Predictors of Outcome for Uvulopalatopharyngoplasty

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The objective of this study was to assess the value of preoperative fiberoptic nasopharyngoscopy with the Müller maneuver (FNMM) and cephalometric radiography in predicting response to uvulopalatopharyngoplasty (UPPP) in patients with obstructive sleep apnea syndrome. Fifty-three such patients having significant obstruction at the soft palatal level and variable degrees of obstruction at the base-of-tongue level underwent both diagnostic procedures before UPPP. Outcome was assessed by the apnea-plus-hypopnea index (AHI) as determined by polysomnography, which was performed before and after surgery. As a group, patients exhibited a significant 10-point reduction in AHI (46.5 to 36.7). However, 17 (32.1%) were judged to be responders as defined by a reduction of the AHI by an increment of 50% or greater with respect to baseline. Of all the cephalometric variables assessed, soft palate length was the only one that differed between responders and nonresponders (45.5 mm versus 42.6 mm, respectively). However, this difference only approached significance (P=.067). Similarly, FNMM results did not discriminate between responders and nonresponders. These results indicate that preoperative cephalometric radiography and FNMM cannot be reliably used to enhance surgical success.

INTRODUCTION

Uvulopalatopharyngoplasty (UPPP) is an established treatment for obstructive sleep apnea syndrome (OSAS). Although its efficacy has been well documented,[1] its use has been limited by a lack of consistent and accurate preoperative criteria for the prediction of successful outcome. The primary treatment for the syndrome is currently nonsurgical, *i.e.*, nasal continuous positive airway pressure (CPAP). Nevertheless, although highly efficacious for most users initially, long-term treatment with CPAP is complicated by diminished compliance rates.[2] The availability of a treatment alternative for the syndrome would therefore be desirable, especially in patients who are unable to use CPAP.

It has been proposed that successful outcome to UPPP is more likely in people in whom the primary site of pharyngeal collapse or physical obstruction during sleep is localized to the soft palatal level rather than the base-of-tongue level. Dynamic changes in the upper airway during sleep have been identified with somnofluoroscopy[3] and cine computed tomography,[4] both of which have been successful in localizing pharyngeal collapse during periods of apnea. Fiberoptic nasopharyngoscopy with the Müller maneuver (FNMM)[5] has been advocated as a practical, clinically applicable, preoperative dynamic diagnostic method of assessing the site of collapse. Since static structural changes can contribute to the genesis of apneas as well, cephalometric radiography[6] has been proposed as a clinically useful method of assessing static upper airway dimensions. However, concerns exist regarding the predictive efficacy of both of these office-based maneuvers for UPPP success and, in the case of cephalometric radiography, there is no consensus regarding which dimensional parameters are of greatest relevance. The objective of this study, therefore, was to examine the predictive value of these office-based methods, one being a measure of dynamic airway collapsibility and the other of static morphology, in OSAS patients undergoing UPPP surgery.

MATERIALS AND METHODS

Patients

Data on 53 OSAS patients (45 men and 8 women, average age 31.9 ± 5.3 years) who selected UPPP surgery and who complied with both preoperative and postoperative polysomnographic studies were included in this study. Patients presented to the sleep disorders program of a large metropolitan university-based hospital. Diagnosis was established by a history of daytime hypersomnolence, reports of heavy snoring by bed partners and house members, and an apnea-plus-hypopnea index (AHI) of at least 5/hour of sleep during baseline polysomnography. In contrast to the usually reported apnea-alone index, we used the AHI because of its better correlation with other measures of severity such as the frequency of oxygen desaturations.[7] Inclusion criteria also included medically stable status and significant (greater than 50%) collapse at the soft palatal level during FNMM.

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Polysomnography

Baseline and postsurgical polysomnography were performed in identical fashion. Postsurgical polysomnography was conducted 24.0 ± 32.4 weeks (mean ± SD; range 3–136 weeks) following UPPP. Recordings began at the time nearest the subject's usual bedtime (in each case between 10 PM and midnight), and lasted approximately 8 hours. Paper speed was 10 mm/sec (model 78D polygraph, Grass Instruments). All recordings were conducted in standard fashion[8] and included monitoring of the electroencephalogram via central (C_3/A_1 and A_2) and occipital (O_2/A_1 and A_2) leads electrooculogram, submental electromyogram, bilateral anterior tibialis electromyogram, electrocardiogram, nasal/oral airflow with thermistors, chest and abdominal respiratory effort with strain gauges, intercostal electromyogram, and oxygen saturation transcutaneously with an ear clip (Biox model IIA oximeter). Polysomnographic records were scored manually by one technician, who was unaware of the patient's status, in 30-second epochs according to standard criteria.[9]

