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Original Article

Effect of Isolated Uvulopalatopharyngoplasty on Subjective Obstructive Sleep Apnea Symptoms

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Objectives. The aims of this study were 1) to evaluate the effect of isolated uvulopalatopharyngoplasty (UPPP) on subjective obstructive sleep apnea (OSA) symptoms in adult patients regardless of the response to surgery, and ultimately 2) to investigate the differences in changes in subjective OSA symptoms between successful and unsuccessful surgery groups.

Methods. Twenty consecutive adult patients who underwent isolated UPPP were enrolled. Pre- and postoperative subjective OSA symptoms (snoring, witnessed apnea, daytime sleepiness, morning headache, daytime fatigue, restless sleep, difficulty with morning arousal) and polysomnographic data were evaluated in all subjects. Changes in subjective OSA symptoms before and after surgery were investigated in the successful (n=11) and unsuccessful (n=9) groups. Surgical success was defined as a reduction of at least 50% in the preoperative apnea-hypopnea index (AHI) and a postoperative AHI less than 20 per hour.

Results. After isolated UPPP, all subjective OSA symptoms changed significantly in the patients, especially in the successful group. In the unsuccessful group, snoring, witnessed apnea and daytime fatigue changed significantly, while other symptoms did not change significantly after surgery.

Conclusion. Isolated UPPP may improve subjective OSA symptoms in adult patients whom surgery was successful or unsuccessful. However, after isolated UPPP, the improvements in subjective OSA symptoms in the unsuccessful group may be different from those in the successful group.

Keywords. *Adult, Obstructive sleep apnea, Polysomnography, Surgery, Symptom*

INTRODUCTION

Obstructive sleep apnea (OSA) is a common disorder characterized by recurrent reductions or cessations in breathing due to partial or complete upper airway obstructions during sleep. Left untreated, these conditions can lead to various signs and symptoms (e.g., snoring, witnessed apnea, daytime sleepiness, morning headache, daytime fatigue, restless sleep, and difficulty with morning arousal) and complications (e.g., hypertension, arrhythmia, stroke, diabetes, metabolic syndrome, and motor vehicle accidents) [1]. The pathophysiological mechanisms of OSA are very complex and multifactorial (e.g., hypoxemia, hypocapnia, frequent arousals or sleep fragmentation, autonomic nervous system imbalance, and fluctuation in intrathoracic pressure) [2].

Although positive airway pressure (PAP) therapy is currently recommended for the primary treatment of OSA, some patients select surgical therapy because PAP therapy may have several adverse or side effects (e.g., nasal obstruction, mask leak, skin breakdown, pressure intolerance, and claustrophobia) [3,4]. There are numerous OSA surgical procedures according to the obstructive level, including the nasal cavity (e.g., turbinate sur-

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gery, septoplasty, and endoscopic sinus surgery), nasopharynx (e.g., adenoidectomy), oropharynx (e.g., tonsillectomy, palatal implants, radiofrequency ablation of the soft palate, uvulopalatopharyngoplasty [UPPP] and uvulopalatal flap [UPF]), hypopharynx (e.g., lingual tonsillectomy, partial glossectomy, radiofrequency ablation of the tongue base, and genioglossus advancement) and the upper airway (e.g., maxillomandibular advancement) [4-7]. Of these, UPPP is one of the most popular procedures for resolving oropharyngeal obstruction [6].

Some studies suggest that UPPP is associated with an improvement in clinical results including subjective sleep apnea symptoms, disease-specific quality of life, cardiovascular outcomes, and a reduction in motor vehicle accidents [8-10]. However, there is a wide discrepancy between subjective and objective outcomes of UPPP in patients with OSA [11]. In addition, a recent study reported that isolated UPPP significantly improves subjective sleep apnea symptoms in patients with OSA regardless of postoperative objective results [12].

In this study, we hypothesized that isolated UPPP may improve subjective sleep apnea symptoms in OSA patients, but the improvements in subjective outcomes in the successful surgery group may not completely correspond to those in the unsuccessful surgery group. Therefore, the aims of this study were 1) to evaluate the effect of isolated UPPP on subjective OSA symptoms in adult patients regardless of postoperative objective results, and ultimately 2) to investigate the differences in changes in subjective OSA symptoms between the successful and unsuccessful surgery groups.

