



The Mandibular Advancement Devices Induce Obstructive Sleep Apnea Treatment

Haval Jalal Rasheed ^{1*}, Zana Qader Omer ²

Abstract

Introduction: Obstructive sleep apnea (OSA) is a prevalent breathing-related disorder characterized by intermittent airflow cessation due to upper airway narrowing or collapse. Polysomnography is the gold standard diagnostic test for sleep disorders, including sleep apnea. This study evaluates the efficacy of mandibular advancement devices, specifically the MSI, by examining changes in various physiological parameters. **Methods:** Twenty patients with mild to moderate OSA risk, selected from 500 patients attending Khanzad Teaching Hospital, were treated with MSI for three months with a 3mm advancement. Physiological records were obtained before and after treatment using a portable sleep study device. **Results:** Significant changes were observed after three months of treatment. The Apnea-Hypopnea Index (AHI)/Respiratory Event Index (REI) showed a slight reduction from 30.5 to 28 events, but this change was statistically non-significant. The Respiratory Disturbance Index (RDI) significantly decreased from 49.42 to 35.94. The Oxygen Desaturation Index (ODI) showed a significant reduction from 34.25 to 33.97. Blood oxygen levels (spO₂%) improved from 77.85% to 89.7%. The pulse rate frequency (50-75 bpm) changed from 80.17 to 81.91, which was non-significant. Respiratory desaturations

decreased from 162.5 to 144, obstructive apnea events reduced from 34.7 to 19.65 (approximately 15%), and hypopnea events decreased from 144.25 to 107.3. **Conclusion:** Statistically significant improvements were recorded in the ODI, spO₂%, desaturations, and RDI, except for the AHI/REI and pulse rate, which showed non-significant differences. Mandibular advancement at a range of 0.5 mm was better tolerated by patients than 0.5 mm per week advancements.

Keywords: Obstructive Sleep Apnea, Mandibular Advancement Device, Polysomnography, Sleep Disorders, Physiological Parameters

Introduction

Sleep has mystified in different cultures from ancient times. Earliest Egyptians specify special parts of papyri to give different explanations of dreaming. The ancient Greek Aristotle wrote about sleep and waking. He also mentioned the effect of different food, which causes sleepiness through “vapor” that passes through blood vessels into the brain. Hippocrates, who is known as the father of medicine in ancient Greece, talked about health and its relationship with sleep. (Kirsch, 2011; Nunn et al., 2016)

A religious text from old Judaism by Maimonides, who was a scholar in the 1100s, describes the following, which looks to be right today. ‘From the 24 hours of the day and night. It is enough for anyone to sleep one-third of its which will be eight hours. It is best to be at the end of the night so when going to sleep until dawn. Thus, he could rise from bed before the sun rises. (Chattu et al., 2018).

Disturbance in the number of sleep hours is usually linked to a

Significance | Mandibular advancement devices significantly improve sleep apnea-related physiological parameters within three months, promoting better sleep quality and overall health.

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number of health and social problems, ranging from a bad performance at school to more serious conditions that might cause death, like accidents, cardiovascular disease, neoplasms, diabetes, and hypertension. The outcomes of adequate sleep have a more immediate effect than that suggested by the International Classification of Sleep Disorders, which defines inadequate sleep as a lessened sleep pattern that continues for three months for almost the whole week associated with daytime sleepiness. As a result of this sleepiness, a person will try to extend the total sleep time and frequency, and episodes of unfavorable mental and physical experiences may be associated with insufficient sleep. Sleep insufficiency and insomnia might be confused to be synonyms, although there are big differences in sleep opportunity between the two as sleep insufficiency typically being unable to sleep. Still, even if there is time and chance to solve the problem with the person himself and with time management. Unlike sleep insufficiency, insomnia is not about the lack of opportunity; it's about the difficulty in achieving. Restful sleep despite having the chance to do so. Persistent sleep difficulties characterize chronic insomnia (Zampogna et al., 2021, Marbach et al., 2020, Kim et al., 2021).

obstructive sleep apnea is kind of breathing related disorders recorded sleeping time, it's usually associated with repeated periods of sporadic stoppage of airflow from nose and mouth associated with some narrowing or collapse in the upper part of the airway, which looks to be due to variety of reasons like anatomical one and/or error in neuromuscular coordination which may in total lead to improper function which normal situations control the airway, at bed time the muscles of throat especially those located in the back part will relax and lead to narrowing of the airway because of soft tissue behavior which in consequence will block the airway which might be either blockage of the airway completely that called (apneas) or may be less harmful and result in a partial decrease rather than complete and called (hypopneas), by about 30% or more for 10 seconds breathing patterns are superficial or irregular, apneas of at least 10 s duration have been considered important, but 15–20 s periods might for about 1–3 min, This situation may be repeated for many times in single night. This will cause a disturbance in sleep, reduce its quality, and, as a consequence, cause excessive sleepiness in the morning. It usually affects daytime sleepiness and other cognitive functions. (Zampogna et al., 2021; Marbach et al., 2020; Kim et al., 2021; The Official STOP-Bang Questionnaire Website. n.d.).