Seventeen patients also underwent diurnal multiple sleep latency testing (MSLT) following each nocturnal polysomnogram at baseline and postoperatively. This standardized technique[10] objectively assesses the severity of daytime somnolence by measuring sleep latency, the time elapsed from lights out to the onset of sleep, during five successive naps conducted at 2-hour intervals. Its underlying assumption is that lower sleep latency scores indicate greater sleepiness and vice versa. Subjects also estimated their subjective sleepiness with the Stanford Sleepiness Scale (SSS)[11] immediately before and after each MSLT subtest (nap).

FNMM

Thirty-six patients underwent FNMM before surgery. The procedures were performed by two otolaryngologists (Z.H.N. and R.L.N.) who established uniformity in methodology and in the coding of results before and intermittently during the course of the study. Both were blind to the results of polysomnography and cephalometric radiography at the time of the FNMM. The nasopharyngoscope (Olympus model ENF, type P2) was passed through the most patent naris following preparation with 1% phenylephrine hydrochloric acid spray. The larynx, vocal cords, and pharyngeal structures were carefully viewed. The scope was then withdrawn to the level of the base of the tongue, and the patient was instructed to deeply inhale and exhale twice, and then to suck in vigorously with mouth closed while the nares were occluded by the examiner. The extent of collapse of the pharyngeal walls in the anterior, posterior, and lateral directions was noted and coded as follows: minimal (1), up to 50% (2), up to 75% (3), and complete (4). The scope was then withdrawn to the level of the soft palate; the FNMM was repeated and the results coded in the same manner. We have observed no appreciable differences in pharyngeal collapsibility between the sitting and supine positions. Therefore, all FNMMs were performed while patients were sitting. As noted earlier, only data for people demonstrating greater than 50% collapse at the soft palatal level were included in the study.

Cephalometric Radiography

Forty patients underwent lateral cephalometric radiographs before UPPP. The procedure was performed while patients were standing with their mouths closed and back teeth in contact. The x-ray source to midsagittal plane was maintained at 5 feet, and the gaze plane was held parallel to the floor. The image was taken at midexhalation. Records were scored by one investigator (A.F.) who was blind to the results of the other procedures in this study. The following variables were quantified on acetate paper tracings of the radiographs (Fig. 1): maximum soft palate width, measured at the velar knee; soft palate length, measured from the posterior nasal spine to the tip of the soft palate; soft palate–pharynx interspace, defined as the distance from the soft palate to the posterior pharyngeal wall along the Frankfort horizontal plane; tongue base–pharyngeal interspace, defined as the distance between the base of the tongue and the posterior pharyngeal wall along the mandibular plane (gonion to gnathion); mandibular plane to hyoid length, the distance perpendicular to the mandibular plane measured from the mandibular plane to the anterosuperior point of the hyoid; mandibular plane to hyoid angle, the angle formed by the intersection of the mandibular plane with a line drawn from the hyoid bone to menton. For the soft palate–pharynx interspace, distances were measured to the first radiographic shadow (minimum), the most opaque shadow (maximum), and the mean of these two (mean). The same variables were defined for the tongue base–pharyngeal interspace.

