Case Series

Management of Obstructive Sleep Apnoea with Two Different Mandibular Advancement Devices

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ABSTRACT

"Laugh and the world laughs with you, snore and you sleep alone." Putting a social spin to this innocuous condition highlights prevalence of sleep disordered breathing amongst the population. Obstructive Sleep Apnea Syndrome (OSAS) is defined as interrupted airflow despite persistent respiratory effort. OSAS is associated with medical comorbidities such as hypertension, ischemic heart disease, pulmonary hypertension etc.

The well-known signs, symptoms and craniofacial risk factors of OSAS are posterior tongue posture, hypoplastic mandible, increased hyoid distance and neck circumference. Although the gold standard for diagnosis of OSAS is overnight polysomnography, the lateral cephalogram provides crucial information about the airway dimensions. With an increase in adult population seeking treatment and a knowledge of craniofacial growth and development, the orthodontist is at a unique vantage point wherein he/she can identify susceptible individuals. Management involves a team approach between orthodontist and pulmonologist. Orthodontic management involves oral appliances and maxillo-mandibular ortho-surgical procedures. Oral appliances are an effective and efficacious treatment modality which can provide cogent improvement. In a developing country where it might not be possible for all patients to afford expensive medical therapy, oral appliances provide a viable alternative and help reduce the economic and disease burden.

This paper will describe two cases of OSAS which were managed conservatively with Oral Appliance therapy showing two different modalities of treatment. There was amelioration in the symptoms of OSAS, improvement in general health as well as a significant improvement in the quality of life.

Keywords: Mandibular advancement device, sleep apnea, snoring.

INTRODUCTION

Humans spend up to one third of their lives asleep, yet surprisingly little is known about the biological role of sleep, and little attention has been paid until recent years to sleep disorders as an important cause of ill health. There is general agreement that sleep is beneficial. Shakespeare's Macbeth described sleep as the "chief nourisher in life's feast", and the age-old remedy for the sick person is to get "plenty of sleep". Some classical writers, however, have viewed sleep with deep suspicion. Sir Thomas Browne wrote "Sleep, in fine, is so like death, I dare not trust it with my prayers", and Tennyson described sleep as "death's twin brother".

Sleep medicine is the youngest medical specialty recognized by American Board of medical specialties. Sleep is a naturally recurring state characterized by reduced or absent consciousness, relatively suspended sensory activity and inactivity of nearly all voluntary muscles. Human beings spend approximately one third

of their lives sleeping and this is recognized as having an important physiological role. During sleep lying in supine position causes complete or partial obliteration of upper airway resulting in upper airway disorders. Sleep disruption caused by breathing disorders are potentially life threatening and therefore an important global health issue and great importance has been given to the upper airway sleep disorders in the last decade or so.

Sleep disorders, particularly untreated obstructive sleep apnoea (OSA) has been linked to deteriorate systemic health and known as a risk and possible causative factor in developing of systemic hypertension, depression, stroke, angina and cardiac dysrhythmias.[1-4] OSA, when left untreated, can be associated with motor vehicle accidents, poor work performance in the office or work place and therefore, also makes a person prone to occupational accidents and reduced quality of life. This constellation of issues adversely affects patients on their personal, social and professional levels. Upper air way sleep disorders commonly considered are: Snoring, Obstructive sleep apnoea (OSA), Sleep bruxism and Upper airway resistance syndrome (UARS). Comprehensive management of upper airway sleep disorders requires an interdisciplinary approach.

Orthodontist can play the role of secondary care provider by helping aid the sleep physician to analyze upper airway, design and fabrication of oral appliance for mandibular advancement, orthodontic treatment during maxillo-mandibular advancement by orthognathic surgery or distraction osteogenesis, use of functional appliance in children to address mandibular deficiency by predicting potential sleep apnoea and instituting the right course of treatment. In this paper two case of upper airway sleep disorder, one a diagnosed case of Moderate OSA other a diagnosed case of severe OSA, are shown managed with two different types of mandibular advancement devices – a rigid acrylic advancement appliance and a tiratable mandibular advancement device, MDSA (Medical Dental Sleep Appliance).

