathia" were excluded. This is not a precise description, but the clinical assessment of the patient should always take precedence over a staging system that offers a broad guideline to treatment. Over the course of the study period, only two to three patients were excluded on the basis of this finding. They were referred to the oral surgeon for mandibular or bimaxillary advancement surgery. Institutional review board approval and informed consents were obtained.

Data Collection

Subjective data were obtained by interviewing the patient and bed partner before and at least 6 months after treatment. Key factors studied were snoring level (visual analogue scale 0–10) and Epworth Sleepiness Scale (ESS). Objective data were preoperative and postoperative (at least 6 months after operation) polysomnographic data. The results of this group were com-

pared with 134 unstaged patients previously treated with UPPP only.

Polysomnography

An all-night attended, comprehensive sleep study was performed using a computerized polygraph to monitor electroencephalogram (C3-A2, C4-A1), left and right electro-oculogram, electrocardiogram, chin and anterior tibialis electromyogram, abdominal and thoracic movement by inductive plethysmograph, nasal oral airflow, oxygen saturation by pulse oximetry (SpO₂), and throat sonogram. Apnea was defined as cessation of breathing for at least 10 seconds. Hypopnea was a decreased effort to breathe at a level at least 50% less than the baseline and with at least a 4% decrease in SpO₂. The apnea-hypopnea index (AHI) was calculated as the sum of total events (apneas and hypopneas) per hour. Polysomnograms were obtained before surgical treatment and repeated postoperatively at the same sleep laboratory and compared with the preoperative studies. Patients whose postoperative polysomnogram indicated less than 6 hours of sleep were not considered to have a complete study and were therefore excluded.

Surgical Technique

UPPP was performed based on a modified technique previously reported.⁶ TBRF was performed using the Somnoplasty System (Gyrus, Inc., Memphis, TN). At the time of UPPP, 1,500 to 4,500 J were delivered to multiple points at the base of the tongue. After completion of the UPPP, the tongue was marked with vertical markings identifying the midline to avoid distortion from an in situ bite block and endotracheal tube. A horizontal mark was used to identify the junction of middle third and base of tongue. A double probe handpiece was used centered in the midline. Each site was treated with 1,500 J delivered to both probes. Two or three sites going as far back from the circumvallate papillae as possible were treated. All patients had nasopharyngeal airways placed for the emergence from anesthesia and kept in place until fully awake and breathing comfortably. Subsequent treatments were performed at 1 month intervals (or longer depending on patient preference). Those treatments were performed under local anesthesia in the outpatient area. A double probe was used to deliver 1,500 J at each treatment. Treatments were continued until symptoms were eliminated and polysomnographic data normalized or until the patient refused further treatments. All patients received postoperative antibiotics and steroids after each treatment.

Statistical Analysis

Student *t* and the Mann-Whitney *U* tests were employed to evaluate significant differences UPPP and UPPP + TBRF treated patients. The paired Student *t* test was used to compare preoperative versus postoperative mean values within each group. The one way analysis of variance (ANOVA) and the Student Newman-Keuls tests were used to compare success rates by stage in patients treated with UPPP only. Statistical significance was accepted when *P* < .05.

RESULTS

A total of 274 patients with OSAHS who had previously failed CPAP treatment and underwent corrective surgical treatment were studied. The charts of 134 patients presenting before June 1, 2000 and treated with UPPP only (*n* = 134) were studied retrospectively, whereas 140 patients presenting after June 1, 2000 allocated to stage II or III and treated with UPPP and TBRF initially and additional treatments of TBRF (up to 6) as

necessary represented the prospective arm of the study. Overall, 247 TBRF treatments were performed (Table II). Demographic data for the two groups including age, sex, Friedman Palate Position,⁴ tonsil size,^{3,4} and BMI by stage is shown in Table III. Subjective improvement of OSAHS symptoms was assessed on the basis of the ESS and the snoring level. We considered the presence of a subjective improvement when both postoperative ESS and snoring level decreased when compared with preoperative levels. The results are illustrated in Table IV. Subjective data on the severity of symptoms was not collected during the time the UPPP-only patients were treated. Thus, data are only available for the prospective UPPP + TBRF patients. Postoperative values for ESS and snoring level were significantly reduced after treatment for both stages II and III. Subjective improvement in the severity of symptoms was obtained in 96.0% of stage II patients and in 86.0% of stage III patients.