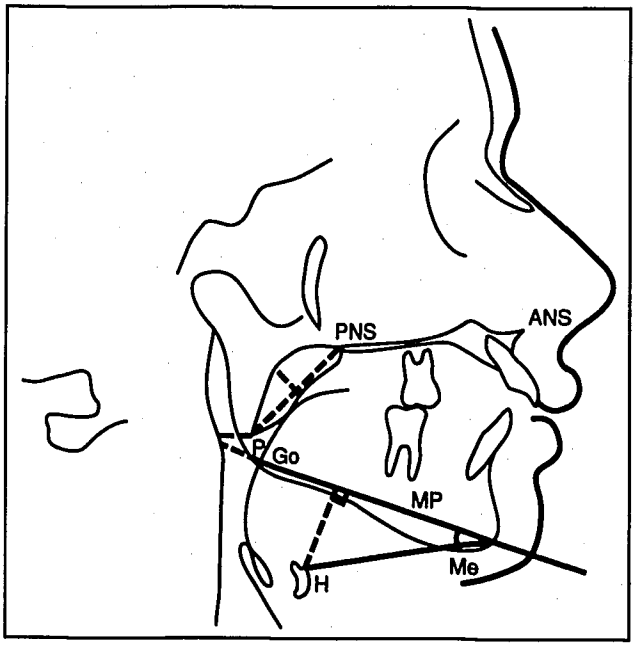

Fig. 1. Cephalometric radiographic tracing. ANS = anterior nasal spine; Go = gonion; H = hyoid; MP = mandibular plane; P = tip of the soft palate; PNS = posterior nasal spine; Me = menton.

UPPP

Under general anesthesia, patients were positioned as for tonsillectomy, which was performed. The midline extent of the resection was determined by pulling the uvula toward the surgeon and marking the natural horizontal crease with a knife. With a no. 2 blade and starting at the lower pole of the anterior tonsillar pillar, a vertical incision was made; at the level of the midline cut, the knife was sharply turned medially and the incision continued to meet the midline cut.

TABLE I.
Comparison of Presurgical and Postsurgical Results.

	Baseline	UPPP	*P* Value
Nocturnal polysomnography			
AHI	46.5 ± 24.9	36.7 ± 26.5	0.016
Sao_2 nadir	75.9 ± 16.5	78.7 ± 15.1	≥0.05
TST (min)	375.8 ± 59.7	363.1 ± 69.8	≥0.05
SL	10.9 ± 14.9	9.6 ± 10.4	≥0.05
WASO	61.5 ± 44.4	62.7 ± 55.2	≥0.05
SE (% TST)	84.0 ± 11.0	83.0 ± 13.0	≥0.05
% Stage I	18.1 ± 11.6	14.6 ± 10.7	0.009
% Stage II	60.1 ± 12.5	59.1 ± 12.6	≥0.05
% Stage delta	7.7 ± 7.2	8.8 ± 9.6	≥0.05
% Stage REM	14.8 ± 6.9	17.6 ± 8.5	0.006
REM latency	122.4 ± 84.4	95.7 ± 70.0	≥0.05
Multiple sleep latency test			
Sleep latency	6.9 ± 3.9	7.7 ± 3.9	0.039
SSS pre score	2.6 ± 1.1	2.5 ± 1.3	≥0.05
SSS post score	2.7 ± 1.0	2.6 ± 1.1	0.046

TST = total sleep time; SL = sleep latency; WASO = wake after sleep onset; SE = sleep efficiency; SSS = Stanford sleepiness scale; BMI = body mass index.

TABLE II.
Cephalometric Variables and Fiberoptic Nasopharyngoscopy With the Müller Maneuver Codes for All Patients and for Responders Versus Nonresponders.

	All Patients (Mean ± SD)	Non-responders (Mean)	Responders (Mean)	*P* Value*
Cephalometric variables				
SP length (mm)	43.4 ± 5.1	42.6	45.5	0.067
SP width	9.9 ± 2.6	9.8	10.2	≥0.05
SP-PH Int, mean	5.3 ± 3.5	5.6	4.6	≥0.05
SP-PH Int, min	4.6 ± 3.8	4.6	4.4	≥0.05
SP-PH Int, max	5.9 ± 3.6	6.5	4.7	≥0.05
TB-PH Int, mean	9.5 ± 4.4	9.6	9.4	≥0.05
TB-PH Int, min	8.8 ± 4.7	8.7	8.9	≥0.05
TB-PH Int, max	10.2 ± 4.5	10.3	9.8	≥0.05
MP-H length	23.9 ± 6.8	23.5	24.9	≥0.05
MP-H angle (degrees)	27.3 ± 8.8	26.5	29.2	≥0.05
Base of tongue FNMM code	2.8 ± 1.5	2.6	2.9	≥0.05

*Comparison between responders and nonresponders.

SP-PH = soft palate–pharyngeal interspace; TB-PH Int = tongue base–pharyngeal intrerspace; MP-H = mandible plane to hyoid.