CASE REPORT

Case 1

The First case was a 25 yr old male who sought consultation for snoring during sleep since last 3-4 yrs (Fig. 1). He was mesomorphic with body mass index (BMI) of 22. Extra oral examination revealed patient had a convex profile with competent lips, a retrognathic mandible and a tendency towards a vertical growth pattern. Intra oral examination revealed a class I molar relationship with severe crowding in the mandibular arch and increased overjet. His past medical and dental

Figure 1 Pretreatment Photographs

history was not significant. His airway grading was modified Mallampatti score III. The lateral cephalogram revealed that the posterior airway space was reduced to 6 mm against normal of 9-11mm and the hyoid distance was increased to 28mm against normal of 15 mm (Fig. 2, Table 1).

The patient was referred to Dept of Respiratory Medicine for overnight polysomnography (PSG) which is the gold standard for diagnosis of sleep disordered breathing. The PSG revealed AHI of 18.3 which was categorised as Moderate OSA.

The treatment planned for this patient aimed at increasing the posterior airway space by keeping the mandible at an advanced position during sleep with the help of a rigid acrylic mandibular advancement appliance. Impressions were made and casts were prepared. Maximum protrusion of the patient was ascertained using George bite gauge to be 11 mm. Hence a bite was recorded with 60% of maximum protrusion i.e 6mm using rubber base impression material and George bite gauge. The appliance was fabricated and delivered to the patient for wear during sleep only.

After an initial period of discomfort the patient adjusted with the appliance and started wearing the appliance during sleep (Fig. 3). Post treatment results showed marked reduction in snoring to almost nil. Overnight PSG revealed a reduction in AHI to 0.7. The cephalogram with mandibular advancement appliance in situ showed increase in posterior airway space to 10mm and decrease in hyoid distance from 28 mm to 13 mm (Fig. 4, Table 1).

Figure 2 Pretreatment Cephalogram mark the increased hyoid distance

Case 2

A 49yrs old female, a diagnosed case of severe OSA with AHI of 57.3/sleep hour was referred to our dental set up from the Dept of Respiratory Medicine for management with dental appliances as the patient was not able to adjust to the Continuous Positive Air Pressure (CPAP) therapy. The chief complaints of the patient were heavy snoring during sleep since last 20 yrs for which she never sought any medical consultation. Her husband also corroborated with the history and complained of inability to sleep due to continuous and loud snoring of the bed partner. He also mentioned that the patient sometimes exhibited choking movements during the night which prompted him to get medical consultation. Patient is a known hypertensive and on medication for the same with an increased BMI of 28.5. Extraoral examination revealed a convex facial profile with a retrognathic mandible and increased submental fat deposition. Intra oral examination revealed a dental class II relationship with retroclined maxillary incisors and an increased overbite. The airway grading of the patient was modified Mallampatti score of IV. The cephalogram of the patient revealed posterior airway space of 5mm against normal of 9-11mm, and hyoid distance of 28mm against normal of 15 mm.

The treatment recommended for this patient by the respiratory and sleep medicine specialist was CPAP therapy, but the patient was not amenable to the therapy. Hence she was referred to our dental set up for management with dental appliances. The patient was managed with weight reduction protocol and titratable mandibular advancement device (MDSA). For the fabrication of MDSA, impressions were made and casts were prepared. Maximum protrusion of the

Table 1 Pre and Post treatment Cephalometric values Case I

Measurement	*Normal Value*	*Pre Treatment*	*Post Treatment*
Posterior airway space	9-11 mm	6 mm	10 mm
Hyoid distance	15 mm	28 mm	13 mm

Figure 3 MAD (Mandibular advancement Splint) in situ

Figure 4 Post -treatment Cephalogram mark the reduction in hyoid distance

patient was ascertained by a using George bite gauge, which was to be 11 mm. Hence the bite was recorded with 60% of maximum protrusion i.e 6mm using rubber base impression material and George bite gauge. The appliance was fabricated and delivered to the patient for wear during sleep only. The MDSA was needed to be titrated for further advancement by 3mm as needed in the case.

After an initial period of discomfort the patient adjusted with the appliance and started wearing the appliance during sleep (Fig. 7). Post appliance results showed marked reduction in snoring to almost nil. There was marked reduction breathlessness during sleep and she started having sound sleep for 5-6 hours. The cephalogram with MDSA in situ showed increase in posterior airway space to 9 mm and decrease in hyoid distance to 15 mm, (Fig. 8, Table 2). The appliance was titrated by 2 mm as required in this case. The polysomnography showed reduction in AHI to 17.7/ sleep hour from 57.3/sleep hour.

