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Treatment of retroglossal obstruction in adult obstructive sleep apnea with tongue retaining device: A clinical report

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ABSTRACT

This clinical report describes the fabrication of tongue retaining device (TRD) for a male patient with a confirmed obstructive sleep apnea (OSA). The prosthesis was fabricated to treat a retroglossal obstruction that was diagnosed by an endoscopic examination. The TRD is a custom-made appliance with a flange that fits between lips and teeth and an anterior plastic bulb that by means of negative pressure holds the tongue forward during sleep. An all-night domiciliary sleep study prior to and after treatment with the tongue stabilizing appliance was recorded to objectively assess sleep quality in terms of the apnea and hypopnea index (AHI), oxygen desaturation index (ODI), and snoring frequency (SF). A reduction of AHI to less than 10/hour and/or a relief of symptoms were considered treatment success criteria in this report. The Patient reported favorable sleep pattern with the use of device. The outcomes of using the TRD in that particular was encouraging and suggested that the use of this device may add much to patients with retroglossal OSA.

Key words: Tongue retaining device, tongue stabilizing appliance

Introduction

Nowadays, OSA is recognized to be a common potentially life threatening well defined medical entity. Its recognition has been ascribed essentially to the continuous growth in sleep research within the past three decades. Increased public awareness, more frequent detection by medical professions, and the use of a more sophisticated diagnostic tools, has led to an obvious increase in the number of diagnosed patients. OSA is a complex multifactorial health problem caused by a combination of anatomic and physiological factors (Quan *et al., 2014*). It is manifested as frequent complete or partial closure of the upper airway during sleep resulting in sleep fragmentation and oxygen desaturation (Khan *et al*., 2013; Lurie 2011) Numerous risk factors including male gender and obesity (Pamidi *et al*., 2011), ethnicity (Ancoli *et al*., 1991), and craniofacial structure (Chi *et al* 2014) have been identified as increasing susceptibility to this disease. OSA has a significant associated morbidity and mortality and has been linked to cardiovascular (Trimer *et al*., 2014; Lin, 2012) and cerebrovascular disease (De Paolis *et al*., 2013; Bounhoure *et al*., 2005), excessive daytime sleepiness (Panossian and Veasey, 2012), and increased risk for motor vehicle accidents (Aldrich, 1989; Ellen *et al*., 2006; George, 2001)

The prevalence of OSA varies depending on diagnostic criteria and population studied, and has been reported as affecting 4% of men and 2% of women in the middle-aged population (Young *et al*., 1993). It was also found that among adults aged 30-69 years, 17% of adults had mild or worse sleep disordered breathing, and 5.7% of adults had moderate or worse sleep disordered breathing (Young *et al*., 2005). As such, OSA is recognized as a significant public health issue. While the gold standard of care combines conservative modalities such as weight loss and nasal continuous positive airway pressure (CPAP) (Tan *et al*., 2002).

Interest in oral devices has been increasing possibly because of compliance difficulties with CPAP. Oral appliances are believed to have a direct effect on mandibular posture and therefore the tongue and consequently affect airway size (De Almeida *et al*., 2005). There are other possible mechanisms of oral appliances in reducing OSA, including ;(a) The stretching and increased stiffness

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of the lateral pharyngeal walls and pillars, (b) Prevention of seal forming between the tongue/ soft palate/ pharyngeal wall caused by forward movement of the tongue, (c) Stabilization of the mandible and hyoid bone that prevent posterior rotation of the jaw and retro-lapse of the tongue during sleep, and (d) The altered anatomic relationship that induces a stretch-induced neurosensory stimulation that influences the motor tone and collapsibility of the airway (Masumi *et al*., 1996; Miljus *et al*., 2014)

Various types of oral appliances have been described in the literature, of which the mandibular advancement splints are the most widely used and well documented (Campbell *et al*., 2009; Sutherland and Cistulli, 2011). The objective of these splints is to repose and maintain the mandible in a protruded position during sleep. This position serves to relieve retro-glossal airway obstruction in several different ways: by indirectly pulling the tongue forward by virtue of its attachment to the geniotubercles, by activation of masseter and submental muscles, by increasing the baseline genioglossus muscle activity, and by stabilizing the mandible and hyoid bone to prevent jaw opening and retrolapse of the tongue (Campbell *et al*., 2009; Sutherland and Cistulli, 2011). The tongue may also be pulled and retained in position with the use of a tongue-retaining or stabilizing device. Tongue retaining device functions by directly holding the tongue in a forward position and opening the airway by accomplishing forward movement of the base of the tongue, increasing the baseline genioglossus muscle activity, and stabilizing the tongue to prevent obstructive collapse during sleep (Lazard *et al.,* 2009; Kurtulmus and Cotert, 2009; Dort and Brant, 2008).