Objective indices of efficacy of treatment such as decreases in postoperative apnea index (AI) and AHI and increase in minimum oxygen saturation (SpO₂) versus preoperative values were demonstrated in UPPP stage I and both UPPP and UPPP + TBRF stage II patients (Table V). Similar objective improvement was also seen in stage III patients who underwent UPPP + TBRF but not in those treated with UPPP only. In addition, postoperative AI (stage II) and AI and AHI (stage III) were lower in the patients treated with UPPP + TBRF when compared with similarly staged patients treated with UPPP only.

Figure 3 compares objective measures of treatment success by stage between patients treated with UPPP only versus patients treated with UPPP + TBRF. Objective success was assessed using the classic criteria: a 50% or more reduction in AHI and a postoperative AHI less than 20. As previously reported, UPPP demonstrated objective success rates of 80.6% in stage I patients, 37.9% in stage II patients, and 8.1% in stage III patients. These values were all different from each other (*P* < .0001). In stage II and stage III patients treated with UPPP + TBRF, success rates were 74.0% and 43.8%, respectively. Objective success rates for stage II and III patients were significantly better after treatment with UPPP + TBRF as compared with stage II and III patients treated with UPPP only (*P* < .0001).

TABLE II.
In 140 Patients, Number of TBRF Treatments by Stage.

No. TBRF Treatments	Stage II (%)	Stage III (%)	Total (%)
1	27 (52.9)	48 (53.9)	75 (53.6)
2	15 (29.4)	26 (29.3)	41 (29.3)
3	2 (3.9)	11 (12.4)	13 (9.3)
4	5 (9.8)	1 (1.1)	6 (4.3)
5	0 (0.0)	3 (3.4)	3 (2.1)
6	2 (3.9)	0 (0.0)	2 (1.4)
Total	51 (36.4)	89 (63.6)	140 (100)

TBRF = radiofrequency base of tongue reduction.

TABLE III.
Demographic Data of 134 Patients Undergoing UPPP Only (Stages I, II, and III) and 140 Patients Undergoing UPPP and TBRF (Stages II and III).

		Stage I	Stage II	Stage III
Age				
UPPP Only		35.4 ± 15.1	40.3 ± 10.1	44.7 ± 14.2
UPPP + TBRF		—	42.1 ± 9.9	48.5 ± 10.6
Sex				
UPPP only	Males	18 (38.3%)	6 (14.0%)	12 (27.3%)
	Females	29 (61.7%)	37 (86.0%)	32 (72.7%)
UPPP + TBRF	Males	—	41 (80.4%)	62 (69.7%)
	Females	—	10 (19.6%)	27 (30.3%)
Friedman Palate Position				
UPPP only	I	16 (53.3%)	5 (17.2%)	3 (4.0%)
	II	12 (40.0%)	5 (17.2%)	0 (0.0%)
	III	0 (0.0%)	6 (20.7%)	49 (65.4%)
	IV	2 (6.7%)	13 (44.9%)	23 (30.6%)
UPPP + TBRF	I	—	6 (11.8%)	1 (1.1%)
	II	—	15 (29.4%)	8 (34.8%)
	III	—	26 (51.0%)	54 (67.5%)
	IV	—	4 (7.8%)	26 (29.2%)
Tonsil size				
UPPP only	0	0 (0.0%)	0 (0.0%)	33 (53.2%)
	1	2 (4.9%)	2 (6.5%)	26 (42.0%)
	2	1 (2.4%)	9 (29.0%)	2 (3.2%)
	3	18 (43.9%)	15 (48.4%)	1 (1.6%)
	4	20 (48.8%)	5 (16.1%)	0 (0.0%)
UPPP + TBRF	0	—	3 (5.9%)	37 (41.6%)
	1	—	11 (21.6%)	25 (28.1%)
	2	—	7 (13.7%)	25 (28.1%)
	3	—	19 (37.3%)	2 (1.4%)
	4	—	11 (21.6%)	0 (0.0%)
BMI				
UPPP only		27.0 ± 5.0	30.8 ± 5.8	31.4 ± 5.2
UPPP + TBRF		—	30.7 ± 3.7	31.9 ± 5.4

