

Obstructive Sleep Apnoea: A Dental Perspective

Kevin M Mulligan

Abstract

Obstructive sleep apnoea (OSA) is regarded as a potentially life threatening breathing disorder characterised by periodic cessation of air intake during sleep.

Treatment modalities include conservative measures such as weight loss, change in sleep position and avoidance of alcohol: these may suffice in reducing airway obstruction. Pharmacotherapy has also been used with various grades of success. Nasal continuous positive airway pressure (nCPAP) helps maintain airway patency during sleep by a continuous stream of air under light pressure. Tracheostomy, by its very nature, completely bypasses any pharyngeal obstruction but is associated with a high degree of morbidity. Other surgical procedures such as uvulopalatopharyngoplasty (UPPP), orthognathic surgery, hyoid-myotomy suspension and tongue reduction have also been used.

Mandibular advancement splints (MAS) are increasingly being recognised as a suitable management option for those subjects with mild to moderate OSA. A study was undertaken to ascertain the effectiveness of using mandibular advancement splints in the treatment of OSA. Mandibular protrusion using a MAS is frequently, but not invariably, associated with improvement in velo- and oro-pharyngeal airway dimensions in awake subjects.

Keywords

Obstructive sleep apnoea, polysomnography, continuous positive airway pressure, mandibular advancement splints

Kevin M Mulligan BCh D, M Sc, M Orth, FDSRCS

Consultant in Child Dental Health and Orthodontics
Department of Health, School Dental Clinic, Floriana
Email: kevin.mulligan@gov.mt

Introduction

Obstructive sleep apnoea (OSA) is regarded as a potentially life threatening breathing disorder with an estimated prevalence in middle-aged males and females of two per cent and one per cent respectively¹. The quality of life for both patient and family may be affected. Medical complications may also arise and accompanying snoring may be incompatible with marital harmony.

Diagnosis is undertaken via an overnight sleep study². Here, sleep quality is examined together with blood oxygen saturation, snoring levels and patterns of ventilation to ascertain the severity of the condition. This is expressed as the apnoea-hypopnoea index (AHI), which describes the number of episodes of cessation of, or significant reduction in, breathing per hour of sleep.

Historical aspect of OSA

OSA has only been diagnosed as a discrete condition relatively recently, although the associated physical features were in evidence as early as the nineteenth century, as evidenced by Charles Dickens' novel, "The Pickwick Papers", where an obese character is described with all the expected physical characteristics classically associated with the condition. This gave rise to the term Pickwickian syndrome.

It was always known that sleeping in the supine position worsened the symptoms of the condition, particularly snoring. Hence attempts to avoid the supine position such as sewing a tennis ball to the back of one's pyjamas was a domestic attempt to avoid obstruction.

Clinical Features

Patients with OSA demonstrate varying combinations of daytime and night-time symptoms largely due to sleep fragmentation and deprivation, hypoxia, or both.

Snoring is almost invariably present and highly characteristic. Restlessness during sleep is also frequently encountered with kicking of the legs and flailing of limbs often described. Nocturnal diuresis and, to a lesser extent, nocturnal enuresis may also occur. Excessive daytime sleepiness (hypersomnolence) arises as a result of sleep fragmentation and its prevalence shows a wide variation and can be easily overlooked. It can be measured objectively using the Epworth Sleepiness Scale³, which translates the patient's reported symptoms to a numerical scale that can be used for comparative purposes. Hypersomnolence could potentially lead to traffic accidents and cognitive impairment. Morning headaches are

also relatively common. Behavioural changes such as poor memory, difficulty in concentration and carrying out everyday tasks, irritability, depression, reduced libido or impotence may also be present.

OSA sufferers are at risk of severe medical complications as a result of nocturnal hypoxia and hypercapnia. These include arrhythmias, negative cardiac inotropic effects, heart failure, ischaemic heart disease, systemic and pulmonary hypertension, neurological complications and even mortality⁴.

