Oral device therapy for the upper airway resistance syndrome patient

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Statement of problem. Upper airway resistance syndrome (UARS) is characterized by repeated increases in resistance to airflow within the upper airway; this resistance results in arousal from sleep and excessive daytime sleepiness. There is no safe and efficacious therapy with good compliance for UARS.
Purpose. The effects of an anterior mandibular positioning device on respiratory function and sleep quality were evaluated polysomnographically in patients with UARS.
Material and methods. Thirty-two patients (15 women, 17 men; mean age 38.4 ± 6.4 years) were diagnosed with UARS based on a combination of clinical complaints. To be included in the study, all subjects had to demonstrate a score of <5 on the apnea-hypopnea index, a score of >10 on the Epworth sleepiness scale, and a score of >10 on an arousal index. An oral device was fabricated for each subject with copolyester foil and autopolymerizing resin. Subjects were scheduled for 2 separate overnight sleep stays, one before treatment with the oral device and one after a habituation period of 14 to 60 days. Respiratory function and sleep quality variables were recorded and compared before and after insertion of the device with the paired t test ($P > .01$)
Results. Patient scores on the Epworth sleepiness scale ($P < .0001$), multiple sleep latency test ($P < .0005$), and arousal index ($P < .0001$) and recorded values for minimal oxygen saturation ($P < .005$) and sleep efficiency ($P < .005$) improved significantly after insertion of the device. No major side effects were noted with use of the oral device.
Conclusion. Within the limitations of this study, the results suggest that an oral device may be an attractive initial treatment for UARS. (J Prosthet Dent 2002;87:427-30.)

CLINICAL IMPLICATIONS

Based on its effectiveness and patient compliance in this study, an oral device seems appropriate for the treatment of UARS, as well as sleep apnea syndrome or snoring.

Upper airway resistance syndrome (UARS) is a form of sleep-disorder breathing in which repetitive increases in resistance to airflow within the upper airway lead to multiple, brief arousals and daytime hypersomnolence.[1-3] Hypertension may be an important sequela of this disorder, likely resulting from autonomic and cardiovascular changes induced by negative intrathoracic pressure.[3] The definitive diagnosis of UARS is made when nocturnal esophageal pressure monitoring demonstrates crescendo changes in intrathoracic pressures followed by frequent arousals or microarousals.[1] Nasal continuous positive airway pressure (nCPAP) can be applied as an efficacious form of therapy, but low patient compliance may limit its practical use.[3] Predictable safety and efficacy of surgical treatments have yet to be demonstrated.

Oral devices that advance the position of the mandible and tongue have been used for the treatment of obstructive sleep apnea syndrome (OSAS) or snoring.[4-6] The American Academy of Sleep Medicine has issued practice guidelines that state that oral device therapy is indicated for simple snoring and mild OSAS and for moderate to severe OSAS if nCPAP is not accepted or if surgery is not appropriate.[7] The nCPAP is a highly effective treatment, but it is used by only 50% to 80% of patients on a long-term basis; patients with mild symptoms are more likely to discontinue treatment.[8] A crossover study reported that oral devices are effective for OSAS, especially for mild to moderate situations, and that they are associated with fewer side effects and greater patient satisfaction than nCPAP.[8] Although these devices also may be useful for UARS, detailed data from a large patient population are lacking. This study treated UARS patients with an oral device to evaluate its effect on respiratory function and sleep quality variables.

MATERIAL AND METHODS

Thirty-two patients diagnosed with UARS were selected for this study. The group comprised 15

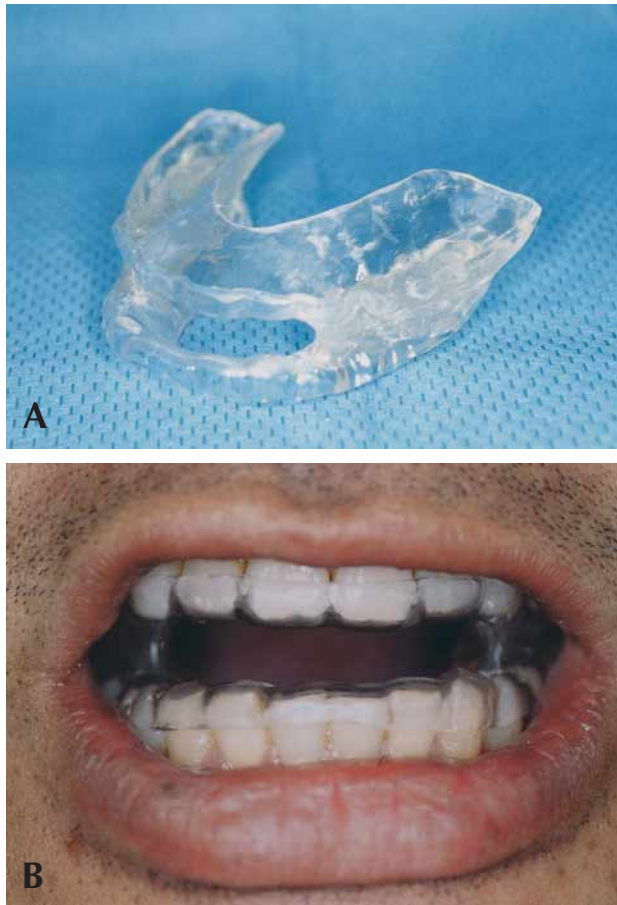[a]Assistant Professor, Department of Oral and Maxillofacial Surgery.

