Using mandibular advancement devices for OSA

Arti Hindocha[1]

According to the UK National Institute for Health and Care Excellence (NICE), obstructive sleep apnoea (OSA) is defined by repeated episodes of apnoea (temporary cessation of breathing) and hypopnoea (slow or shallow breathing), loud snoring, and excessive daytime sleepiness.

OSA is the most common form of sleep-related breathing disorder (SRBD) (Terzano et al, 2001). Chronically poor sleep disrupts hormones, leading to inflammation, weight gain, and cardiovascular issues, impairing blood sugar regulation, cognition, and memory.

Further, sleep disorders significantly increase the risk of road traffic accidents. In 2017, drowsy driving alone caused an estimated 91,000 crashes, 50,000 injuries, and nearly 800 deaths in the US (National Highway Traffic Safety Administration).

Prevalence of OSA

OSA affects an estimated 1.5 million adults in the UK, yet 85% of these are undiagnosed, and untreated (British Lung Foundation, 2015). It is thought that around eight million people aged 30 to 69 years may be affected by OSA in the UK alone.

Ling (2023) stated an estimated 39 million adults in the US are suffering, and globally, the figures are staggeringly high. Based on American Academy of Sleep Medicine (AASM) 2012 diagnostic criteria, Benjafield et al (2019) estimated that 936 million adults aged 30 to 69 years (men and women) have mild to severe obstructive sleep apnoea and 425 million adults aged 30 to 69 years have moderate to severe obstructive sleep apnoea globally. The number of affected individuals was highest in China, followed by the USA, Brazil, and India.

The role of the dental profession in the treatment of OSA

An article by Dr Aoife Brid Stack (2022) highlights the profound impact dentists can have on patients' lives. Beyond pain relief, creating beautiful smiles, and detecting oral cancer, Dr Stack proposes that dental sleep medicine offers another opportunity to significantly improve patients' wellbeing.

I echo her sentiments and believe dentists and orthodontists are ideally positioned to screen patients and direct them to appropriate care, often providing treatment themselves that can improve patients' overall health and lifespan.

In 2021, NICE guidelines included mandibular advancement devices (MADs) as a treatment option for mild, moderate and severe OSA. This addition to the guidelines highlights an opportunity for dentists and orthodontists to diagnose and treat patients who are suffering from snoring or sleep apnoea in their clinics.

This minimally invasive, portable and cost-effective device has the potential to significantly improve patients' quality of life.

[1] Arti Hindocha, BDS(HONS) MJDF RCS (ENG) MCLINDENT MORTH RCS(ENG) FDS ORTH RCS (ENG) CILT
Consultant orthodontist, Kettering General Hospital, UK
Private practice, London and Northampton, UK.

Core symptoms

OSA symptoms include excessive daytime sleepiness and apnoeas or hypopnoeas (blockages or partial blockages of the airway leading to breathing cessations), leading to dysfunction as a result of non-refreshing fragmented sleep, which has an overall reduction in quality of life (Stoohs et al, 2008). Other associated symptoms are:

- Loud snoring
- Observed episodes of stopped breathing during sleep
- Waking during the night and gasping or choking
- Awakening in the morning with a dry mouth or sore throat
- Morning headaches
- Trouble focusing during the day
- Depression
- High blood pressure
- A decreased interest in sex (Mayo Clinic, 2023).

Untreated OSA has been linked with heart disease, stroke, type two diabetes, risk of motor vehicle accidents and impaired quality of life (Ahrens et al, 2011; British Lung Foundation, 2015).

OSA can shorten life expectancy and sufferers are also at a higher risk of hypertension (British Lung Foundation, 2015).

Risk factors

The most significant risk factors for OSA are age and obesity. Being over 65 years of age and a body mass index (BMI) of over 25kg/m2 has a 93% sensitivity for OSA and increased risk of developing the condition (Eckert and Younes, 2014).

Weight loss has been suggested as an alternative treatment option, as high BMI is a major risk factor for OSA. Other modifiable risk factors include alcohol consumption.

With the increasing obesity crisis and increased life expectancy in many populations across the globe, the number of OSA cases looks set to rise further. Interestingly, a recent position statement from the American Academy of Sleep Medicine highlights that chronic opioid use could be another contributing factor, which is especially worrying given the need for such medication in many chronic and end-stage respiratory conditions (Lancet Respiratory Medicine, 2020).

Sleeping in a supine position encourages the tongue and soft palate to fall backwards onto the back of the throat, causing an obstruction of the upper airway (Greenstone and Hack, 2014).

