Effect of Uvulopalatopharyngoplasty on Positional Dependency in Obstructive Sleep Apnea

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Objective: To assess the effect of uvulopalatopharyngoplasty (UPPP) on positional dependency in patients with obstructive sleep apnea (OSA).

Design: Retrospective analysis.

Setting: Tertiary care university hospital.

Patients: Ninety-six patients who underwent UPPP because of OSA from June 1, 2004, through July 31, 2008, were included. Both preoperative and postoperative attended full-night polysomnography were conducted in all patients. Positional dependency was diagnosed if the patient’s apnea-hypopnea index score in the supine position was more than twice as high as that in the lateral position.

Main Outcome Measures: Position-specific outcomes of UPPP, such as the success rates in the supine or lateral position, were assessed, as well as overall treatment outcomes. The outcomes were also analyzed according to the severity level of the apnea-hypopnea index in each position. The change of positional dependency after UPPP was evaluated.

Results: The apnea-hypopnea index score in the lateral position was markedly reduced after UPPP in position-independent patients (\(P = .02\)). However, the overall success rates were only 31.8% and 34.6% in patients with and without positional dependency, respectively. The success rate in the lateral position was 68.2% in position-independent patients and 32.7% in position-dependent patients (\(P = .01\)). In addition, 14 of 22 patients with position-independent OSA (64%) gained positional dependency after UPPP.

Conclusions: Uvulopalatopharyngoplasty is successful treatment for obstructive events occurring in the lateral sleep position, especially in patients without positional dependency. This implies that patients who have become position dependent may benefit from positional therapy after UPPP.


Obstructive sleep apnea (OSA) has been found to be closely related to the development of cardiovascular complications such as hypertension, myocardial infarction, heart failure, and stroke. In addition, the risk of such complications is in proportion to the severity of OSA, expressed by the apnea-hypopnea index (AHI). Various treatments are available for OSA, such as surgical intervention, an oral device, a continuous positive airway pressure device, body weight control, and positional therapy. Each of these methods has advantages and disadvantages; therefore, individualized treatment approaches have the best chance for success. In fact, a combination of the methods is necessary in some patients and can be achieved by behavior modification; however, positional therapy may be useless in patients without positional dependency of apnea-hypopnea. Uvulopalatopharyngoplasty (UPPP) has been widely used to treat patients with snoring or OSA. However, successful surgical outcomes, demonstrated by polysomnographic variables such as the AHI, have been reported in no more than 40% of cases. Therefore, in most cases, soft-palate operations such as UPPP are not recommended as the first choice of treatment for OSA, according to the guideline published by the American Academy of Sleep Medicine in 2009. Despite the disappointing results thus far, treatment outcomes of UPPP should be reevaluated according to the sleep position, since the treatment outcome can change significantly according to the changes of the sleep position, as reported. Although it is well known that the
overall AHI is markedly affected by the proportion of each sleep position, it is not well known how much UPPP can change sleep position–specific AHIs, such as the supine and lateral categories, and thus change postoperative positional dependency. In the present study, the effect of UPPP on the treatment of supine and lateral apnea-hypopnea was evaluated. Those results, as well as use of positional therapy after UPPP, are discussed.

METHODS

PATIENTS

Patients evaluated at the Seoul National University Bundang Hospital for snoring and/or sleep apnea underwent attended full-night polysomnography (PSG). In addition, sleep videofluoroscopy and upper airway endoscopic examination while awake were performed to identify the location of any obstruction in the upper airway. Treatment modality was determined with consideration of the results of all tests. For patients eligible for surgical intervention, UPPP was the primary treatment, even for those who had obstructive components in the level of the tongue or hypopharynx. Hypopharyngeal soft-tissue or bone framework operations were used in patients for whom the initial treatment was unsuccessful. For cases of nasal diseases, such as deviated nasal septum and inferior turbinal hypertrophy, septoturbinoplasty was performed at the same time. A total of 96 patients who underwent UPPP from June 1, 2004, through July 31, 2008, were included in this study. Twenty-two patients who spent less than 5% of total sleep time in either the supine or lateral position were excluded; thus, positional dependency was analyzed in 74 patients (72 men and 2 women). The mean age was 47 years (range, 21-71 years). Preoperative and postoperative attended full-night PSG were conducted in all patients. The postoperative evaluation was carried out at least 6 months after the operation (range, 6-12 months). This study was approved by the institutional review board of Seoul National University Bundang Hospital.

ANALYSIS OF SLEEP POSITION AND POSITIONAL DEPENDENCY

The sleep position was identified by placing a sensor on the chest, which distinguishes between the supine and lateral position of the trunk, and confirmed by a sleep technician. The patients were divided into 2 groups according to positional dependency. If the AHI in the supine position was more than twice as high as that in the lateral position, the patient was considered to have positional dependency, according to the definition of Cartwright. We defined the positional dependency score (PDS) as the ratio of lateral AHIs to supine AHIs. According to this definition, PDS was less than 0.5 in position-dependent patients and 0.5 or more in position-independent patients.

