

# Role of Oral Appliances in the Management of Sleep Disorders

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## Abstract

**Background:** A study was undertaken with the aim to evaluate the therapeutic and clinical efficacy of oral appliances in the management of upper airway sleep disorders like snoring and obstructive sleep apnea (OSA).

**Methods:** Oral appliances were prescribed in eight cases of non - apneic snoring and 42 polysomnography (PSG) diagnosed cases of OSA. The cases were assessed on Epworth Sleepiness Scale (ESS) and Apnea – Hypopnea Index (AHI).

**Result:** 62.5% of the non - apneic snoring cases reported gross reduction/cessation of snoring. In the OSA cases, the mean AHI and ESS scores decreased from  $51.48 \pm 23.70$  to  $32.78 \pm 18.06$  and  $12.50 \pm 3.57$  to  $7.20 \pm 2.917$  respectively. A statistically significant ( $p < 0.0001$ ) improvement in AHI and ESS scores was observed.

**Conclusion:** Short term therapeutic efficacy of oral appliances therapy in non-apneic snoring and OSA cases was observed.

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**Key Words :** Snoring; Obstructive sleep apnea; Oral appliances

## Introduction

Sleep disorder of the upper airway results from any condition or disease that causes complete or partial obstruction when patient goes to sleep in supine position. Common upper airway sleep disorders are snoring, upper airway resistance syndrome (UARS), obstructive sleep apnea (OSA) and sleep bruxism. Polysomnography (PSG) is considered as gold standard for diagnosing sleep disorders and the management protocol includes behavior modification, sleep position changes, weight control, continuous positive air pressure (CPAP), oral appliances and surgery. Mandibular advancement devices are the commonly prescribed oral appliances (OA). They help in placing the mandible in a protruded position during sleep. These oral appliances help in increasing the retroglossal and retropalatal space when the patient assumes a supine position or in sleep. The aim of the study was to evaluate therapeutic and clinical efficacy of oral appliances in the management of upper airway sleep disorders. We also compared baseline Apnea Hypopnea Index (AHI) and Epworth Sleepiness Scale (ESS) scores after the use of oral appliances.

## Material and Methods

Oral appliances for non - apneic snoring were prescribed for eight cases of which five were males and rest females with mean age of 49 and 44.5 years respectively. Oral appliances were also prescribed for 42 polysomnography (PSG) diagnosed OSA cases. In 30 cases the PSG was done 3-4

weeks following insertion of oral appliances. All the cases were referred after evaluation and PSG study by the Department of Respiratory Medicine. The inclusion criteria for oral appliance therapy were:

- Primary non - apneic snoring of adults
- Adults with mild OSA who do not respond or are not appropriate candidates for treatment with behavioral measures or sleep position change
- In patient of moderate and severe OSA who are intolerant or refuse treatment with nasal CPAP
- Patients who refuse or who are not candidates for tonsillectomy, adenoidectomy, maxillo-mandibular advancement surgery and tracheostomy.

The exclusion criteria were:

- Children with upper airway sleep disorders
- Central and mixed sleep apnea
- Patients who could protract the mandible to a maximum of 5 mm
- Completely edentulous cases
- Patients with advanced periodontal disease and multiple mobile teeth
- Patients with pre existing temporo- mandibular joint disorders
- Patients with maximum inter incisal opening of less than 35 mm.

The baseline characteristics of the study subjects with OSA are summarized in Table 1. Case details were recorded

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on a sleep disordered breathing examination form. ESS was recorded in all the cases. All cases were subjected to lateral cephalograms at end expiration for craniofacial analysis.

Oral appliances prescribed were Karwetzky activator (KZY), mandibular advancement splint (MAS), tongue retaining device (TRD) and Herbst appliance (HST) (Fig. 1-4) and their distributions is given in Table 2.

The standard clinical and laboratory protocol for fabrication of removable functional orthodontic appliances was followed. During bite recording the mandibular advancement did not exceed 70% of the maximum protrusion. Vertical opening did not exceed 3-4 mm beyond free way space. In eight cases the oral appliance had to be refabricated two or more times as the patients did not report improvement subjectively or found it uncomfortable due to excessive vertical opening. PSG with oral appliance was performed only after the patient reported subjective improvement and was performed after 3-4 weeks of use. The patients were asked to use oral appliance only in the night.