The sleep quality of the patient improved which resulted in better control of the blood pressure, reduced day time sleepiness and improvement in quality of life.

DISCUSSION

Obstructive sleep apnea (OSA) is characterized by episodes of airway obstruction for more than 10 seconds during sleep, resulting in pauses in breathing. OSA is the most common condition among a group of disorders, called sleep-disordered breathing which includes snoring, upper airway resistance syndrome and sleep bruxism. Sleep disruption caused by breathing

Figure 5 Pre treatment photographs

Figure 6 Pre -treatment Cephalogram mark the reduction in PAS and increased hyoid distance

disorders are potentially life threatening and therefore an important global health issue.

Obstructive sleep apnoea (OSA) is characterised by recurring breathing pauses during sleep, usually due to obstruction at the oropharynx. OSA syndrome (OSAS), which combines OSA with relevant clinical features such as daytime sleepiness, has a prevalence of at least 4% in the general adult population, and is twice as common in males as females. OSAS is a major independent risk factor for cardiovascular diseases such as hypertension, ischemic heart disease and stroke. Driving accidents are up to 10 times more common in patients with OSAS.

It is been established that approximately 25% of all men and 5–10% of all women snore[5] and in western countries it is estimated that 4% of middle aged men and 2% of middle aged women in the general population meet the minimum criteria for sleep apnoea syndrome.[6]

INVESTIGATIONS

Polysomnogram (PSG) is considered the gold standard test for diagnosis of OSA. Along with PSG dynamic MRI and CT scans can be useful adjunct in diagnosis of snoring and OSA.[7,8] Orthodontist can play an important role in diagnosis of sleep disordered breathing by analysing airway on lateral cephalogram taken at end expiration stage. The most important cephalometric measurements include posterior airway space, length of soft palate and distance of hyoid measured perpendicular to mandibular plane[9,10] as are being evaluated in both the cases described.

Even expert clinical assessment by history and physical examination alone has inadequate power to distinguish OSAS from non-OSAS patients

Overnight polysomnography remains the gold standard for investigation of OSAS but is expensive and time consuming

Cardiorespiratory monitoring without sleep staging is accurate in identifying moderate to severe OSAS

Figure 7 MDSA in situ

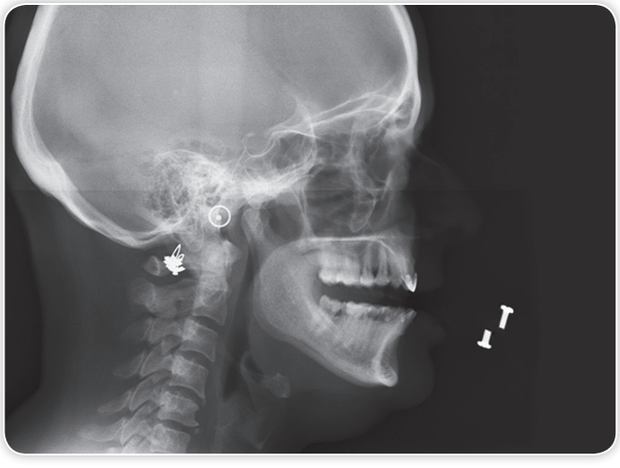


Figure 8 Cephalogram with MDSA in situ mark the improvement in PAS and reduction in Hyoid Distance

Table 2 Pre and Post treatment Cephalometric values case II

Measurement	*Normal Value*	*Pre Treatment*	*Post Treatment*
Posterior airway space	9-11 mm	5 mm	9 mm
Hyoid distance	15 mm	28 mm	15 mm

patients but may not detect some non-OSAS sleep disorders.

Future technological developments will permit many patients to be investigated at home by means of portable monitoring systems

TREATMENT MODALITIES

The *management protocol* includes behavioural modifications sleep position change and weight control by modification in lifestyle. Definite modalities include

continuous positive airway pressure (CPAP), surgery to enlarge upper airway and orthognathic surgery for bringing the mandible and maxillae forward and oral appliances. In developing country like India the oral appliances can be one of the most important treatment modality as they are less costly, easy to transport, and does not require power supply when compared to CPAP. Most of the oral appliances work by placing the mandible forward and thus increases the space between post-pharyngeal wall and tongue.