Other predisposing factors for young, healthy individuals are macroglossia, excess fat in the palate, and adenoidal tonsillar hypertrophy (Douglas and Polo, 1994)

Aetiology

Sleep apnoea occurs when the upper airway becomes blocked or narrowed during sleep. This blockage disrupts breathing patterns, causing the partial or complete cessation of breathing for brief periods. There are two main reasons why this blockage might happen.

In obstructive sleep apnoea, the most common type, relaxed throat muscles and soft tissues collapse during sleep, blocking the airway. During sleep when the upper airway relaxes, the pharyngeal dilator tone is lost and the base of the tongue and soft palate relax and rest on to the pharyngeal wall, resulting in a partial or complete airway obstruction. This is often linked to factors like excess weight and a large neck circumference.

Hypoventilation means a drop in blood oxygen levels and stimulates an enhanced respiratory effort. This is often observed as a gasp for air and restlessness. This cycle repeats throughout the night, and the more severe, the more it occurs (Parmenter and Millar, 2023; Epstein et al, 2009; Zwillich, 1998). Less commonly, central sleep apnoea happens when the brain fails to send proper signals to the muscles controlling breathing. This can be caused by underlying medical conditions or heart problems.

Diagnosis

Diagnosis often begins with a two-pronged approach: gathering evidence through patient history and questionnaires, and conducting specialised sleep studies.

During an initial consultation, medical history forms can be a valuable tool for uncovering potential sleep-disordered breathing (SDB).

Research suggests that screening for SDB is crucial during hypertension treatment, as the two conditions are often linked. SDB is prevalent in diabetics due to its impact on glucose metabolism. In children, SDB is frequently associated with ADHD (Urbano et al, 2021).

Secondly, clinicians can utilise questionnaires like the Epworth Sleepiness Scale (ESS) and STOP-BANG to assess potential risk factors based on symptoms like daytime sleepiness, loud snoring, and witnessed breathing pauses during sleep.

The ESS is subjective, scoring the patient out of 24 for varying daytime sleepiness symptoms. The higher the scores, the more severe the symptoms of daytime sleepiness.

STOP-BANG is an acronym for the first letter of each symptom or physical attribute often associated with OSA:

- Snoring: this question assesses whether or not you snore loudly enough to bother a bed partner
- Tiredness: this symptom involves feeling daytime tiredness, which may include falling asleep during daily tasks
- Observed apnoea: if a sleep partner has noticed that you stop breathing or gasp for air as you sleep, this can be a sign of OSA

- Pressure: high blood pressure is also a symptom
- BMI: physicians look for a body mass index that is higher than 35
- Age: those who are older than 50 are at higher risk for OSA
- Neck circumference: physicians measure your neck circumference. A measurement greater than 16 inches is considered a risk factor
- Gender: males are considered to be more likely to have OSA.

However, these questionnaires provide a preliminary picture. Definitive diagnosis often relies on sleep studies like polysomnography, which monitors factors like brainwaves, breathing patterns, and blood oxygen levels during sleep. This detailed data allows healthcare professionals to pinpoint the severity of sleep apnoea and determine the most appropriate treatment course. Working in unity with medical professionals is the correct and holistic approach for a proper diagnosis.

The degree of OSA is classified by the number of apnoea and hypopnoea events, recorded by polysomnography, in an apnoea-hypopnoea index (AHI). Most classifications denote mild cases as five to 15 events per hour, moderate as 15 to 30 per hour, and severe as more than 30 events per hour.

MAD versus CPAP

Traditionally, CPAP has been considered the most effective treatment for sleep apnoea across mild, moderate, and severe cases (Spicuzza et al, 2015).

A CPAP machine delivers constant and steady air pressure through a hose connected to a mask or nosepiece worn during sleep. This pressurised air helps keep the airway open, preventing apnoea episodes.

However, CPAP can be difficult to tolerate for some patients, which can result in poor compliance rates. Lack of compliance is often due to intolerance of the mask, feeling claustrophobic, and feeling a lack of benefit (Ojuawo et al, 2023), escaping air, difficulty sleeping, nasal congestion and xerostomia (Mayo Clinic, 2023).

A study that analysed factors affecting long-term compliance of 400 patients referred for CPAP treatment between 2012 and 2015 found that after a mean time of three and a half years of follow-up, only around 50% of OSA patients were still using CPAP (Gabryelska et al, 2021).

Low compliance rates for CPAP range between 30% and 60%, suggesting the need for alternative treatment methods (Rotenberg et al, 2016).