Fig. 1. Oral device for treatment of upper airway resistance syndrome. **A,** Anterior opening permits breathing and speech. **B,** Oral device in place.

women and 17 men with a mean age of 38.4 ± 6.4 years (range 28 to 49 years) and a mean body mass index of 25.2 ± 2.6 kg/m². UARS diagnosis was made based on a combination of clinical complaints such as daytime hypersomnolence and fatigue, snoring, and polysomnographic findings, as described previously.[9] Excessive daytime sleepiness was evaluated with the Epworth sleepiness scale (ESS).[10] To be included in the study, all patients had to demonstrate a score of <5 on the apnea-hypopnea index (AHI), a score of >10 on the ESS scale, and a score of >10 on the arousal index. The purpose of the study was explained to the patients, and all of them gave informed consent. An oral device (Fig. 1) was fabricated for each patient with copolyester foil and autopolymerizing resin as described previously.[4,6,11]

All patients underwent standard overnight polysomnography for 2 nights: once before insertion of the device, and again after a habituation period of 14 to 60 days after first use of the device. A computer (Medilog SAC 847 system; Oxford Instruments,

Oxford, England) was used to gather the data described previously.[4,11] The following parameters were monitored: electroencephalograms, electrooculograms, submental electromyograms, electrocardiograms, nasal and oral airflow, thoracic and abdominal chest movement, finger oxymetry, and body position. Apnea, hypopnea, and sleep staging were determined as reported previously.[6,11]

Sleep efficiency was defined as the total sleep time divided by the time from sleep onset to final awakening in the morning. An arousal was analyzed if sleep was interrupted by continuous alpha activity and increased electromyographic activity for more than 3 seconds. The morning after each overnight study, patients underwent a multiple sleep latency test (MSLT) in accordance with published guidelines.[12] The effect of the oral device on snoring was estimated by a bedroom partner on a 4-grade scale: satisfactory effect, slight effect, no effect, or worsened effect. Ten of the 32 patients did not snore.

Changes in the tested parameters before and after insertion of the device were assessed with the paired *t* test. The research hypothesis was rejected at the 1% level (*P*<.01) to reduce the chance that the multiple *t* test would be significant by chance alone.

RESULTS

ESS scores decreased significantly (*P*<.0001), from a mean of 13.2 ± 1.3 before treatment to 5.8 ± 1.1 with the oral device. The mean MSLT score increased significantly (*P*<.0005), from 6.3 ± 3.3 min to 12.9 ± 6.9 min. Snoring was satisfactorily reduced in all 22 snorers as estimated by a bedroom partner.

Table I presents a summary of pretreatment and post-treatment polysomnographic recordings. Initially, the mean AHI was 3.1 ± 2.0; it decreased significantly (*P*<.0001) after insertion of the device (1.9 ± 1.8). Minimal oxygen saturation was significantly higher (*P*<.0005) with than without the device. Changes in sleep structure were in the direction of improvement with the device. Mean wake time decreased from 9.7% ± 3.9% to 6.4% ± 2.6% (*P*<.005), and mean rapid eye movement sleep increased from 15.2% ± 4.1% to 21.6% ± 3.4% (*P*<.0001). Sleep efficiency improved significantly (*P*<.005). Total arousal index scores declined significantly (*P*<.0001) after insertion of the device, from 35.5 ± 8.8 to 8.9 ± 4.1.

Three patients experienced transitory discomfort of the masticatory muscles or temporomandibular joint after first use of the device; within a few days, the discomfort disappeared spontaneously. Side effects such as excessive salivation and transient tooth discomfort were minor and tolerable. No serious complications were observed. The mean follow-up was 18.2 ± 3.5 months, during which time all patients continued to wear the device.