UPPP = uvulopalatopharyngoplasty; TBRF = radiofrequency base of tongue reduction; BMI = body mass index.

Complications

No significant complications occurred. All patients were extubated and, with the use of nasopharyngeal airways, no airway obstruction occurred. No intraoperative or postoperative bleeding occurred. Six patients developed increased pain 7 to 10 days after treatment, suggesting possible infection at the tongue base, but all resolved with antibiotic treatment. One patient actually described a foul-tasting burst of drainage in his throat, suggesting spontaneous drainage of an abscess. No patients required a return to the operating room for drainage of an abscess nor did any patient develop postoperative delayed airway obstruction.

DISCUSSION

UPPP is the most common and, in many situations, the only surgical procedure performed by otolaryngolo-

TABLE IV.
In 140 Patients Treated with UPPP + TBRF, Preoperative and Postoperative Epworth Sleepiness Score (ESS) and Snoring Level.

		Stage II	Stage III
Subjective improvement (%)		48 (96.0)	77 (86.0)
Epworth Sleep Score (ESS) (Mean ± SD)	Preoperative	15.2 ± 3.1	15.2 ± 3.2
	Postoperative	6.6 ± 3.1*	8.7 ± 4.2*
Snoring level (1–10 scale) (Mean ± SD)	Preoperative	7.9 ± 0.8	7.6 ± 1.2
	Postoperative	1.6 ± 1.7*	2.2 ± 2.4*

Subjective improvement required decrease in both postoperative ESS and snoring level as compared to preoperative scores.

*Significantly different from preoperative value.

UPPP = uvulopalatopharyngoplasty; TBRF = radiofrequency base of tongue reduction.

gists for the treatment of OSAHS. Many studies have documented three important issues that must be considered in recommending the surgical procedure to a patient: 1) a meta-analysis of unselected patients treated with UPPP revealed that only 40.8% of patients had “successful” surgery, defined by an AHI reduction of 50% and a postoperative AHI less than 20 or an AI reduced by 50% and a postoperative AI less than 10;¹ 2) despite some data indicating that preoperative selection criteria may identify those patients likely to fail, before the development of this staging system, there have been no clear cut, reproducible physical findings that have been shown to consistently help in the selection process; 3) a study published by Senior et al.² demonstrated that UPPP not only does not cure OSAHS in 60% of cases but also often makes it worse. It has been a common misconception to assume that although UPPP has only a 40% success rate the responders would be those with mild disorders. Therefore, the procedure is often recommended for patients with mild and moderate OSAHS. Senior et al.² have demonstrated that within this subgroup the risk of failure and the risk of aggravating the disease are extremely high. These findings are consistent with our own observations and data. Similar findings were seen in patients treated with laser-assisted uvulopalatoplasty. The procedure not only fails 60% of the time, but often makes the condition worse.

Surgery with a 40% success rate is certainly less than ideal. Our ultimate goal is, of course, to develop a treatment with a high success rate. In the absence of that treatment, however, our goal should be to identify those patients who are likely to benefit from UPPP, which is a valuable procedure for those patients who can be cured with it. The ideal identification process would identify those patients with a high likelihood of success of UPPP versus those with a high likelihood of failure and, therefore, who require treatment of other areas of the upper airway. In this particular study, we used TBRF as a means of enlarging the hypopharyngeal airway. This study was not designed to endorse TBRF as the only or the best means of treatment for the hypopharynx. That would require a study comparing different procedures addressing the tongue base. The purpose of this study was to test the hypothesis that the clinical staging system can direct treatment to improve subjective and objective results. Al-

TABLE V.
Preoperative Versus Postoperative Data Obtained During Polysomnography in UPPP Only and UPPP + TBRF.