MATERIALS AND METHODS

Subjects

The study was reviewed and approved by the Institutional Review Board of Korea University Ansan Hospital. Eligible subjects were adults (age ≥18 years) who 1) complained of clinical symptoms and/or signs suggestive of OSA except nasal obstruction; 2) had an apnea-hypopnea index (AHI) ≥5 per hour of total sleep time (TST) on diagnostic polysomnography; 3) refused to accept medical treatment such as PAP therapy or an oral appliance; 4) were treated with isolated UPPP or UPF; 5) were evaluated with follow-up polysomnography three months after surgery; and 6) had completed questionnaires regarding subjective OSA symptoms before and after isolated UPPP. Twenty consecutive eligible patients (mean age=42.4±12.3 years, mean body mass index [BMI]=27.0±3.2 kg/m^2) were finally included in this study. There were 17 males and 3 females.

Subjective OSA symptoms

The subjects were asked to complete a questionnaire regarding subjective OSA symptoms including snoring, witnessed apnea, daytime sleepiness, morning headache, daytime fatigue, restless sleep, and difficulty with morning arousal. A seven-point Likert scale ranging from 0 (none of the time) to 6 (all of the time) was used to compare the severities of subjective OSA symptoms before and after surgery. The Epworth Sleepiness Scale (ESS) was used to measure the level of excessive daytime sleepiness. The total ESS score is the sum of eight item scores, with possible scores for each item ranging from 0-3 points. Thus, the final ESS score could range from 0 (minimum) to 24 (maximum), with a score of 10 or more indicating pathological sleepiness. All postoperative questionnaires were administered three months after surgery.

Polysomnography

All patients underwent pre- and postoperative polysomnographic evaluations using an overnight, attended, laboratory-based polysomnography unit (Alice 4; Respironics, Atlanta, GA, and USA). The recorded physiological signals included an electroencephalogram, electrooculogram, submental and leg electromyogram, electrocardiogram, airflow at the nose and mouth (thermistor, nasal pressure transducer), chest and abdominal respiratory movements, arterial oxygen saturation measured with pulse oximetry, snoring, and body position. A sleep technician observed the behaviors of the subjects and confirmed their sleep positions using an infrared camera placed inside the room.

All sleep studies were manually interpreted by a sleep technician according to the standard criteria of the *American Academy of Sleep Medicine (AASM) Manual for the Scoring of Sleep and Associated Events* and were reviewed by certified physicians [13]. Apnea was defined as an absence of airflow for a period lasting at least 10 seconds and hypopnea was defined as at least a 30% reduction in airflow associated with a 4% or greater decrease in oxygen saturation. The apnea index (AI) was defined as the number of apneic episodes per hour of TST, and the AHI was defined as the number of episodes of apnea and hypopnea per hour of TST. The arousal index was defined as the number of arousals per hour of TST.

Surgery and surgical success criteria

All subjects were treated with isolated UPPP (n=18) or UPF (n=2) under general anesthesia. All UPPP procedures were undertaken based on the technique explained by Fujita et al. [14] except for preservation of the uvula, and all UPF procedures were performed using the technique described by Powell et al. [15] Surgical success was defined as a reduction of at least 50% in preoperative AHI and a postoperative AHI less than 20 per hour.

Statistical analysis

All of the data obtained in this study are presented as mean±SD for continuous variables, and as frequencies (percentage) for categorical variables. The Wilcoxon signed rank test was used to compare objective data (BMI, TST, sleep efficiency [SE], AHI, AI, minimum SaO_2, and arousal index) and subjective data (snor-

ing, witnessed apnea, daytime sleepiness, morning headache, daytime fatigue, restless sleep, difficulty with morning arousal, and ESS score) in all subjects in both the successful and unsuccessful surgery groups before and after isolated UPPP. The Mann-Whitney *U*-test was performed to compare subjective and objective data between the successful and unsuccessful groups. Statistical analysis was performed using SPSS ver. 12.0 (SPSS Inc., Chicago, IL, USA), and a P-value<0.05 was considered statistically significant.

RESULTS

Objective and subjective data before and after isolated UPPP are given in Table 1. There were no significant differences between preoperative and postoperative BMI, TST, and SE. However, after isolated UPPP, objective OSA parameters (AHI, AI, minimum SaO_2, and arousal index) and subjective OSA symptoms (snoring, witnessed apnea, daytime sleepiness, morning headache, daytime fatigue, restless sleep, and difficulty with morning arousals) changed significantly in all patients regardless of the response to surgery.

Objective and subjective data in the successful and unsuccessful groups before and after isolated UPPP are shown in Table 2. There were no significant differences in baseline data between the successful and unsuccessful groups. In the successful group, BMI, TST, and SE did not change significantly, whereas objective OSA parameters and subjective OSA symptoms changed significantly after surgery. In the unsuccessful group, minimum SaO_2, snoring, witnessed apnea and daytime fatigue changed significantly, while other objective parameters and subjective symptoms did not change significantly after surgery.

