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Treatment of Severe Obstructive Sleep Apnoea Using a Customized Mandibular Repositioning Appliance – A Case Report

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Abstract

Mandibular advancement devices are known to be effective in treating mild to moderate obstructive sleep apnoea and provide a viable treatment alternative for patients intolerant to continuous positive airway pressure therapy. This case report describes the treatment of severe obstructive sleep apnoea in a 42 year old patient using a customized mandibular repositioning appliance. Following clinical examination, the diagnosis of obstructive sleep apnoea was established through epworth sleepiness scale subjective questionnaire, lateral cephalogram and polysomnography following which a custom made mandibular repositioning appliance was fabricated with an advancement of 60% of maximum mandibular protrusion. The 2 year follow up results confirmed significant improvement in pharyngeal airway width substantiated through marked decline in apnoea/hypopnoea index values providing relief from day time discomforts associated with sleep apnoea and improving quality of sleep. The case report concluded that customized mandibular repositioning appliances can be used as an effective and efficient alternative therapeutic option for patients with severe obstructive sleep apnoea.

Keywords: Obstructive sleep apnoea, Mandibular repositioning appliance, Epworth sleepiness scale, Polysomnography

Introduction

Obstructive sleep apnoea (OSA) is a chronic condition characterized by frequent episodes of upper airway collapse during sleep, probably caused by the combination

of an anatomically narrow upper airway and a failure of the dilating muscles to overcome the negative intrathoracic inspiratory pressure.[1] OSA is considered one of several potentially treatable contributors to systemic hypertension, and has been associated with coronary artery disease, stroke, congestive heart failure, atrial fibrillation, increased motor vehicle accident rate, sleepiness, impaired quality of life, and increased mortality.[2] Continuous positive airway pressure (CPAP) is considered the gold standard treatment option for OSA because its use can improve sleep-related symptoms and quality of life. CPAP acts as a pneumatic splint that stabilizes the upper airway with constant positive pressure via a mask interface. Other positive airway pressure modalities are available for patients intolerant to CPAP or requiring high levels of positive pressure.[3] Bilevel PAP ventilation provides two different levels of pressure (higher during inhalation and lower during expiration) and can potentially treat OSA at a lower mean pressure than CPAP, whereas Auto-CPAP automatically and continuously adjusts the delivered pressure (within a maximal and minimal value, set by the operator) in order to maintain upper airway patency following changes in airflow resistance.[4] Even though various advances evolved overtime with the airway pressure treatment for masking the difficulties encountered, patient compliance were still not addressed. Oral appliance (OA) therapy is a unique, established approach that provides better sleep quality to patients suffering from snoring and mild-to-moderate OSA with excellent patient compliance. Mandibular repositioning appliances (MRA) cover the upper and lower dentition and hold the mandible in a forward position with respect to the resting position and can be customizable which enhances precision fit of the appliance. Mandibular protrusion advances the tongue position and subsequently increases oropharyngeal volume and it provides a viable alternative for patients intolerant to CPAP therapy. MRAs were believed to exert their effects predominantly in the oropharynx and hypo pharynx but some studies have suggested an effect on the retro palatal airway as well.[5] A recent study demonstrated that treatment with mandibular advancement splints produced statistically and clinically significant psychosocial and cardio-respiratory improvements in patients suffering from OSA.[6] The present case report aims to evaluate the effectiveness of customized MRA on severe OSA patients intolerant to CPAP.

Case Report

A 42yr old male patient reported to the department of orthodontics with a chief complaint of loud snoring and daytime sleepiness. The patient's demographic data was recorded and evaluated along with pre-treatment photographs (Figure 1). The body mass index (BMI) was calculated using the method described by Revicki and Israel (1986)[2] (BMI = Weight kg/Height m2). The subject was overweight, with a BMI of 31.16 kg/m^2. The size of patient's neck was determined using a measuring tape around the neck just below the prominence of the thyroid cartilage and the neck circumference measured was 19.5 inches.

Diagnosis

After dental and stomatognathic examination, patient was evaluated with Epworth sleepiness scale (ESS) subjective sleep study questionnaire, lateral cephalogram and polysomnography (PSG). The ESS score (range, 0-24) is usually elevated in sleep apnoea patients, indicating a propensity to fall asleep. An ESS score above 10 was considered abnormal. The patient was instructed to fill the questionnaire at the beginning of treatment and recorded with ESS score of 17. Lateral cephalograms were made in an upright position and with the teeth in intercuspation and the patient's head supported by a cephalostat and

oriented according to the Frankfort horizontal plane (Figure 2). Pharyngeal airway width was assessed between the anterior and posterior pharyngeal wall along five reference planes (Figure 3). Hyoid bone position was recorded vertically in relation to these reference planes (Figure 3). The reference planes used is depicted in Table 1. PSG study comprised recordings of the pulse rate, apnoea/hypopnea index (AHI), oxygen desaturation index (ODI), respiratory disturbance index (RDI), arterial blood oxygen saturation (SaO_2), respiratory movements, intensity and duration of snoring, and body positions.