Aetiology

Fundamental to the pathogenesis of OSA is the interaction of physiological and anatomical alterations of the upper airway⁵. Stability and patency of the upper airway depend on the action of oropharyngeal dilator and abductor muscles that are normally activated rhythmically during inspiration. Airway collapse occurs when the force produced by these muscles is exceeded by negative inspiratory airway pressure generated during contraction of the diaphragm and intercostal muscles. Sites of obstruction will range from the velopharynx through to oropharynx and hypopharynx. A loss in muscle tone in velopharyngeal and tongue musculature occurs with resulting collapse of the pharynx on inspiration⁵. An increased soft palate length and thickness has been reported and increased area of contact between the soft palate and base of the tongue⁵. Posterior airway space has also been reported reduced at all levels from the palatal to the mandibular plane⁶. Tongue morphology has also been implicated with increased tongue length and area reported⁷.

Skeletal factors have also been identified as contributing to development of the condition. Mandibular retrognathia and micrognathia and abnormal cervico-craniofacial morphology has been reported^{8,9,10}. Maxillary deficiency has also been reported⁶. Hyoid position appears to be an important variable with a number of researchers finding that it is more inferiorly placed in relation to the mandibular plane in OSA sufferers^{7,11,12}.

OSA has been linked to body weight and specifically body-mass index (BMI) with an increased BMI common among OSA sufferers. Alcohol consumption also predisposes to development of the condition.

Investigation

Apart from a thorough history and clinical examination, polysomnography is essential to yield a clear diagnosis of OSA. It combines electrophysiologic indices of sleep stage, electromechanical parameters contrasting respiratory effort with actual ventilation and measurements reflecting the consequences of abnormal respiratory events. A tracing (Figure 1) is produced showing the duration and number of obstructive and hypoxic events during six to eight hours of sleep. In this way it is possible to work out the AHI and thus the presence and severity of OSA.

Sleep nasendoscopy can also be used to determine the site(s) of obstruction while the patient is induced to sleep with propofol. Lateral skull cephalometry is a useful tool for the investigation of craniofacial morphology in OSA^{7,13}. CT and MRI provide a three-dimensional picture of airway space, but are expensive

and CT is associated with high doses of ionising radiation. Somnofluoroscopy can be used to obtain a dynamic recording of pharyngeal dimensions during function in supine OSA patients.

Treatment modalities

Lifestyle modification plays a role in the overweight and obese patient. Weight loss will improve and occasionally cure OSA. In addition, avoidance of alcohol and sedative drugs can also prove beneficial.

Nasal continuous positive airway pressure (nCPAP) is considered the "gold standard" for treatment of OSA¹⁴. It helps keep the airway open during sleep through a continuous stream of air under light pressure, applied to the pharynx through a nasal mask. It should be used for a minimum six hours every night and is virtually always effective if used regularly (see Figure 2). The constant stream of air allows positive expiration while keeping the airway open and works irrespective of body position.

However, there are a number of drawbacks associated with the use of nCPAP. It is noisy and patients may not find it easy to tolerate. There remains some difficulty with expiration. This has been addressed, in part, by a variant of CPAP called BiPAP that allows the release of expired air through a separate channel. The application of a face mask can be a hindrance to patients who may find it suffocating. Drying of the airway mucosa often occurs which can be overcome by the inclusion of a humidifier. It is relatively bulky, and for example, not easily transported during air travel.

Mandibular advancement splints

Prosthetic mandibular advancement was popularised in the early 1980's by Meier-Ewert, when good therapeutic benefits were found without unfavourable side effects.

Mandibular advancement splints (MAS) are now used as an alternative to other established therapies for OSA treatment, primarily because of problems associated with other forms of treatment. They are meant to increase airway size and alter shape by reducing its collapsibility and drawing the tongue and soft palate forwards, maintaining airway patency during sleep. Success of treatment of OSA with a MAS could be attributed to an increased airway space, stable anterior position of the mandible and tongue and also forward movement of the soft palate^{15,16}. They often also remove or considerably reduce the volume of snoring.