ASSESSMENT OF SURGICAL OUTCOMES

Surgical success was defined as reduction of AHI by 50% or more and a postoperative AHI of 20 or less. In addition to the overall treatment outcomes, the position-specific surgical outcomes, such as the success rates for the supine position and lateral position, were assessed according to the same criteria as the overall success rate. The success rates were compared among mild (AHI, 5-14), moderate (AHI, 15-29), and severe (AHI, ≥30) disease in each position, as well as between the position-dependent and position-independent patients. The change in positional dependency after UPPP was evaluated.

STATISTICAL ANALYSES

The t test was used to compare the demographic findings and PSG variables between position-independent and position-dependent patients. Differences between preoperative and postoperative values were analyzed using the paired t test. Finally, the Pearson χ² test was used to compare surgical success rates between the 2 groups. All statistical analyses were conducted using commercial software (SigmaStat for Windows, version 17.0; SPSS, Inc, Chicago, Illinois); P < .05 was considered statistically significant.

RESULTS

DEMOGRAPHIC FINDINGS AND PREOPERATIVE PSG VARIABLES ACCORDING TO POSITIONAL DEPENDENCY

Of 74 patients, 22 (30%) were position independent and 52 (70%) were position dependent. Mean age, Friedman staging, and body mass index were not significantly different between the 2 groups of positional dependency. The mean preoperative overall AHI in the position-independent patients was 50.0 and that in the position-dependent patients was 30.9 (P < .001). The mean preoperative lateral AHI was 46.3 in the position-independent patients and 9.7 in the position-dependent patients, which was also significant (P < .001). In contrast, the mean preoperative supine AHI was not significantly different between the groups (P = .80) (Table 1).

TIME SPENT IN SUPINE AND LATERAL POSITIONS

During the preoperative PSG, position-independent patients assumed supine and lateral positions during 59.8% and 39.5% of the total sleep time, respectively. The proportion of supine and lateral sleep positions was maintained postoperatively (paired t test, P = .35 and P = .77, respectively). Similarly, the proportion of supine and lateral sleep positions in position-dependent patients was 54.1% and 45.4% preoperatively, respectively. There were no significant differences in the proportion of each sleep

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<th>Table 1. Demographic Findings and Preoperative Polysomnographic Variables According to Positional Dependency</th>
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Abbreviations: AHI, apnea-hypopnea index; BMI, body mass index (calculated as weight in kilograms divided by height in meters squared).

a Values represent mean.

b P < .001 (unpaired t test).
The mean overall AHI declined from 50.0 to 35.4 in position-independent patients \( (P = .045) \) and from 30.9 to 22.9 in position-dependent patients \( (P = .002) \) after UPPP. In terms of sleep position–specific AHI, the surgical outcome was different between position-independent and position-dependent patients. In the position-independent patients, the lateral AHI decreased from 45.5 to 18.5 \( (P = .02) \), whereas the supine AHI did not change significantly \( (P = .35) \). In position-dependent patients, the supine AHI decreased from 51.1 to 35.3 \( (P < .001) \), whereas the lateral AHI exhibited no apparent changes \( (P = .37) \) postoperatively (Table 2).

### CHANGES OF OVERALL AND POSITION-SPECIFIC AHI AFTER UPPP

The position-specific success rates following UPPP were significantly different between position-independent and position-dependent patients. The lateral success rate of the position-independent patients was significantly higher than that of the position-dependent patients, whereas the supine success rate was not significantly different between the groups.

### CHANGES IN PDS AFTER UPPP

As mentioned in the “Analysis of Sleep Position and Positional Dependency” subsection of the “Methods” section, PDS was defined as the ratio of lateral to supine AHI. The PDS declined markedly from 1.01 to 0.39 after UPPP in position-independent patients \( (P = .001) \). Positional dependency was achieved by 64% (14 of 22) of position-independent patients after UPPP.

### SUCCESS RATES AFTER UPPP

The overall success rates after UPPP were only 31.8% and 34.6% in position-independent and position-dependent patients, respectively. The supine and lateral success rates were both 32.7% in position-dependent patients; however, in position-independent patients, the lateral success rate reached 68.2%, whereas the supine success rate was only 27.3%. The lateral success rate was significantly higher in position-independent patients than in position-dependent patients \( (P = .01) \), and the supine success rate was not significantly different between the groups \( (P = .52) \) (Figure 1).

### SUCCESS RATES ACCORDING TO SEVERITY OF OSA

Of 22 position-independent patients, 9 had moderate and 13 had severe OSA; no patient had mild OSA. The overall success rates were 33.3% and 30.8% in patients with moderate or severe OSA, respectively. Among the 52 position-dependent patients, OSA was mild in 11, moderate in 31, and severe in 10. The overall success rates were not significantly different among these groups (Figure 2).