		Stage I	Stage II	Stage III
Apnea index				
UPPP only	Preoperative	5.4 ± 14.2	16.0 ± 26.9	8.7 ± 14.5
	Postoperative	0.3 ± 1.3*	2.7 ± 5.4*	12.4 ± 24.8
UPPP + TBRF	Preoperative	—	11.5 ± 15.5	9.3 ± 18.2
	Postoperative	—	2.7 ± 7.8*	3.2 ± 7.4*†
Apnea-hypopnea index				
UPPP only	Preoperative	24.0 ± 12.8	47.2 ± 31.3	34.9 ± 22.4
	Postoperative	6.7 ± 4.7*	34.2 ± 29.9*	39.1 ± 22.7
UPPP + TBRF	Preoperative	—	47.9 ± 26.6	41.7 ± 21.8
	Postoperative	—	19.5 ± 16.4*†	28.5 ± 21.9*†
Minimum SpO ₂ (mm Hg)				
UPPP only	Preoperative	85.9 ± 12.5	80.0 ± 15.0	85.7 ± 8.8
	Postoperative	93.1 ± 1.9*	85.3 ± 8.2*	82.8 ± 12.9
UPPP + TBRF	Preoperative	—	82.1 ± 9.7	79.9 ± 14.3†
	Postoperative	—	87.5 ± 6.7*	83.8 ± 14.8*

*Significantly different from preoperative value.

†Significantly different from UPPP only.

SpO₂ = arterial oxygen saturation; UPPP = uvulopalatopharyngoplasty; TBRF = radiofrequency base of tongue reduction.

though the results are less than perfect, they clearly show that the staging directed treatment is statistically better than UPPP alone.

This study is an initial attempt to define a staging system to help direct treatment of OSAHS to appropriate anatomic sites. Specifically, it tested the hypothesis that stage II and stage III patients need treatment at the tongue-base level. This study has many limitations. The most significant drawback is that this was not a matched,

controlled study. It was also not blinded in any way. A matched, controlled study, however, would be impossible to design because once the results of classical UPPP only on stage II and stage III patients had been assessed (as being 40.9% and 8%, respectively), it would be wrong to subject patients to a treatment that is clearly ineffective for their stage. In addition, some of the criteria for exclusion are somewhat vague. Specifically, this study was based on combined treatment of the palate and tongue base. The tongue-base treatment was directed by the patients' anatomic stage. That patients with stages II and III disease have obstruction at the tongue was our hypothesis. The palate was treated in most patients on the basis of classical thinking and clinical observation. Any staging system is presented as an aid to clinical examination and helps in treatment planning but should not be relied on as the sole criteria. Although the specific exclusion of patients with "severe micrognathia" and those "without palatal obstruction" are somewhat vague, these were observed in a very small percentage of patients. Over 95% of patients presenting without previous surgery fit into the standard staging system and were included in the study.

In our study, as in many other studies related to OSAHS, the objective cure rate lags behind the subjective improvement rate. Although, ideally, we would prefer a treatment that results in a normal polysomnogram, we cannot disregard the importance of symptom elimination. Most patients seek treatment for the common symptoms of snoring and daytime somnolence. Many other symptoms are associated with OSAHS but were not studied in detail because they are harder to quantify. Currently, most patients complete quality of life questionnaires, but these were not available to our patients in the control group.