Customized mandibular repositioning appliance

Customization of MRA was carried out using digital or physical impressions of the dentition which is then transferred to dental laboratory. In this case, a physical dental impression of the upper and lower arch was made using polyvinyl siloxane (PVS) impression material for the fabrication of MRA. Bite registration was done using George bite gauge (Great Lakes Orthodontics, Ltd., New York, USA) with mandibular advancement of 60% of maximum mandibular protrusion (Figure 4). Vertical opening of mandible was kept as low as possible around 3mm using standardized 3mm bite fork. Custom made MRA ($MicrO_2$ sleep & snore device - Prosomnus™ USA) (Figure 5) was fabricated using high grade polymethyl methacrylate (PMMA). Customization provides adequate fit for the appliance even after long term use with fewer negative effects on the dentition. Sequential advancement of the mandible was carried out using 3 set of appliances with 1mm titration every 6 month for a time interval of 2 year. Lateral cephalogram with MRA shown in Figure 6.

Results

The results of overnight polysomnography are shown in Table 2. There was a significant improvement in AHI, from 60.6 events/h to 28.6 events/h, the SaO_2 nadir increased from 84.4% to 97%. The patient reported improvement in sleep quality and in his quality of life, presenting more disposition for his daily activities, without daytime sleepiness (the patient scored 4 points in the ESS after the treatment from a pre-treatment score of 17). Corresponding positive change was observed in pharyngeal airway width and hyoid bone position in after treatment along the five reference planes namely nasal floor (NF), occlusal plane (OP), mandibular plane (MP), base of C2 and base of C3 (Table 3). The case report substantiates the efficiency of custom fit MRA with very minimal negative effects in occlusion apart from angular relationships of incisors with their respective jaws with no post-treatment change in occlusion (Figure 7)

Discussion

The literature revealed fewer numbers of treatment strategies and case reports on managing cases of severe OSA using customized MRAs. OAs has emerged as an alternative treatment modality to CPAP for OSA treatment. OAs are designed to improve upper airway configuration and prevent collapse through alteration of jaw and tongue position. Current practice parameters of the AASM indicate OA as first-line therapy in patients with mild-to-moderate OSA and in more severe OSA patients who fail treatment attempts with CPAP therapy.[7] In the present case report, however, a positive effect was also registered in patients with severe OSA, a result that confirms those of Cohen.[8] Apart from AHI, other parameters used were ODI, SaO_2, RDI, Heart rate and Snoring. We found a strong positive correlation between PSG parameters of OSA severity and the amount of improvement in those PSG parameters with the device. In the current study, the mean oxygen saturation level improved from 86.78% ± 3.31% to 96.12% ± 1.57%. Similar improvements in oxygen saturation levels with oral appliances were reported by Bernhold and Bondemark,[9] and Bonham et al.[10]Increased ESS scores

indicate increased daytime sleepiness, and vice versa. A positive correlation between pre-treatment values of ESS and AHI is helpful to distinguish patients with mild, moderate, and severe OSA according to the ESS scores. Murray WJ[11] reported similar findings. The anteroposterior dimension at the smallest cross-section of the airway shows the severity of the obstruction of the upper airway in the sagittal plane. In the current study posterior airway space, i.e. the space between the base of the tongue and the posterior oropharynx in relation to NF, OP, MP, base of C2, the base of C3 was significantly increased from baseline with OA therapy. Similar results were reported by Schmidt-Nowara WW et al[12] The hyoid bone plays an important role in maintaining the upper airway dimension.[13] Because it serves as an anchor for the lingual musculature, it has received considerable attention, and inferior positions of this bone have been widely reported in patients with OSA.[14] current study substantiates the efficiency of custom fit MRA with very minimal negative effects in occlusion apart from angular relationships of incisors with their respective jaws. These devices provide a precision fit and sequential advancement through multiple set of appliance which permit the patient to gradually learn to advance the jaw forward, improving their effectiveness. They are likely to be more comfortable and used more frequently by the patient to control OSA. Johal A et al[15] compared the effectiveness of a custom-made versus ready-made MRDs in the management of OSA which demonstrated significant clinical effectiveness of a custom-made mandibular repositioning device over ready-made particularly in terms of patient compliance and tolerance.

Conclusion

OSA is indeed a health condition, which comes with fair share of psychological trauma and may lead to confecting heart murmur and sudden death, which can be reduced to a great extent by use of this cost effective and simple to use MRA. The current report confirms that treatment with MRA is a valid therapeutic option for patients with mild-to-moderate OSA and for severe OSA patients who has non-compliance towards CPAP, if the improvement of respiratory parameters can be confirmed during follow-up PSGs.

