Obstructive Sleep Apnoea:
A Dental Perspective

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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.

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 respectively. 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 study. 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 Scale, 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

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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 mortality.

**Aetiology**

Fundamental to the pathogenesis of OSA is the interaction of physiological and anatomical alterations of the upper airway. 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 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.

The application of a face mask can be a hindrance to patients that allows the release of expired air through a separate channel. The use of nCPAP is considered the “gold standard” for treatment of OSA. 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. They often also remove or considerably reduce the volume of snoring.

**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.

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**Figure 1: Polysomnography tracing**
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.

**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 frequently. Orthognathic surgery has shown positive changes in airway dimensions by surgical advancement of the maxilla and/or mandible. 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 mandibular 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 splint. 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.

**Table 1: Subject characteristics and amounts of protrusion**

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

**Figure 3: Herbst 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 sleep. They were designed in an attempt to increase airway size an alternative to other established therapies for the treatment of OSA. 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 CPAP, 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.

**References**

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!