Tongue retaining devices can be used for edentulous patients, patients with lack of tooth support and in dentate patients as well. Although there is increasing interest in the use of oral appliances to treat obstructive sleep apnea (OSA), the evidence base for this is weak. Unfortunately, it has been reported that a small proportion of patients had experienced worsening of their sleep apnea with either mandibular advancement splint or tongue stabilizing device. So, it is imperative, then, that further researches have to be conducted to optimize the role of oral appliances in treating. This clinical report represents one of the various indications of using tongue retaining device to treat upper airway sleeping disorders and emphasize the vital role of the prosthodontists in managing disabilities in the maxillofacial region.

Clinical report

The patient described was 25 years old man with a previous history of OSA. The patient was selected from a pool of patients seeking for dental care at the specialty clinics of the Oral and Maxillofacial prosthodontics Department at the Faculty of Dentistry of the King Abdul-Aziz University. The patient was obviously overweight as the body mass index of the patient was 28.4 kg/ $m^{2,}$ while the neck circumference measured 44 cm.

According to Moore, (2002), the patient was suffering from mild to moderate OSA (AHI score 15 to 30 per hour of sleep) as previously confirmed with a successfully completed all-night polysomnogram. Clinical examination revealed an adequate dentition for support and retention of the oral appliance as well as a patent nasal breathing. A 30-40 mm distance between the incisal edges of the maxillary and mandibular incisors during opening was confirmed. A retroglossal level of obstruction was confirmed by endoscopic examination. Basic demographic data and morphologic variables were also recorded .The patient's height and weight were measured and the body mass index was calculated using the method described by Stępień *et al*., 2014 where the patient's body mass was divided by the square of his or her height with the value universally being given in units of kg/m2. The neck circumference of each subject was measured at the level of the cricothyroid membrane. A decision was made to fabricate a tongue retaining device to relieve the upper airway obstruction that occurs behind the tongue during sleep. The tongue-stabilizing device consisted of a mouthpiece that covers the entire upper and lower dental arches, with a definite mandibular therapeutic protrusion that represented a 75% of the maximal comfortable protrusive range. The tongue stabilizing portion pulled the tongue forward due to the negative pressure created by the displacement of air from the lingual compartment of the device. This device was made from casts of the tongue and teeth using a clear acrylic resin (Fig. 1&2). Maxillary and mandibular preliminary impressions were made with irreversible hydrocolloid impression material by using stock trays. Definitive impressions were made with elastomeric impression material using an individualized acrylic tray. The maxillary cast was

mounted on a semi-adjustable articulator using earpiece facebow. And the lower cast was mounted by a protrusive interocclusal record that was made at 75% of the patient's potential protrusion range.

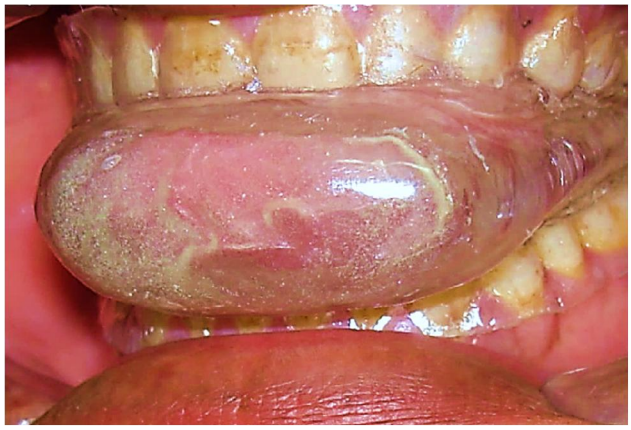

Fig. 1: Intra-oral view of tongue retaining device

Fig. 2: Extra-oral view of tongue retaining device

A mandibular advancement division of the appliance was first fabricated. This mono-block appliance was trimmed and polished. In a subsequent step, a wax block on the anterior segment of first part of the combination was roughly shaped as a housing (vacuum bulb) and adapted to make the functional impression of the tongue and to manufacture tongue-retaining division of the combination. The wax housing was filled with an alginate impression material and was placed in the patient's mouth. The patient was then asked to hold the device tightly and to insert his tongue into the housing filled with irreversible hydrocolloid material; thereby, the functional impression of the patient's tongue was provided to produce an individual vacuum chamber. In the second step, the vacuum-formed bulb was processed to the rest of the prosthesis with a flexible polyvinyl material. The patient was able to breathe comfortably through the nasal airway. Instructions for use and care were provided at insertion appointment. The patient was advised to wear the appliance for at least 6 hours during the night. 4 weeks were allowed for acclimatization during which regular care was accomplished and any needed adjustment was finished.