Table I. Polysomnographic findings with and without the oral device tested in this study

	Pretreatment (mean ± SD)			Post-treatment (mean ± SD)			*P* value
Apnea-hypopnea index (No/h)	3.1	±	2.0	1.9	±	1.8	.0001
Apnea index (No/h)	1.0	±	0.8	0.4	±	0.3	.0001
Mean oxygen saturation (%)	95.0	±	1.8	95.4	±	1.7	NS
Minimal oxygen saturation (%)	85.4	±	3.8	89.4	±	1.9	.0005
Total sleep time (min)	435.6	±	44.6	450.3	±	37.9	NS
Sleep efficiency (%)	85.4	±	4.8	90.3	±	4.6	.005
Wake time (%)	9.7	±	3.9	6.4	±	2.6	.005
Stage 1 sleep (%)	10.9	±	4.9	8.7	±	2.3	NS
Stage 2 sleep (%)	55.2	±	10.0	50.6	±	5.8	NS
Stage 3 sleep (%)	6.9	±	5.2	8.9	±	2.9	NS
Stage 4 sleep (%)	2.0	±	2.9	3.7	±	1.7	NS
Rapid eye movement sleep (%)	15.2	±	4.1	21.6	±	3.4	.0001
Arousal index (No/h)	35.5	±	8.8	5.8	±	1.1	.0001
ESS (point)	13.2	±	1.3	5.8	±	1.1	.0001
MLST (min)	6.3	±	3.3	12.9	±	6.9	.0005

NS = not significant; *ESS* = Epworth sleepiness scale; *MSLT* = multiple sleep latency test.

DISCUSSION

This study is the first to demonstrate polysomnographically the effects of an oral device for the treatment of UARS on respiratory function and sleep quality variables. Nocturnal esophageal pressure monitoring is the gold standard for the definitive diagnosis of UARS.[3] Factors preventing its widespread use include patient refusal or intolerance and the technical expertise and expense associated with the method.[13] Without the use of esophageal pressure monitoring, many patients are diagnosed with UARS on the basis of the qualitative perception of possible respiratory-related arousals from standard nocturnal polysomnography.[3] In the present study, patients were diagnosed with UARS based on clinical inclusion criteria, as described previously.[9]

Oral devices are fabricated with the goal of moving the position of the mandible and tongue forward to minimize the possibility of oropharyngeal obstruction. Patients with UARS present a narrow posterior airway space behind the base of the tongue.[2] On the basis of cephalometric radiographs, oral devices have been shown to increase various upper airway dimensions in patients. Hypotonia of the masticatory and tongue muscles and the weight of the mandible, particularly in the supine position, can lead to passive mouth opening and further dorsal displacement of the mandible and tongue, which in turn can result in pharyngeal narrowing and airway resistance.[14] It has been suggested that an oral device works by maintaining the activity of the muscles, protracting the tongue and holding the mandible in an increased vertical and protrusive position.[14] As a result, repeated increases in resistance to airflow within the upper airway seemed to be reduced.

In this study, significant reductions in arousal and excessive daytime sleepiness were accomplished with the use of an oral device.

CONCLUSIONS

Within the limitations of this study, the results suggest that an oral device is an important treatment option and may be the preferred initial treatment for upper airway resistance syndrome.

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Noteworthy Abstracts of the Current Literature

Clearance of biofilms from dental unit waterlines through the use of hydroperoxide ion-phase transfer catalysts.
Shepherd PA, Shojaei MA, Eleazer PD, Stewart AV, Staat RH.
Quintessence Int 2001;32:755-61.

Purpose. The American Dental Association has proposed a goal of no more than 200 colony-forming units per millimeter of water in dental water supply lines. This study evaluated the clinical effectiveness of the hydroperoxide ion-phase transfer catalyst (HPI-PTC) cleaner for both initial removal of biofilms from dental unit water lines (DUWLs) and subsequent maintenance of the lines.

Material and methods. Samples from DUWLs were collected from 9 operatories at the University of Louisville Dental School and from 108 private practice clinics throughout the United States. Samples were collected in sterile specimen cups from the high-speed air-water syringe. Tap water samples also were taken from most locations. All samples were received in the laboratory within 24 hours of collection. Samples were plated on appropriate bacteriologic media and incubated. The presence or absence of biofilms was confirmed by scanning electron microscopy. Twenty-two of the dental units were retrofitted with independent water systems; the cleaning procedure involved an overnight application of an HPI-PTC cleaner followed by a 2-minute water rinse.

Results. The data were organized according to pretreatment recovery of planktonic bacteria, major planktonic bacterial types, predominant streptococci species, and recovery of planktonic bacteria from waterlines before and after cleaning. Water from both the air-water syringe and the high-speed handpiece lines from all untreated units contained at least 6×10^2 colony-forming units per millimeter of planktonic or free-floating bacteria; the average was 1.4×10^5 CFU/mL. An initial 5% solution of HPI-PTC cleared the lines of any apparent biofilm after being applied for 3 consecutive days. Thereafter, weekly use of the cleaner maintained the dental unit water supplies free of significant numbers of planktonic organisms.

Conclusion. A cleaner containing the hydroperoxide ion coupled with phase transfer catalysts was able to maintain bacterial counts well below the American Dental Association goal. 30 References.—*ME Razzoog*