A randomised controlled crossover trial by Barnes and colleagues (2004) investigated the effectiveness of continuous positive airway pressure (CPAP) and mandibular advancement splints (MASs) in treating mild-to-moderate obstructive sleep apnoea (OSA) in 80 sleep clinic patients.

The participants underwent three-month treatment periods with each of CPAP, MAS, and an oral placebo tablet. The study found that both CPAP and MAS significantly reduced sleep apnoea severity compared to the placebo. However, CPAP was more effective than MAS in improving overall sleep apnoea. Interestingly, the study also revealed that MAS treatment improved night-time blood pressure dips, while CPAP did not show this specific benefit. Overall, the findings suggest that both CPAP and MAS are effective treatment options for mild-to-moderate OSA, but CPAP may provide a more comprehensive therapeutic effect.

A Cochrane review by Lim and colleagues (2009) evaluated the effectiveness of oral appliances (OA) compared to an inactive control in treating sleep-disordered breathing. The review found that OA improved subjective sleepiness and SDB indices compared to the control. However, CPAP remained more effective in significantly reducing the AHI.

Notably, the review also highlighted a patient preference for oral appliances over CPAP. This suggests OA may be a suitable alternative for individuals with mild sleep apneoa or those who struggle to tolerate CPAP therapy.

Mechanism of Action: MADs

Mandibular advancement devices (MADs) work by physically advancing the mandible forward relative to the maxilla, as described by Jayesh and Bhat (2015), This widens the airway and helps prevent its collapse during sleep, reducing sleep apnoea episodes.

There are two different types of MADs:

1. Custom-fitted MADs, which are fabricated by a dentist/orthodontist from a patient's impression, offering the best comfort and compliance
2. Boil-and-bite MADs, which are the most readily available online, but these often lack proper fit and effectiveness, leading to compliance issues (Corliss, 2021).

A randomised controlled crossover trial by Vanderveken and colleagues (2007) published in the American Journal of Respiratory and Critical Care Medicine investigated the effectiveness of custom-made mandibular advancement splints (MAS) compared to off-the-shelf devices in treating sleep apnoea.

The study found that custom-made MAS significantly improved the apnoea-hypopnea index (AHI), with a success rate of 60% compared to only 31% for off-the-shelf devices. Additionally, custom-made MAS led to a greater reduction in snoring. However, compliance (measured by device

Steps for treating obstructive sleep apnoea and snoring

1. Initial consultation with patient

Screening for sleep apnoea risk. Conduct a pre-screening questionnaire to assess potential risk of OSA. Utilise validated tools, such as the Epworth Sleepiness Scale, and the STOP-BANG questionnaire (NICE, 2021). Other options include the Berlin Questionnaire and Flemons SACS Questionnaire (Xiong et al, 2019).

Depending on the score, a referral to a medical doctor for further evaluation of OSA may be recommended. For safe and effective use, mandibular advancement devices require careful patient selection and informed consent. Communication with patient's medical practitioner. As a best practice, send a letter to the patient's general medical practitioner informing them about the consultation, even if snoring is the primary concern. This is because snoring can be a risk factor for OSA, and early detection is crucial.

2. Impressions/intraoral scan (if available)

Take impressions or an intraoral scan (if your practice offers it) to create a precise model of the patient's teeth and jaw. Send the impressions/scan along with a bite registration to a reputable dental laboratory accredited for manufacturing mandibular advancement devices (MADs).

3. Fit appliance for patient

Once the MAD is fabricated, the patient returns for a fitting. Depending on the severity of sleep apnoea (determined by the initial consultation or referral) and the patient's comfort level, an adjustment period ('titration') is recommended. During titration, the protrusion level of the MAD is gradually increased to find the most effective and comfortable position for preventing airway closure during sleep.

4. Follow-up appointment

Schedule a follow-up appointment to assess the effectiveness of the MAD. Discuss the patient's experience with the device, including comfort, sleep quality, and any reduction in snoring (reported by the patient or their sleep partner). Based on the findings, adjustments to the MAD or treatment plan might be necessary.

Regular follow-up appointments are crucial to monitor treatment progress and ensure the MAD continues to be effective and comfortable and to monitor any side effects.

Additional considerations

It is important to inform patients that MADs are typically most effective for mild to moderate OSA. In severe cases, a continuous positive airway pressure (CPAP) machine might be a more suitable treatment option and is still the gold standard treatment modality for severe OSA.

retention) was a challenge, with one-third of patients failing to consistently use the off-the-shelf MAS.