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Legends Table and Figure

Table 1: Definition of reference planes used

Reference Planes
NF- Nasal floor; a line connecting anterior nasal spine (ANS) and posterior nasal spine (PNS)
OP- Occlusal plane; a line connecting Mc and the incisal tip of the most prominent maxillary incisor (is)
MP-Mandibular plane; line tangent to the lower border of the body of the mandible through menton (Go-Me)
Base of C2 (2nd cervical vertebrae) – a line connecting aC2 and pC2
Base of C3 (3rd cervical vertebrae) – a line connecting aC3 and pC3

Table 2: Comparison of pre- treatment and post-treatment Polysomnography parameters

Variables		Values
AHI (/h)	Pre	60.6
	Post	28.6
ODI (/h)	Pre	69.2
	Post	17.6
RDI (/h)	Pre	60.6
	Post	28.6
SaO_2 (%)	Pre	84.4
	Post	97
HR (bpm)	Pre	62.8
	Post	54.1
SNORING (%)	Pre	52.6
	Post	31.6

AHI- Apnoea/hypopnea index, ODI- Oxygen desaturation index, RDI- Respiratory disturbance index, SaO_2- Oxygen saturation of arterial blood, HR- Heart rate, bpm- beats per minute

Table 3: Comparison of pre-treatment and post-treatment lateral cephalometric variables

Variables		Values
Pharyngeal dimensions (mm)		
P- NF	Pre	17
	Post	17

P- OP	Pre	7
	Post	9
P- MP	Pre	10
	Post	11
P- aC2	Pre	9
	Post	11
P- aC3	Pre	11
	Post	10
Hyoid position (mm)		
HY-NF	Pre	69
	Post	67
HY-OP	Pre	54
	Post	51
HY-MP	Pre	27
	Post	23
HY-aC2	Pre	44
	Post	46
HY-aC3	Pre	35
	Post	37

P- pharynx, HY- hyoid bone, NF- nasal floor, OP- occlusal plane, MP- mandibular plane,
aC2- base of C2, aC3- base of C3

Figure 1: Pre-treatment extra oral and intra oral photographs

Figure 2: Pre-treatment lateral cephalogram

Figure3: Pre-treatment lateral cephalogram tracing measuring pharyngeal dimension and hyoid position

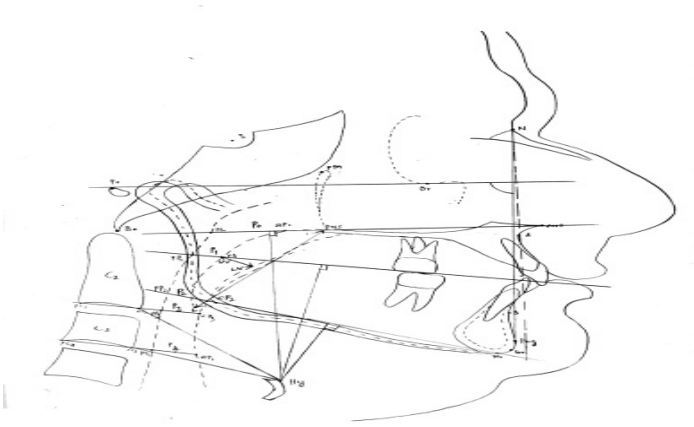
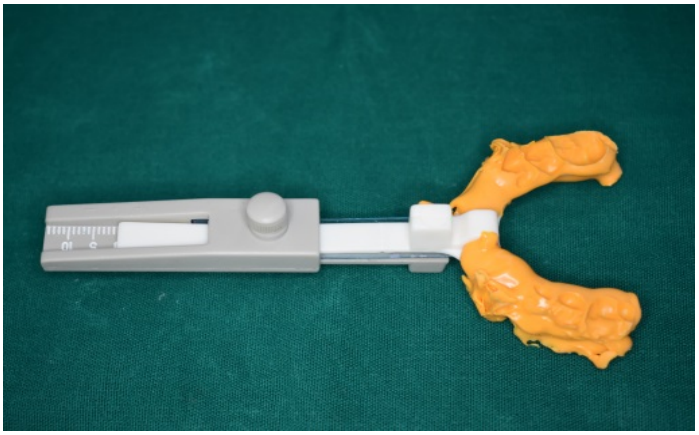


Figure 4: George gauge with registered bite



Used 3mm thick standard bite fork to maintain vertical opening at 3mm

Figure 5: Customized mandibular repositioning appliance {MicrO_2 Sleep & Snore Device, Prosomnus^{TM} USA}

Set of 3 appliances with 1mm advancement used for sequential mandibular advancement

Figure 6: Lateral cephalogram with mandibular repositioning appliance

Figure 7: Post-treatment intra oral photographs