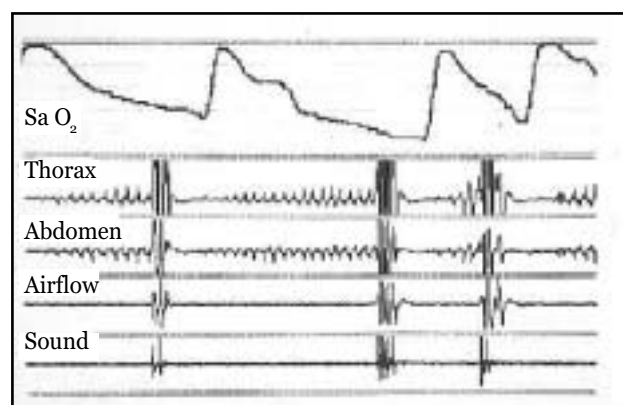


Figure 1: Polysomnography tracing



Figure 2: CPAP in use

Most MAS are manufactured specifically to the patient's mouth in a dental laboratory (Figures 3 and 4) and are retained to the upper and lower teeth. They keep the mandible in a position of protrusion (at a predetermined amount) with minimal vertical opening. The amount of mandibular protrusion is largely determined by patient comfort, but a figure of 75% maximal protrusion has been advised. In general, the more the protrusion, the better is the effect on apnoeic episodes. Other designs of oral appliances are prefabricated and shaped to the subject's mouth and dentition by heating the material and moulding it to the mouth.

Compliance rates are generally good. Common reasons given for discontinuation are discomfort or lack of efficacy in the short-term, masticatory muscle discomfort and excessive salivation. Muscle discomfort normally disappears after two to three nights of appliance wear and any abnormal bite experienced on awakening is transient and acceptable. Long-term side effects may include temporomandibular joint discomfort and dental occlusal changes although the limited duration of wear does not usually result in any significant tooth movement. Oral splints are found to be of benefit in the vast majority of patients with mild to moderate OSA and allow the patient to travel freely without having to carry the CPAP machine around.

Table 1: Subject characteristics and amounts of protrusion

	Median ± SD	Minimum	Maximum
Age	50.25 ± 10.68	30.38	72.52
AHI	25.69 ± 19.53	5.10	68.10
Body Mass Index	27.65 ± 3.16	21.30	34.00
Epworth Sl. Scale	12.60 ± 4.76	5.00	23.00
Mand. protrusion	5.74 ± 3.22	0.87	9.06

The normal values for AHI and BMI are <5 and 20-25 respectively. A normal value for ESS has not been reported, but a value >10 is regarded as pathological.

Surgical treatment

There are also a number of surgical treatment modalities. Tracheostomy is highly effective since it bypasses the entire upper airway, but of course, it is associated with a high degree of morbidity. Hence, it is only used as a last resort. Uvulopalatopharyngoplasty (UPPP) is the most widely used surgical procedure for treatment of OSA. It involves removal of the uvula, a portion of the soft palate, tonsils and adenoids as well as a variable portion of the lateral wall of the pharynx. In most cases, snoring is eliminated, but reduction of apnoea and oxygen desaturation occurs less frequently¹⁷. Orthognathic surgery has shown positive changes in airway dimensions by surgical advancement of the maxilla and/or mandible^{18,19}. Other forms of surgical treatment have also been advocated without any great long-term success.

Clinical Study

A prospective clinical study was undertaken, in which, consecutively referred subjects from the Royal National Throat Nose and Ear Hospital in London were recruited. All subjects (30 in total) had their diagnosis of OSA confirmed by overnight polysomnography and were judged to be suitable for MAS therapy by mandibular lift performed under propofol sedation and sleep nasendoscopy. All subjects were aged more than 18 years, had an AHI of more than 5, were prepared to wear a MAS and had sufficiently healthy teeth to allow MAS construction. Written consent was obtained and a removable Herbst advancement splint fitted at a predetermined amount of protrusion. Subject characteristics and amounts of protrusion are shown in Table 1.

Subjects' quality of sleep and quality of life were assessed using recognised questionnaires both before and after fitting of the splint²⁰. Median changes in ESS scores and AHI were a reduction of 6.52 and 12.13 respectively, which are significant ($P < 0.005$). The changes in AHI were obtained by repeat polysomnography following a minimum of three months of using the MAS and were carried out with the subject wearing the splint during overnight polysomnography. The change is particularly clinically significant with improvements shown in sleep patterns and quality of life. Daytime sleepiness was also reduced as was extent and severity of snoring.



Figure 3: Herbst advancement splint



Figure 4: Silensor-type advancement splint

Of the thirty subjects studied, thirteen reported muscular discomfort and twelve temporomandibular joint discomfort. Nine subjects complained of an altered bite on awakening while eleven subjects complained of a dry mouth or excessive salivation.