**Table 1**

**Baseline characteristics of the study subjects**

Characteristic	PSG diagnosed OSA cases
Number	30
Age (mean $\pm$ SD)	52.73 $\pm$ 11.95
Sex distribution	
Male	20
Female	10
BMI (mean $\pm$ SD)	29.5 $\pm$ 4.33

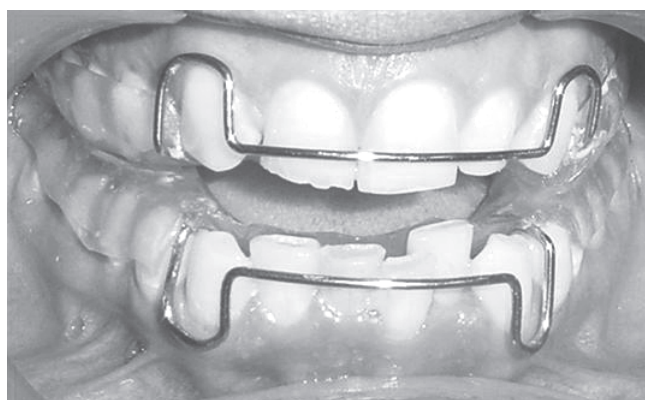


Fig. 1 : Intra oral frontal view of Karwetzky Activator.

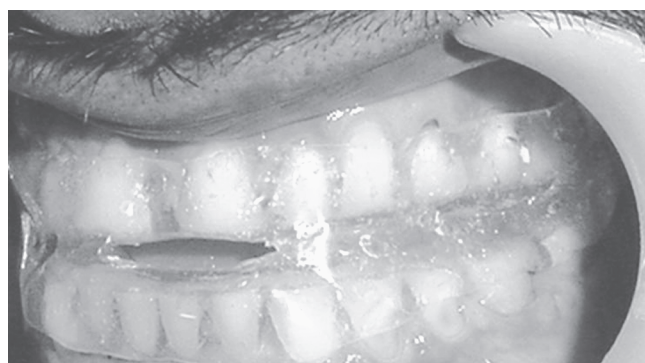


Fig. 2 : Intra oral lateral view of Mandibular Advancement Splint.

The data base was compiled on MS Excel worksheet and SPSS version 13 was used for analysis. Appropriate statistical tests of significance were carried out.

## Results

Of the eight cases treated with Karwetzky activator for non - apneic snoring, 5 (62.5%) reported gross reduction/cessation in intensity and frequency of snoring, while 3 (37.5%) did not respond to therapy.

Out of 42 cases of PSG diagnosed OSA cases, 30 underwent PSG with OA. Twelve cases were lost to follow up. Comparison of pre AHI scores (diagnostic PSG) with post AHI scores (PSG with OA in-situ) showed a decrease from  $51.48 \pm 23.70$  to  $32.79 \pm 18.06$ . A highly significant ( $p < 0.0001$ ) improvement in AHI was observed (Table 3). In two cases post treatment AHI increased and in one there was no change in pre and post treatment AHI.

Pre and post ESS score showed a mean decrease from  $12.50 \pm 3.57$  to  $7.20 \pm 2.917$  (Table 4). However no change in ESS score was observed in three cases. A highly significant ( $p < 0.0001$ ) improvement in ESS score was observed.

The average improvement in AHI was 36.89%, with 40%

**Table 2**

**Type and distribution of oral appliance**

Type of OA	Frequency	Percentage
KZY	12	40.0
MAS	5	16.7
TRD	6	20.0
HST	7	23.3

KZY : Karwetzky activator; MAS : Mandibular advancement splint; TRD : Tongue retaining device; HST : Herbst appliance