The procedure was repeated on the other side so that the final incision was similar to a U in appearance. The "cathedral dome" or V appearance was avoided. Scissors were used to cut through the full thickness of the muscle. Brisk bleeding at the midline was cauterized with a suction Bovie. Throughout the procedure, the posterior mucosa were kept intact. The nasopharyngeal palatal mucosa were entered in a beveled fashion, leaving them approximately 5 mm longer than the anterior mucosa to advance the posterior mucosa to the anterior and ensure that the suture line was away from the nasopharynx. Finally, all excessive posterior pillar mucosa were removed and the posterior pillar advanced and sutured to the anterior pillar with 3.0 chromic interrupted sutures.

Statistical Analysis

Two-tailed *t* tests were used, with paired samples used to compare presurgical to postsurgical data and independent samples used to compare subgroups.

RESULTS

The mean group AHI diminished following surgery (Table I). However, the Sao_2 nadir remained unchanged. Sleep quality improved, as evidenced by the decrease in the proportion of stage I (shallow) sleep and the increase in the proportion of REM sleep. The mean MSLT sleep latency increased, indicating that objectively measured daytime somnolence diminished. Patients' subjective assessment of sleepiness (SSS) following MSLT naps also diminished. Body mass index remained unchanged (31.9 ± 5.3 versus 31.8 ± 4.9 kg/m^2, $P \geq .05$).

Response was defined as a reduction of the AHI by a factor of 50% or greater with respect to baseline. Judged by this criterion, 17 (32.1%) responded to surgery and 36 (67.9%) did not. The two groups were identical with respect to mean age, body mass index, and preoperative sleep variables, including AHI. Cephalometric variables and FNMM results for the entire group and for responders versus nonresponders appear in Table II. The soft palate was longer in responders than in nonresponders (45.5 mm versus 42.6 mm, respectively). However, this difference only approached significance ($P = .067$). The two groups did not differ in other cephalometric measures. Similarly, FNMM results did not discriminate between responders and nonresponders.

DISCUSSION

UPPP did lower the average AHI in our patients when considered as a group. However, in keeping with the findings of others,[1,5,7] 50% of patients at most were considered to be responders. The persistence of OSAS in more than half of all patients highlights the importance of identifying reliable preoperative predictive factors to UPPP, which was the primary objective of this study. Nevertheless, neither cephalometric radiography nor FNMM were able to reliably identify the patients who did respond.

Regarding cephalometric radiography, others have reported data either suggesting[12–14] or demonstrating[15] its predictive value. These reports have focused on the pharyngeal airway diameter at either the soft palatal or base-of-tongue level. However, these reports have yielded inconsistent results. Our study does not support the value of airway interspace measurements at either level in the awakened state. It does, however, suggest that the length of the uvula may be the most important predictive cephalometric parameter. Clearly, further studies are warranted in this area. Regarding FNMM, patients were selected because they exhibited high collapsibility at the soft palatal level and variable degrees of collapsibility at

the base of tongue level. Nevertheless, the procedure was not of predictive value. This conclusion is in agreement with that of others.[16]

Our largely negative findings regarding the predictive value of these two diagnostic procedures are consistent with two possible conclusions. First, it is possible that, although FNMM and cephalometric radiography are practical clinical tools, they are unable to localize the critical upper airway occlusive site in OSAS. A comparison of these techniques with somnofluoroscopy, cine computed tomography, or other investigational methods promises to address this question. However, it is also possible that FNMM and cephalometric radiography are effective in localizing the site of obstruction but that UPPP surgery does not reliably alleviate the critical abnormality that causes apneas during sleep. It has been suggested that apneas are primarily due to enhanced pharyngeal collapsibility due to a dysfunction in dilator muscles and that static structural airway changes play only a contributory role. If this formulation is correct, we cannot anticipate that enhancing static airway patency by UPPP would lead to predictable results.

Finally, it is of interest that UPPP led to a slight improvement in sleep architectural quality and in daytime somnolence as assessed by objective methods (MSLT). To the best of our knowledge, this is the first study in which an objective basis has been provided to the common report by patients that they feel more alert after UPPP. Previous studies[17] of this question noted improvement in subjective daytime somnolence levels, yet there was no demonstrable improvement in objective measures. Impairment in sleep quality and consequent daytime somnolence are associated with OSAS and contribute not only to morbidity in the form of impaired occupational performance, depression, and poor interpersonal relationships, but also to mortality; individuals with untreated OSAS are seven times more likely to have automobile accidents than others in the population.[18] Further studies are warranted to determine whether UPPP does, in fact, predictably diminish daytime somnolence by objective criteria. Such a finding, if substantiated, could provide an important role for this procedure.

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