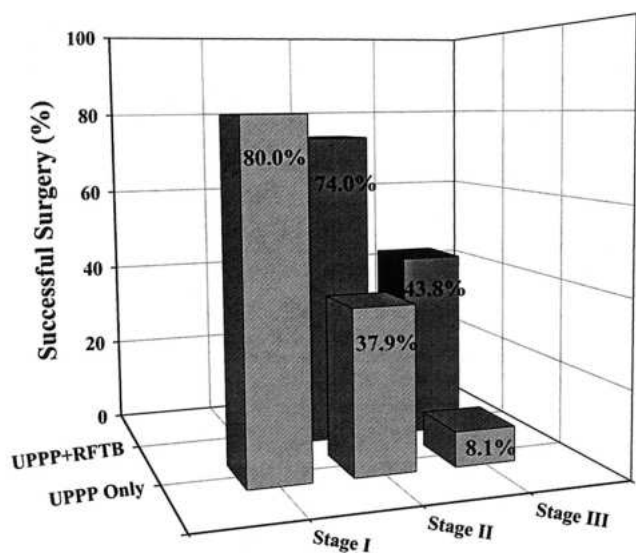


Fig. 3. Objective success in treatment of obstructive sleep apnea/hypopnea syndrome (OSAHS) in patients treated with uvulopalatopharyngoplasty (UPPP) only (n = 134) and UPPP + tongue-base reduction using a radiofrequency technique (TBRF) (n = 143) stratified into stages based on the Friedman staging system for OSAHS.

We used any improvement in snoring and daytime somnolence as criteria for subjective improvement. Although we required improvement in both areas, we did not require complete elimination of symptoms. Therefore, an improvement of snoring from a level 10 to level 8 and improvement of ESS from 24 to 22 would be considered a “positive” improvement. This explains the high “subjective improvement” rate in our experimental group.

The staging system used for this study was modified from the original system published in 2002.³ Because the goal of the staging system is to direct treatment, it became evident that a fourth stage should be added. Both stage II and stage III patients were treated with surgery directed at the palate. Some patients were considered not to be candidates for this type of treatment, and therefore, they became stage IV patients. In a prospective study, it became obvious that patients with severe morbid obesity (BMI > 40 kg/m²) and patients with skeletal deformities such as micrognathia and midface hypoplasia are not candidates for palatal or tongue-base surgery. The morbidly obese patients were directed toward bariatric treatment, and the patients with skeletal deformities were directed toward skeletal treatment (maxillary mandibular advancement or others). Identification of stage IV patients also directs definitive treatment, although this study has no data to substantiate that claim.

CONCLUSIONS

This study supports the use of the clinical staging system previously described by us. Staging-directed treat-

ment clearly improved subjective and objective success in the prospective study. Patients with stage I disease have an 80% chance of successful outcome when treated with UPPP. Patients with stage II and stage III disease have a statistically significantly improved cure rate when treated with UPPP + TBRF. Subjective improvement for stage II disease is up to 96%, and objective success increased from 37.9% to 74%. Stage III patients had a subjective improvement of 85.4%, and the objective cure rate increased to 43.8% when compared with 8.1% with UPPP only.

BIBLIOGRAPHY

1. Sher AE, Schechtman KB, Piccirillo JF. The efficacy of surgical modifications of the upper airway in adults with obstructive sleep apnea syndrome. *Sleep* 1996;19:156–177.
2. Senior BA, Rosenthal L, Lumley A, et al. Efficacy of uvulopalatopharyngoplasty in unselected patients with mild obstructive sleep apnea. *Otolaryngol Head Neck Surg* 2000; 123:179–182.
3. Friedman M, Tanyeri H, LaRosa M, et al. Clinical predictors of obstructive sleep apnea. *Laryngoscope* 1999;109: 1901–1907.
4. Friedman M, Ibrahim H, Bass L. Clinical staging for sleep-disordered breathing. *Otolaryngol Head Neck Surg* 2002; 127:13–21.
5. Friedman M, Ibrahim H, Lee G, Joseph NJ. Combined uvulopalatopharyngoplasty and radiofrequency tongue base reduction for treatment of obstructive sleep apnea/hypopnea syndrome. *Otolaryngol Head Neck Surg* 2003; 129:611–621.
6. Friedman M, Landsberg R, Tanyeri H. Submucosal uvulopalatopharyngoplasty. *Otolaryngol Head Neck Surg* 2000; 11:26–29.