Table 1. Objective and subjective data before and after isolated uvulopalatopharyngoplasty (n=20)

Variable	Before	After	*P*-value
Objective data			
Body mass index (kg/m^2)	27.0±3.2	27.0±3.5	0.736
Total sleep time (minutes)	408.0±70.0	409.0±76.8	0.654
Sleep efficiency (%)	86.4±12.6	88.2±15.3	0.433
Apnea-hypopnea index†	37.2±22.9	20.1±20.4	0.006*
Apnea index†	26.0±21.5	10.5±17.4	0.001*
Minimum SaO_2 (%)	76.4±12.0	82.9±11.3	0.001*
Arousal index†	44.8±18.7	33.6±19.5	0.037*
Subjective data			
Snoring (0-6)	5.5±0.7	2.7±1.3	0.000*
Witnessed apnea (0-6)	4.8±1.1	1.8±1.0	0.000*
Daytime sleepiness (0-6)	3.4±1.8	1.9±0.9	0.007*
Morning headache (0-6)	2.1±2.0	1.2±1.3	0.004*
Daytime fatigue (0-6)	3.6±1.6	2.2±1.4	0.003*
Restless sleep (0-6)	4.4±1.3	3.1±1.4	0.002*
Difficulty with morning arousal (0-6)	2.9±2.2	1.4±1.6	0.002*
Epworth Sleepiness Scale score (0-24)	11.6±4.7	7.3±2.9	0.002*

Values are presented as means±SD.
TST, total sleep time; SaO_2, arterial oxygen saturation.
*P<0.05. †Events/hour of TST.

Table 2. Objective and subjective data in the successful (n=11) and unsuccessful (n=9) groups before and after isolated uvulopalatopharyngoplasty

	Baseline data			Successful group			Unsuccessful group		
	Successful group	Unsuccessful group	*P*-value	Before	After	*P*-value	Before	After	*P*-value
Age (year)	42.7±13.9	41.9±10.8	0.766	-	-	-	-	-	-
Sex (male:female)	9:2	8:1	-	-	-	-	-	-	-
Body mass index (kg/m^2)	27.2±1.9	26.8±4.4	0.503	27.2±1.9	27.1±1.7	0.726	26.8±4.4	26.8±5.0	0.944
Total sleep time (minutes)	415.4±30.4	398.9±101.3	0.552	415.4±30.4	411.0±45.3	0.689	398.9±101.3	406.6±106.9	0.906
Sleep efficiency (%)	89.8±4.0	82.2±17.9	0.824	89.8±4.0	91.7±9.2	0.328	82.2±17.9	83.8±20.3	0.953
Apnea-hypopnea index†	38.0±21.5	36.3±25.8	0.710	38.0±21.5	7.3±7.2	0.003*	36.3±25.8	35.7±20.6	0.678
Apnea index†	24.6±20.0	28.0±24.7	0.840	24.6±20.0	2.8±2.7	0.003*	28.0±24.7	21.0±23.5	0.263
Minimum SaO_2 (%)	80.6±5.8	71.2±15.7	0.175	80.6±5.8	86.4±7.2	0.032*	71.2±15.7	78.7±14.3	0.008*
Arousal index†	43.7±19.1	46.2±19.1	1.000	43.7±19.1	24.0±13.7	0.013*	46.2±19.1	45.4±19.5	0.953
Snoring (0-6)	5.6±0.5	5.3±0.9	0.552	5.6±0.5	1.9±0.8	0.003*	5.3±0.9	3.6±1.2	0.011*
Witnessed apnea (0-6)	4.6±1.1	5.0±1.2	0.604	4.6±1.1	1.8±1.2	0.011*	5.0±1.2	1.8±0.9	0.011*
Daytime sleepiness (0-6)	3.6±1.6	3.1±2.0	0.552	3.6±1.6	2.0±1.1	0.034*	3.1±2.0	1.8±0.4	0.088
Morning headache (0-6)	2.2±2.1	2.0±2.0	0.941	2.2±2.1	1.0±1.3	0.016*	2.0±2.0	1.3±1.2	0.119
Daytime fatigue (0-6)	3.6±1.7	3.5±1.7	0.603	3.6±1.7	2.4±1.8	0.040*	3.5±1.7	1.9±0.6	0.042*
Restless sleep (0-6)	4.7±1.3	4.0±1.1	0.131	4.7±1.3	3.1±1.6	0.011*	4.0±1.1	3.1±1.0	0.102
Difficulty with morning arousal (0-6)	3.6±2.0	2.0±2.2	0.131	3.6±2.0	1.6±1.9	0.007*	2.0±2.2	1.1±1.1	0.131
ESS score (0-24)	12.9±4.4	9.9±4.8	0.175	12.9±4.4	7.2±3.5	0.005*	9.9±4.8	7.4±2.2	0.182

Values are presented as means±SD.
TST, total sleep time; SaO_2, arterial oxygen saturation; ESS, Epworth Sleepiness Scale.
*P<0.05. †Events/hour of TST.