Unlike the overall success rates, the position-specific success rate exhibited distinct differences between patients with position-independent or position-dependent OSA. In position-independent patients, the lateral success rate was 87.5% in patients with lateral AHIs of 15 to 29 (moderate OSA severity) and 57.1% in those with lateral AHIs of 30 or more (severe). In position-dependent patients, the lateral success rate was 29.5% in patients with lateral AHIs of 5 to 14 (mild) and 62.5% in those with lateral AHIs of 15 to 29 (moderate). The supine success rate incidence in position-independent patients was 42.8% in patients with supine AHIs of 15 to 29 (moder-
ate) and 21.4% in those with supine AHIs of 30 or more (severe). The success rates were somewhat higher in position-dependent patients: 66.6% in patients with supine AHIs of 5 to 14 (mild), 50.0% in patients with supine AHIs of 15 to 29 (moderate), and 22.8% in those with supine AHIs of 30 or more (severe) (Figure 3).

According to several studies, positional dependency may be related to factors such as disease severity (AHI), body mass index, age, and sleep stages; the AHI is generally accepted to be most closely associated with positional dependency. Our study also showed that overall AHIs in position-independent patients were higher than those in position-dependent patients. Despite the differences in the overall AHIs, the mean supine AHI was almost the same between position-independent and position-dependent patients. Thus, positional dependency of the patients was ascribed to low lateral—not high supine—AHIs. Postoperatively, the overall AHI was improved in both position-independent and position-dependent patients. However, the position-specific surgical outcome differed between the groups. In position-independent patients, the lateral AHI declined markedly, whereas the supine AHI did not change significantly. However, in position-dependent patients, the supine AHI was reduced significantly and the lateral AHI remained almost the same. Improvement of lateral sleep-specific AHI in position-independent patients indicates that UPPP can result in patients becoming position dependent. The changes in PDS also clearly showed this tendency. The PDS in position-independent patients dropped from 1.01 to 0.39 after UPPP. When the patients were regrouped in accordance with postoperative AHI, 64% of position-independent patients were found to have become position dependent. This tendency directly influenced the position-specific success rates. Although overall success rates were as low as 31.8% and 34.6% in the position-independent and position-dependent patients, respectively, the lateral position-specific success rate in position-independent patients reached 68.2%. When the patients were divided into 3 subgroups according to position-specific severity, the lateral position-specific success rate was as high as 88% in position-independent patients with moderate lateral OSA severity.

Accordingly, it can be inferred that UPPP may enhance positional dependency in position-independent patients who have not been considered eligible for positional therapy. Several types of positional therapies, such as tennis ball techniques, the sleep vest, and the positioner, have been attempted since Cartwright adopted sleep position training by using a posture alarm to treat OSA in patients with positional dependency. Although those positional therapies have shown limited success, a recent article reported that positional therapy was equivalent to continuous positive airway pressure therapy at normalizing the AHI in patients with positional OSA, with similar effects on sleep quality and nocturnal oxygenation. Therefore, with the advent of new technologies, adherence to positional therapies can be expected to improve. In this regard, achievement of positional dependency after UPPP may have a clinical implication for positional therapy.

The mechanism of the alteration of positional dependency after UPPP is likely related to changes in anatomic structures. Although several attempts have been made to identify those changes, findings have varied, presumably because of several factors, including technical variations among surgeons and preoperative variability among patients. Despite the lack of agreement, the size and shape of the velopharyngeal and retropalatal cross-sectional areas are accepted as critical factors for successful treatment outcomes. The changes of positional dependency demonstrated in the present study are thought to be the result of the lengthening effect of the lateral diameter in the oropharyngeal area by the removal of palatine tonsils. The elongated lateral diameter achieved with UPPP may prevent gravity-associated sagging of the pharyngeal walls in the lateral position.

In conclusion, although the overall success rates were low in patients with OSA who underwent UPPP, lateral

![Figure 3](https://archotol.jamanetwork.com/)

Figure 3. The position-specific success rates according to the severity of obstructive sleep apnea (OSA). In the position-independent group (A and B), the lateral success rate was as high as 88% and 57% in patients with moderate and severe lateral OSA severity, respectively. Furthermore, in the position-dependent group (C and D), the lateral success rate was 63% in moderate lateral OSA severity.
sleep position–specific obstructive events were markedly alleviated in those with position-independent OSA. Accordingly, we suggest that UPPP may achieve positional dependency in these patients, making them eligible for use of positional therapy. However, because of the technical limitations of positional therapy at the present time, surgeons performing UPPP should keep in mind that respiratory disturbances that occur in the supine position may require additional treatment.

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