Outcome measures

Before treatment commenced an overnight domiciliary sleep study were carried out and outcomes were saved as base line data. . Additional home sleep monitoring were repeated after the 4-weeks acclimatization period with the appliance in place. Treatment success was defined as a resolution of symptoms and /or an AHI of less than 10/hour. Failure was defined as persistent clinical symptoms and/or an AHI of more than 10/hour. Polysomnographic studies were made using ApneaLink TM Plus device (*ResMed Corporation, San Diego, Calif, USA*). The ApneaLink TM Plus device consists of a nasal cannula attached to a small case that houses a pressure transducer. The device is held in place by a belt worn around the user's chest. It operates on battery power, has a sampling rate of 100 Hz, and has a 16-bit signal processor. The internal memory storage is 15 MB, which allows for approximately 10 hours of data collection. The ApneaLink software analyzes data generated by the flow signal, producing a 1-page report. Full disclosure of data is available for review and rescoring by the clinician. The apnea, hypopnea, apnea hypopnea index (AHI), oxygen desaturation index (ODI), and snoring frequency (SF) were assessed in this study. An apnea was defined as a decrease in airflow by 80% or more of baseline for at least 10 seconds. A hypopnea was defined as a decrease in airflow by 50% to 80% of baseline for at least 10 seconds. The AHI from the ApneaLink device was based on total study time.

Efficacy of the tongue retaining device

Generally, there was an obvious improvement in all polysomnographic parameters after wearing the tongue device during sleep .The pretreatment AHI measured at home was 26.8 /hr. This baseline value was markedly reduced after using the TRD. The AHI recorded with the appliance was 8.4/hr. Using a treatment success criteria of reducing AHI to less than 10/hr, successful treatment was achieved by this particular device. There was an improvement in arterial blood oxygenation after the use of the TRD. The ODI of 21.06 (i.e. 78.94% oxygen saturation) recorded at the pre-treatment stage was favorably reduced after the use of the oral appliance to 8.47 (i.e. 91.3% oxygen saturation). The appliance was also effective in reducing the frequency of snoring. The SF recorded 30.6 after wearing of the appliance.

Discussion

Sleep apnea syndrome is a relatively common yet potentially fatal syndrome that is characterized by the transitory cessation of the breathing impulse. The most prevalent type is obstructive sleep apnea (OSA), which results from a collapse or obstruction in the oropharyngeal region of the upper airway. Despite the effectiveness of surgical intervention in the treatment of some cases of OSA, there may be contraindications for such techniques as in medically unfit patients for general anaesthesia, and patient's refusal. Therefore attempts have been made to employ oral appliances alternatively. Prosthodontists have recently become one of the general team in the field of sleep medicine. However, it is very important that the dentist should not provide the primary care of the patient; instead he has to work through a medical team work. Most of the treatment options are medical in nature, the problem often ranges far beyond that of a dental condition, and it often requires multiple medical studies. Consequently, the role of dentist in treating those cases should be linked to a team which include a thoracic physician, oral and maxillofacial surgeon ear, nose, and throat surgeon, restorative dentist, and an orthodontist. Therefore, it is imperative that the patient be referred to a physician for examination, appropriate studies, diagnosis, and course of treatment (Ivanhoe *et al*., 1999; Nayar and Knox 2005). Oral appliance therapy for treatment of OSA can be categorized into;(a) those that hold the tongue forward and (b) those that reposition the mandible and the attached tongue forward during sleep (Nayar and Knox 2005). In this clinical report it seemed obvious that the use of tongue retaining device to relieve the OSA symptoms in this particular patient was useful. The effects of the TRD on baseline tongue muscle activity have been studied. Ono *et al*., 1996 found that the TRD has different effects on the awake genioglossus muscle activity in control subjects and OSA patients. In awake OSA patients, the TRD reduces genioglossus muscle activity and corrects the delayed timing of the muscle before an apneic period during sleep. The TRD may counteract fatigue in the tongue muscles and fluctuations in the activity of the genioglossus muscle. In addition, the TRD may provide a pneumatic splint to enlarge the upper airway similar to that seen with nasal CPAP (Ono *et al*., 1996). However, before drawing a substantial conclusion about the use of tongue retaining device, a randomized cross-over clinical trials should first be carried on a wide range of population.

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