MADs have long been considered to be an effective way to eliminate the symptoms of snoring and, more recently, as a treatment for mild, moderate and severe sleep apnoea (Jayesh and Bhat, 2015; NICE, 2021). Yet, MADs are not without their side effects, and may cause short-term issues such as muscle discomfort, drooling or dry mouth, and temporary jaw misalignment upon waking. Potential long-term complications include changes in bite and temporomandibular joint (TMJ) discomfort.

Despite their side effects, a key reason for considering a MAD instead of CPAP are the factors that cause non-compliance of CPAP. MADs may absolutely be considered for patients who cannot tolerate CPAP, aren't willing to try CPAP, or for those who are awaiting referral to a sleep clinic for CPAP treatment (Fleury, Lowe and Oral Appliance Network for Global Effectiveness Group, 2014; NICE, 2021).

References

Ahrens, A., McGrath, C., & Hagg, U. (2011). 'A systematic review of the efficacy of oral appliance design in the management of obstructive sleep apnoea'. European Journal of Orthodontics, 33(3), pp. 318–324.

Benjafield AV, Ayas NT, Eastwood PR, Heinzer R, Ip MSM, Morrell MJ, Nunez CM, Patel SR, Penzel T, Pépin JL, Peppard PE, Sinha S, Tufik S, Valentine K, Malhotra A. Estimation of the global prevalence and burden of obstructive sleep apnoea: a literature-based analysis. Lancet Respir Med. 2019 Aug;7(8):687-698. doi: 10.1016/S2213-2600(19)30198-5. Epub 2019 Jul 9. PMID: 31300334; PMCID: PMC7007763.

Barnes M, McEvoy RD, Banks S, Tarquinio N, Murray CG, Vowles N, Pierce RJ. Efficacy of positive airway pressure and oral appliance in mild to moderate obstructive sleep apnea. American journal of respiratory and critical care medicine. 2004 Sep 15;170(6):656-64.

British Lung Foundation. (2015). Obstructive Sleep Apnoea (OSA) Toolkit for commissioning and planning local NHS services in the UK. Available at: https://www.asthmaandlung.org.uk/sites/default/files/OSA_Toolkit_2015_BLF_0.pdf (Accessed: 20 March 2024).

Corliss, J. (2021). 'Dental appliances for sleep apnea: Do they work?' Harvard Heart Letter. Available at: https://www.health.harvard.edu/blog/dental-appliances-for-sleep-apnea-do-they-work-2021042822476 (Accessed: 19 March 2024).

Davey, J. (2007). Current trends in the treatment of snoring & sleep apnoea. Available at: https://britishsnoring.co.uk/napc_review.php (Accessed: 15 March 2024).

Douglas NJ, Polo O. Pathogenesis of obstructive sleep apnoea/hypopnoea syndrome. The Lancet. 1994;344(8923):653-5.

Eckert DJ, Younes MK. Arousal from sleep: implications for obstructive sleep apnea pathogenesis and treatment. Journal of Applied Physiology. 2014 Feb 1;116(3):302-13.

Epstein LJ, Kristo D, Strollo Jr PJ, Friedman N, Malhotra A, Patil SP, Ramar K, Rogers R, Schwab RJ, Weaver EM, Weinstein MD. Adult Obstructive Sleep Apnea Task Force of the American Academy of Sleep Medicine. Clinical guideline for the evaluation, management and long-term care of obstructive sleep apnea in adults. J Clin Sleep Med. 2009 Jun 15;5(3):263-76.

Fleury, B., Lowe, A. A., & ORal Appliance Network for Global Effectiveness Group. (2014). 'Current barriers and study needs for oral appliance therapy: the personal perspective of a physician and dentist'. Journal of Dental Sleep Medicine, 1(3), pp. 123–127.

Gabryelska, A., Sochal, M., Wasik, B., Szczepanowski, P., & Białasiewicz, P. (2021). 'Factors affecting long-term compliance of CPAP treatment - A single centre experience'. Journal of Clinical Medicine, 11(1), 139.

Greenstone M, Hack M. Obstructive sleep apnoea. BMJ. 2014 Jun 17;348.

Jayesh SR, Bhat WM. (2015). 'Mandibular advancement device for obstructive sleep apnea: An overview'. J Pharm Bioallied Sci, 7(Suppl 1), p. S223-5.

Leigh C, Faigenblum M, Fine P, Blizard R, Leung A. (2021) 'General dental practitioners' knowledge and opinions of snoring and sleep-related breathing disorders'. Br Dent J. 231(9), pp. 569-574.

Ling, V. (2023). Sleep Apnea Statistics and Facts You Should Know. Available at: https://www.ncoa.org/adviser/sleep/sleep-apnea-statistics/#:~:text=936%20million%20adults%20around%20the,up%20to%2094%25%20of%20patients. (Accessed: 20 March 2024).