These symptoms reduced significantly in prevalence and severity with continued wear of the appliance and twenty-six considered the benefits derived from splint wear to outweigh the disadvantages and side effects. Despite this, a significant problem exists with non-compliance with splint wear. Six patients did not return for review appointments or could not tolerate the appliance.

Discussion

Mandibular advancement splints were developed as an alternative to other established therapies for the treatment of OSA. They were designed in an attempt to increase airway size and/or reduce its collapsibility by drawing the tongue and soft palate forwards and thereby maintaining airway patency during sleep. Success with MAS could be attributed to an increase in airway space, stable anterior position of the mandible and tongue as well as forward movement of the soft palate^{21,22}. The clinical utility of any form of treatment relies on the balance of its benefit, patient compliance, cost, side-effects and complications. On this basis, MAS treatment has no long term or permanent side effects and has the advantage of being far less cumbersome than CPAP despite some initial discomfort. However, while CPAP is almost universally effective in the treatment of OSA, the same cannot be said of MAS therapy because of the different modes of function and varying levels of patient tolerance. Studies have demonstrated the effectiveness of MAS therapy with increases in post-pharyngeal space following mandibular protrusion with MAS²³. Other studies have shown reductions in AHI with MAS therapy²⁴. This particular study showed a mean reduction from an AHI of eleven to that of five in mild cases, twenty seven to seven in moderate cases and fifty three to fourteen in severe OSA cases. The authors suggested follow-up polysomnography after MAS fitting because of the risk of silent OSA occurring in the absence of snoring. Clark *et al.* (1993)²⁵ found that, with MAS treatment, the oxygen desaturation pattern in OSA patients did change but only a partial return to a normal sleep stage architecture was seen. It was thought that either these phenomena were not strongly

related or that any chronic effect of OSA on the patients' sleep stage pattern was not easily reversible.

Obstructive sleep apnoea is a condition that requires urgent attention by the medical professional because of the potentially serious complications that may arise. Proper assessment is vital and should be carried out by a respiratory physician or otolaryngologist preferably through the use of polysomnography. Mandibular advancement splints provide a very effective treatment modality for this condition with a high degree of benefit. Side effects are relatively minor and generally only last for a short while immediately following the start of splint wear. They are often more acceptable to OSA sufferers than CPAP²⁶, which however, remains the treatment of choice. Mandibular advancement splints should be designed by the experienced dental professional in order to be successful and relatively comfortable for the patient. They should only be provided following consultation with a respiratory physician or otolaryngologist following confirmation of OSA and if the MAS is thought to be of benefit.

The identification of subjects who would benefit from MAS therapy would be very helpful because of the considerable expense involved in MAS construction. The use of sleep nasendoscopy and radiography could be helpful in this regard and this could be a good idea for future research. In addition, long-term assessment of splint wear on the dentition and facial complex is needed as well as compliance rates.

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PALS – MALTA surpasses 100

The success of this year's Paediatric Advanced Life Support (PALS) Course held in February, means that PALS (Malta) had now turned over more than 100 qualified PALS Providers.

Indeed, this translates into one of the best ratios of trained resuscitators for children per head of population! These 'providers' span several medical, nursing and paramedical disciplines, thereby providing advanced paediatric resuscitation cover across many walks of life! The two-day intensive course is as popular as ever and remains consistently oversubscribed, despite this years session spanning Sunday and Monday, which happened to be a national holiday!

Needless to say, an initiative requiring this amount of organisation and support is dependent on the backing of several individuals and institutions. Indeed, the course would not be possible without the support and financial backing of the Health Division, as well as our fellow PALS instructors from the United Kingdom who offer their time and services for no reward whatsoever – and, this year, we could not even

offer decent weather!

We are also extremely grateful to Technoline Ltd., Braun (Malta), and the Maltese Paediatric Association for their sponsorship, the Institute of Health Care for use of their excellent premises, the SAS Radisson for hosting the Course dinners, Mr Charles Messina and the local PALS organising Committee and Faculty including Drs Tanya Esposito, Maryrose Cassar, Jonathan Joslin and Mrs Annabelle Abela. To all those involved in PALS – a heartfelt thankyou! Ultimately, however, it is the enthusiasm and eagerness of the candidates themselves that makes this course such a pleasurable and worthwhile event.

We are delighted that 'PALS' is now established as a regular fixture on the annual Training Programme in Childcare, and has come of age at 100!