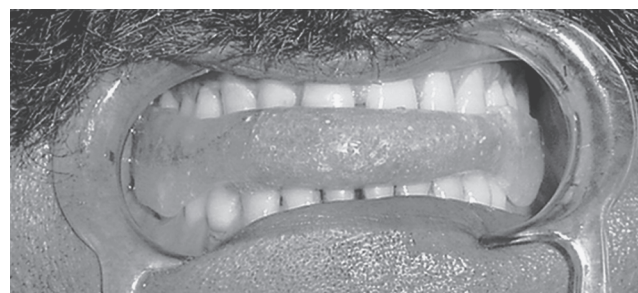


Fig. 3 : Intra oral frontal view of Tongue Retaining Device

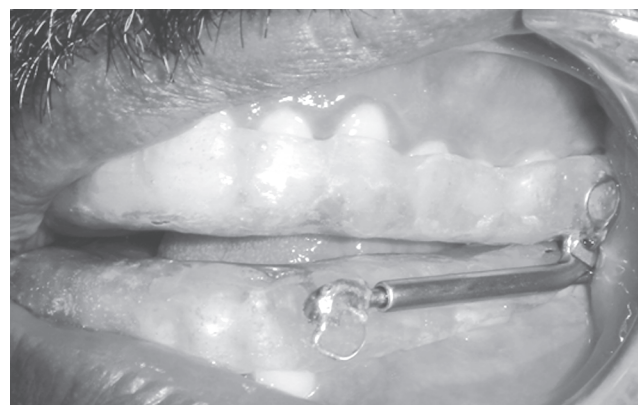


Fig. 4 : Intra oral lateral view of Herbst Appliance

**Table 3**

Comparison of pre and post AHI with OA therapy

Characteristic	Values
Pre-treatment AHI (mean $\pm$ SD)	51.48 $\pm$ 23.70
Post-treatment AHI (mean $\pm$ SD)	32.79 $\pm$ 18.06
Z value	- 4.144
p value	0.000

Wilcoxon signed ranks test

cases showing 50% or more improvement. Three patients, who were prescribed TRD, complained of inability to retain the tongue in the tongue bulb for longer period. Seven patients reported pain in the TMJ region and headache during first week with oral appliance therapy, which improved subsequently. Karwetzky activator showed 49.75% improvement in AHI.

## Discussion

Non - apneic snoring and OSA are common upper airway sleep disorders. OSA is characterized by repetitive episodes of complete or partial airway obstruction leading to diminished or absent air flow to the lungs. These apneic/ hypopneic spells last for 10-30 seconds. Prevalence studies in western countries estimate 4% of middle aged men and 2% of middle aged women in the general population would meet the minimum criteria for sleep apnea syndrome [1]. Estimated prevalence of sleep disordered breathing is 19.5% and OSA is 7.5% in urban Indian males [2].

Snoring is the commonest sleep disorder. The obstruction happens when the base of the tongue obstructs upper airway in supine position during sleep. With a reduced airflow, the patient increases the speed of the airflow in an attempt to maintain the required oxygen to the lungs. The increase in the airflow velocity causes vibration of the soft tissues. This vibration is the sound of snoring [3].

A randomized control trial of oral appliance for management of severe snoring in 2001 concluded that mandibular advancement appliance was significantly more effective than the placebo in reducing the frequency and loudness of snoring, the reported day time sleepiness and frequency of morning tiredness. In this study 84% reported reduction in snoring loudness and 76% reported snoring on fewer nights per week [4]. In our case series 62.5% reported gross reduction/ complete cessation of snoring. 37.5% discontinued treatment for non-apneic snoring as partners reported no improvement with Karwetzky activator and two cases reported excessive salivation.

The upper airway is a non - rigid structure. During inspiration the negative pressure tends to cause a change in the shape of the airway which is resisted by activity of tensor veli palatini and genioglossus [5]. It is the

**Table 4**

Comparison of pre and post ESS score with OA therapy

Characteristic	Values
Pre-treatment ESS score (mean $\pm$ SD)	12.50 $\pm$ 3.57
Post-treatment ESS score (mean $\pm$ SD)	7.20 $\pm$ 2.917
Z value	-4.553
p value	0.000

Wilcoxon signed ranks test

perfect synchrony of the activity of various muscle groups that keeps the airway open. In the OSA cases there is reduction in the activity of those muscles that result in decreased airway space. In cases of obvious mandibular deficiency or functional retrusion, the tongue is placed posteriorly resulting in obstruction.

Obesity can also narrow the upper airway. The mean body mass index (BMI) in our study group was  $29.5 \pm 4.33$  which suggests that most were obese. The narrowing of retro-palatal space can occur due to approximation of soft palate with posterior pharyngeal wall. This can occur due to increased length and width of soft palate as well as maxillary deficiency which can occur due to hypoplastic or retrognathic maxilla. Posterior and inferior placement of hyoid bone also can be a contributing factor. All cases of OSA snore but all snoring cases need not have OSA. In our study population all cases reported snoring.

Lateral cephalograms were useful for evaluating upper airway and craniofacial pattern. We observed decreased posterior airway space, increased hyoid distance, increased length of soft palate and decreased SNB angle in OSA cases [6]. In many cases lateral cephalograms were recorded with OA in situ to evaluate its effect on posterior airway space, hyoid position and thus predict prognosis.

A review of oral appliance therapy for OSA in 1995 signaled the entry of dentistry into the field of mainstream sleep medicine [7]. Adjustable mandible advancing oral appliances became the predominant form of dental therapy for sleep disordered breathing in 1990's. Controlled studies during the same period indicate effectiveness and greater patient preference for oral appliances as compared to CPAP in mild and moderate OSA [8].