CONTEMPORARY APPROACH TO MANAGEMENT

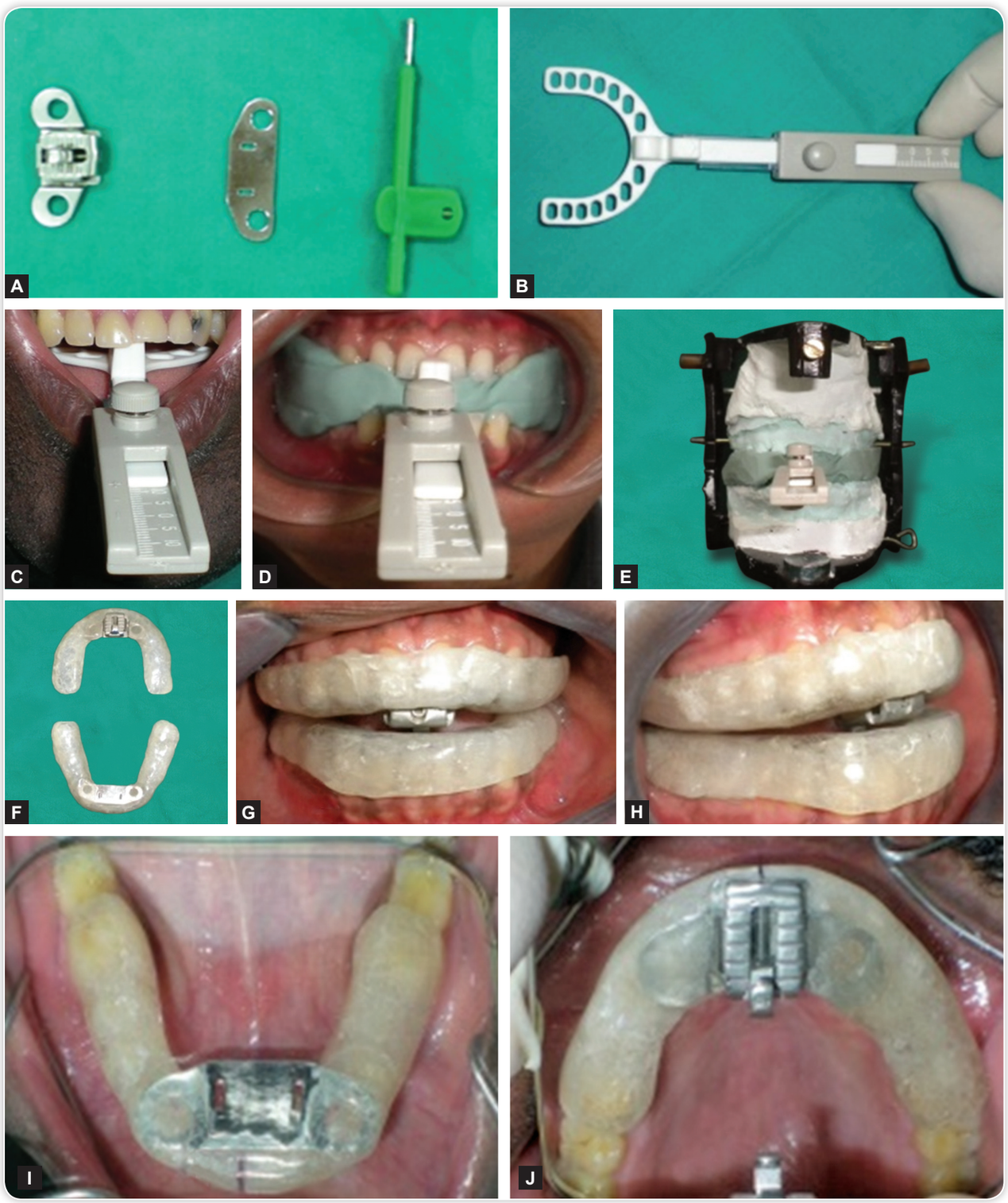
- Nasal CPAP is the treatment of choice in most patients with OSAS but compliance is lower in patients with mild disease and in relatively asymptomatic patients
- CPAP frequently produces dramatic improvements in daytime alertness levels and is associated with major improvements in cardiovascular morbidity and mortality, in addition to reduced accident risk
- Auto-adjusting pressure devices APAP are indicated in some OSAS patients, particularly where high fixed pressures are required Weight loss improves OSAS, but is difficult to achieve
- No pharmacological therapy currently available produces clinically relevant improvements in OSAS
- Surgical intervention has an unacceptably low success rate in OSAS, except in patients with a clearly identifiable obstructing lesion in the upper airway
- Yearly follow-up is recommended by the ISS (Irish Sleep Society)
- Studies have indicated greater effectiveness and patients' preference for oral appliances compared with CPAP in mild and moderate OSA.[11-13]
- The mechanisms of action of mandibular advancement devices for improvement of airway are[14]
- Elevation of the base of the tongue.
- Stretching of palatoglossus muscle which pulls the soft palate forward.
- Allows the pharynx to expand.
- Helps stabilise lateral pharyngeal wall by applying tension to pharyngomandibular raphe which is coupled to pharyngeal constrictors.
- Splays the tonsillar arches formed by palatoglossus and palatopharyngeal muscles which leads to further stabilisation of lateral pharyngeal wall.
- Various oral appliances for mandibular advancement can be simple splints as used in our first case, activator, bionator, twin block, Karwetzky activator, removable Herbst appliance and various titratable mandibular advancement devices such as Thornston adjustable positioned or MDSA as used in our second case.