DISCUSSION

This study was undertaken to determine whether isolated UPPP may improve subjective OSA symptoms not only in the successful surgery group, but also in the unsuccessful surgery group. The results of the current study provide evidence that the improvements in subjective OSA symptoms in the unsuccessful group may not be entirely equal to those in the successful group after isolated UPPP. To our knowledge, this is the first study to evaluate the pure effectiveness of UPPP for treating subjective OSA symptoms in the successful and unsuccessful surgery groups according to postoperative objective data such as AHI.

In the present study, after isolated UPPP, subjective OSA symptoms were significantly improved in adult patients with OSA in both the successful and unsuccessful surgery groups. These findings are similar to those of the recent studies. Weaver et al. [12] performed a prospective, multicenter, longitudinal study to examine the hypothesis that isolated UPPP alleviates OSA symptoms and OSA-related quality of life based on the Functional Outcomes of Sleep Questionnaire (FOSQ). They found that OSA symptoms (snoring, sleep apnea problem and symptoms, awakening with headache, and ESS scores) and OSA-related quality of life (FOSQ scores) were significantly alleviated at 3 and 6 months in patients with OSA after isolated UPPP [12].

Although there are variations in the effects of UPPP on objective parameters according to individual characteristics, including anatomical and neuromuscular factors, it has been reported that UPPP is usually associated with an improvement in subjective OSA symptoms in patients with OSA [12,16]. However, previous studies related to the effects of UPPP on subjective outcomes included data for cases in which UPPP was performed along with other surgical procedures, such as nasal surgery [11]. This bias confounds the efficacy of isolated UPPP with regard to subjective outcomes, as nasal surgery alone may improve OSA symptoms, such as subjective or objective snoring and daytime sleepiness, in patients with OSA [17,18]. Li et al. [17] assessed the effects of isolated nasal surgery on snoring, sleep apnea, and daytime sleepiness in patients with OSA based on a literature review and meta-analysis. They reported that subjective snoring assessed by questionnaires and daytime sleepiness as indicated by ESS scores were significantly alleviated after nasal surgery alone in patients with OSA according to data extracted from related studies [18]. Our study also found that isolated nasal surgery was significantly effective in reducing objective snoring according to polysomnography and an assessment of the extent of daytime sleepiness in OSA patients [18].

Little is known about the pure effectiveness of UPPP on subjective outcomes in patients with OSA in whom surgery is unsuccessful [12]. In this study, after isolated UPPP, some subjective OSA symptoms (snoring, witnessed apnea and daytime fatigue) significantly improved in the unsuccessful surgery group, but not to the extent observed in the successful group. The exact mechanisms underlying the improvement in subjective outcomes in the unsuccessful group after isolated UPPP are not yet understood. However, there are several potential explanations for this discrepancy: 1) polysomnographic data such as AHI may be discordant with subjective outcomes including symptoms and quality of life; 2) although AHI did not change significantly, the significant increase in minimum SaO_2 may have influenced the improvement in subjective OSA symptoms; and 3) the placebo effect may have played a role in the subjective measurements [19,20].

It is ideal to achieve both subjective and objective improvement, whereas no improvement in both subjective and objective outcomes is undesirable after surgery. It is undetermined whether the improvement of some subjective outcomes without the improvement of objective outcomes influences changes of health in unsuccessful group after surgery. However, it is clear that subjective OSA symptoms are associated with OSA-related quality of life. Therefore, the improvement of some subjective outcomes may have an effect on the improvement of quality of life in unsuccessful group after surgery.

The greatest strength of our study is the inclusion of postoperative polysomnographic data for all subjects. This study has several limitations. First, it is not a randomized controlled study. Second, the results of the current study may not be representative of the long-term effects of isolated UPPP because the follow-up period was relatively short. Third, the sample size was relatively small. Fourth, there was no control group that did not receive treatment for OSA. However, the comparison of subjective outcomes between the successful and unsuccessful groups may contribute to our understanding of the pure effect of UPPP. The outcomes of the present study should be interpreted cautiously in the context of these limitations.

In conclusion, isolated UPPP may improve subjective OSA symptoms in adult patients, including both successful and unsuccessful surgery patients. However, after surgery, the improvement in subjective OSA symptoms in patients for whom surgery was unsuccessful may not completely correspond to that in patients for whom surgery was successful. In the unsuccessful group, isolated UPPP may be partially effective in improving subjective OSA symptoms.

CONFLICT OF INTEREST

No potential conflict of interests relevant to this article was reported.

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