National Highway Traffic Safety Administration. Drowsy Driving. Available at: https://www.nhtsa.gov/risky-driving/drowsy-driving (accessed April 2024).

NICE. (2021). Obstructive sleep apnoea/hypopnoea syndrome: Guidance. Available at: https://www.nice.org.uk/guidance/ng202/chapter/1-Obstructive-sleep-apnoeahypopnoea-syndrome#initial-assessment-for-osahs (Accessed: 19 March 2024).

Mayo Clinic. (2023). Obstructive sleep apnea. Available at: https://www.mayoclinic.org/diseases-conditions/obstructive-sleep-apnea/symptoms-causes/syc-20352090 (Accessed: 19 March 2024).

Ojuawo, O., Jamil, M., Abbas, Z., Htwe, T., Mohamed, A., Howell, S., Swaminathan, N., Nathani, N., & Ansari, Z. (2023). 'Assessment of non-compliance with continuous positive airway pressure (CPAP) therapy in patients with obstructive sleep apnoea (OSA) in a teaching NHS Trust in the UK'. ERJ Open Research, 9 (suppl 11), 26.

Palomäki, M., Tarja Saaresranta, T., Anttalainen, U., Partinen, M., Keto, J., & Linna, M. (2022). 'Multimorbidity and overall comorbidity of sleep apnoea: a Finnish nationwide study' ERJ Open Research, 8: 00646-2021.

Parmenter D, Millar BJ. How can general dental practitioners help in the management of sleep apnoea?. British Dental Journal. 2023 Apr 14;234(7):505-9.

Rotenberg B, Murariu D, Pang K. Trends in Cpap adherence over twenty years of data collection: A flattened curve. J Otolaryngol Head Neck Surg. 2016;45(1).

Spicuzza, L., Caruso, D., Di Maria, G. (2015). 'Obstructive sleep apnoea syndrome and its management', Therapeutic Advances in Chronic Disease, 6(5), pp. 273-285.

Stack, A. Why now is the time to get involved in dental sleep medicine. Br Dent J 233, 258–259 (2022). https://doi.org/10.1038/s41415-022-4944-9

Stoohs RA, Knaack L, Blum HC, Janicki J, Hohenhorst W. Differences in clinical features of upper airway resistance syndrome, primary snoring, and obstructive sleep apnea/hypopnea syndrome. Sleep medicine. 2008 Jan 1;9(2):121-8.

Terzano MG, Parrino L, Sherieri A, Chervin R, Chokroverty S, Guilleminault C, Hirshkowitz M, Mahowald M, Moldofsky H, Rosa A, Thomas R. Atlas, rules, and recording techniques for the scoring of cyclic alternating pattern (CAP) in human sleep. Sleep medicine. 2001 Nov 1;2(6):537-54.

The Lancet Respiratory Medicine. (2020). 'Time to wake the giant of obstructive sleep apnoea.' 8(1), p. 1. Available at: https://www.thelancet.com/journals/lanres/article/PIIS2213-2600(19)30449-7/fulltext (Accessed: 19 March 2024).

Urbano G L, Tablizo B J, Moufarrej Y, Tablizo M A, Chen M L, Witmans M. The Link between Pediatric Obstructive Sleep Apnea (OSA) and Attention Deficit Hyperactivity Disorder (ADHD). Children (Basel) 2021; doi: 10.3390/children8090824.

Vanderveken OM, Devolder A, Marklund M, Boudewyns AN, Braem MJ, Okkerse W, Verbraecken JA, Franklin KA, De Backer WA, Van de Heyning PH. Comparison of a custom-made and a thermoplastic oral appliance for the treatment of mild sleep apnea. American journal of respiratory and critical care medicine. 2008 Jul 15;178(2):197-202.

Xiong, M., Hu, W., Dong, M., Wang, M., Chen, J., Xiong, H., Zhong, M., Jiang, Y., Liu, D., & Hu, K. (2019) 'The Screening Value Of ESS, SACS, BQ, And SBQ On Obstructive Sleep Apnea In Patients With Chronic Obstructive Pulmonary Disease,' Int J Chron Obstruct Pulmon Dis, 14, pp. 2497–2505.

Zwillich CW. Sleep apnoea and autonomic function. Thorax. 1998 Oct 1;53(suppl 3):S20-4.

This article first appeared in Clinical Dentistry and has been reprinted with permission. Hindocha A. Using mandibular advancement devices for OSA Clinical Dentistry 4 (5): 82-84