Oral appliances are indicated for use in patients with primary snoring, mild and moderate OSA cases who do not respond or are not appropriate candidates for treatment with behavioral measures such as weight loss or sleep position change. It can also be considered in patients who are not amenable to CPAP therapy or surgery. In the present case series the mean AHI scores decreased from  $51.48 \pm 23.70$  to  $32.79 \pm 18.06$ . As per international norms 50% reduction in AHI scores is



considered successful treatment. We could not achieve the same in our case series. However the improvement in AHI scores was statistically significant ( $p < 0.0001$ ). Twelve cases in the present study showed 50% reduction in AHI scores. This can be attributed to the fact that 20 cases in the study population treated had severe OSA (AHI  $> 40$ ) where oral appliance therapy is not the first choice.

One of the case with severe OSA who was not amenable to CPAP therapy, was treated with acrylic Herbst splint appliance. The AHI improved from 75.2 to 48.3 and AI decreased from 51 to 8 [9]. The case also reported marked improvement subjectively. In another case a 52 year old female patient with severe OSA, switched over from CPAP therapy to OA therapy. Karwetzky activator was used in this case. In this case the AHI decreased from 43.6 to 17.9.

Studies with mandibular advancement appliances have shown that there is an increase in size of the pharyngeal airway at both post palatal and post lingual airway dimensions [10]. Oral appliance which mechanically holds the mandible in the forward position causes the constricted upper airway to enlarge and reduce the collapsibility of the upper airway particularly in the velopharynx region during wakefulness and sleep. Forward displacement of mandible stretches the soft palate ventrally since lateral wall of soft palate connects to the base of the tongue via palatoglossus arch [11].

All the appliances were made of hard acrylic. Most modern laboratories make appliances with thermoplastic materials which is more comfortable. We had to re-fabricate the mandibular advancement appliances more than once in eight cases for achieving optimum subjective improvement. This is avoided if one uses titratable oral appliances. In a recent study Thornton adjustable positioner (TAP), which is a titratable mandibular protrusive appliance, was examined for initial effects with PSG in patients with OSA and a predictable AHI based results were achieved [12].

Karwetzky activator was most patient friendly in our study, which permitted some amount of titration by adjusting the loops of the appliance. The mean AHI improved from 46.50/hr to 23.37/hr suggesting a 49.75% improvement thus meeting international norms. This is agreement with a recent study by Rose et al [13]. However, they were not clear if oral appliance therapy could be recommended for life.

Significant ( $p < 0.0001$ ) improvement in ESS score was observed. This subjective scale includes assessment criteria like sleepiness experienced while driving a motor car and sleepiness following lunch after consumption of alcohol. This cannot always be applied always in our

population as many of our patients do not drive car particularly elderly women. Therefore there is a need to modify the Epworth sleepiness scale to suit our conditions.

In our study post treatment AHI scores increased in two cases and did not show any difference in one case. It is not clear as to why oral appliance were effective in most except three cases. Various individual anatomic factors, the degree of vertical and sagittal opening, the skeletal pattern of the skull and oro-pharyngeal tissue compliance may influence therapeutic efficacy as reported in the literature [14].

A review by Ferguson et al [15], on oral appliance therapy for OSA concluded that majority of published trials on oral appliance therapy are small, short term and usually retrospective in design, without or any control or comparison group. Many of the studies have poorly designed outcome criteria, usually subjective and a failure of all patients to have a PSG at base line and outcome. Most studies excluded the patients with severe OSA and included patients who failed other treatment modalities with significant source of bias [15]. Although the present study has not considered controls/ comparison groups, it has included severe OSA cases and the outcome has been evaluated vide PSG and ESS in all the cases.

We have observed short term therapeutic efficacy of oral appliances both subjectively and by PSG. We recommend long term multicentric studies to evaluate the continued efficacy of oral appliances in treating OSA. Although less efficacious than CPAP for improving the PSG indices, oral appliances are preferred by the patients. This has the potential of translating into better patient compliance and an equivalent health outcome.

### Conflicts of Interest

This study is funded by the research grants from the Office of DGAFMS.

### Intellectual Contribution of Authors

*Study Concept* : Lt Col B Jayan

*Drafting & Manuscript Revision* : Lt Col B Jayan

*Statistical Analysis* : Lt Col B Jayan

*Study Supervision* : Col RK Dhiman, Brig BNBM Prasad, SM, VSM

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