TITRATABLE MADS

Titratable mandibular advancement devices are fast becoming popular because of their ability to titrate mandibular advancement or sequentially advance the mandible in small increments until subjective improvement in symptoms occur.[15] Recent studies have shown a predictable AHI reduction with titratable MADs[16] and better acceptance of the appliance by patients' as compared to other MADs such as Karwetzky activator.[17]

FABRICATION OF MADS (FIG. 9)

- Steps followed for appliance fabrication include impression making with sodium alginate impression material and preparation of two sets of plaster models. Set one is used for preparation of appliance while 2nd set is used as diagnostic records.
- Bite recording can be done with modelling wax, articulation of models with recorded bite and appliance fabrication with heat cure acrylic. During bite recording, mandibular advancement should not exceed 70% of maximum protrusive movement[18] and 7–8 mm of vertical opening. Bite recording can also be done conveniently with a device called George bite gauge, which allows indexing of anterior teeth and uses bite fork along with a scale to determine the amount of vertical opening and advancement.[19]
- The models with the bite are transferred onto semiadjustable articulator. The appliance can be fabricated in thermoplastic or acrylic material. Most modern dental laboratories make appliances with thermoplastic materials which are more comfortable to patients. Maintaining the recorded vertical height on the articulator, accurate placement of titrating assembly on the upper base and rod/plate on lower base is the key to successful fabrication of these appliances.



Figures 9(A–J) Fabrication of MDSA. A: MDSA assembly, B: George bite gauge, C: Maximum protrusion recorded with George bite gauge, D: Bite recorded with rubber base impression material (70% of maximum protrusion), E: Articulation of casts using bite, F: Fixing MDSA on acrylic splint, G: MDSA in situ frontal view, H: MDSA in situ lateral view, I-J : MDSA in situ occlusal view.

LIMITATIONS OF MADS

Although the oral appliance therapy is popular and widely accepted, it has some inherent limitations which are[15,20]

- The appliances require acclimatization period which defer the assessment of efficacy of treatment.
- There is an uncertainty about the selection of maximum 'dosage' of mandibular advancement required to control OSA in individual patients.
- Potential long-term complications of therapy with respect to TMJ and occlusion are yet to be assessed.

CONCLUSION

Orthodontist plays a vital adjunctive role in management of patients with sleep disordered breathing. Oral appliances play an important role in establishing the new speciality called 'Dental Sleep Medicine'. Many patients are unable to adjust to the bulky CPAP apparatus and find a new lease of life with the oral appliances. MADs are easy to fabricate, cost effective and well accepted by patients and they show good therapeutic efficacy. Titratable mandibular advancement devices have an added advantage of facilitating sequential mandibular advancement in case the patient is unable to tolerate the prescribed initial advancement.

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