Stop-bang questionnaire.

The Stop Bang questionnaire (Table 1) is one of the earliest screening tools for the detection of sleep apnea. It is composed of 8 different questions. All 500 participants were asked to complete the part of questions which is related to the symptoms. At the same time, the researchers or supervisor took the responsibility of

completing the remaining part of the questions with the patient. (Chung et al., 2008; STOP-Bang Questionnaire Website. n.d.; Nagappa et al., 2015)

Polysomnography

Polysomnography (PSG) is a diagnostic test used to monitor and record various physiological parameters during sleep. It is considered a golden tool for the diagnosis of sleep disorders generally, and for sure, diagnosis of sleep apnea helps in the evaluation and diagnosis; in this test, many things can be recorded in different physiological signals. Those can be classified into different categories like AHI/REI (Apnea-Hypopnea Index (AHI): The AHI quantifies the quality of apnea detected by the number of apneas and hypopneas occurring at sleep)(Respiratory Event Index (REI): When a home sleep study is conducted, the AHI is often expressed as the REI)(AHI is specific to sleep time, while REI considers the entire recording time), RDI(Respiratory Disturbance Index), ODI(Oxygen Desaturation Index), SpO₂(blood oxygen levels), plus rate, desaturations(Respiratory desaturation refers to a situation where your blood oxygen saturation drops below the normal level, obstructive apnea (repeated breathing interruptions during sleep), hypopnea (partially blocked airflow during sleep), flow limitation. The use of sleep study clinics may not be practical or available every time; portable monitors can be used as an alternative for sleep monitoring as they show the ability to be used at home, they cost less and are faster to deploy, more accessible, and show great accuracy as laboratory polysomnography. There are four types of portable monitors based on the number and type of recording channels; 'American Academy of Sleep Medicine' recommends that the lowest level of portable monitors should be able to record the flow of air, respiratory effort, and blood oxygenation; this level of monitoring is found among type 3 portable monitors This device is used to assess sleep-disordered respiration, a 12-channel Type 3 home portable recorder, MediByte® (Fig. 1), was utilized. The subsequent variables. (Bruyneel and Vincent., 2014; Raveendran & Chung 2015; Mendonça et al., 2018).

Mandibular advancement device (MAD)

Orthodontic treatment is one possible way of treating sleep apnea through using a custom-made device that patients wear at night. Consequently, it should be simple, without excess volume for better sealing of the lips, enough space for the tongue and not cause any hindrance during sleep. Lastly but most importantly, it must fit within the patient's budget thereby enabling affordability by many concerned parties. In essence, this device works by advancing mandible and tongue forwards so as to provide open upper airway when sleeping; lower interfacial proportions are reduced while maintaining normal maxilla-mandibular relation preventing

Snoring?
 Yes No
 Do you snore loudly (loud enough to be heard through closed doors or your bed partner elbows you for snoring at night)?

Tired?
 Yes No
 Do you often feel tired, fatigued, or sleepy during the daytime (such as falling asleep during driving)?

Observed?
 Yes No
 Has anyone observed you stop breathing or choking/gasping during your sleep?

Pressure?
 Yes No
 Do you have or are being treated for high blood pressure?

Body mass index more than 35 kg/m²?
 Yes No

Age older than 50 years?
 Yes No

Neck size large? (measured around Adam's apple)
 Yes No
 For male, is your shirt collar 17 inches or larger?
 Yes No
 For female, is your shirt collar 16 inches or larger?

Sex = male?
 Yes No

Notes: Scoring criteria (for general population): low risk of OSA, yes to 0-2 questions; intermediate risk of OSA, yes to 3-4 questions; high risk of OSA: yes to 5-8 questions, yes to 2 of 4 STOP questions + individual's sex is male, yes to 2 of 4 STOP questions + BMI >35 kg/m², yes to 2 of 4 STOP questions + neck circumference (male) 17"/(female) 16". Property of University Health Network.
Abbreviations: OSA, obstructive sleep apnea; BMI, body mass index.

Table 1. STOP-Bang questionnaire (STOP-Bang Questionnaire, n.d.)

Figure 1. Sleep study report by MediByte (Braebon, n.d.)

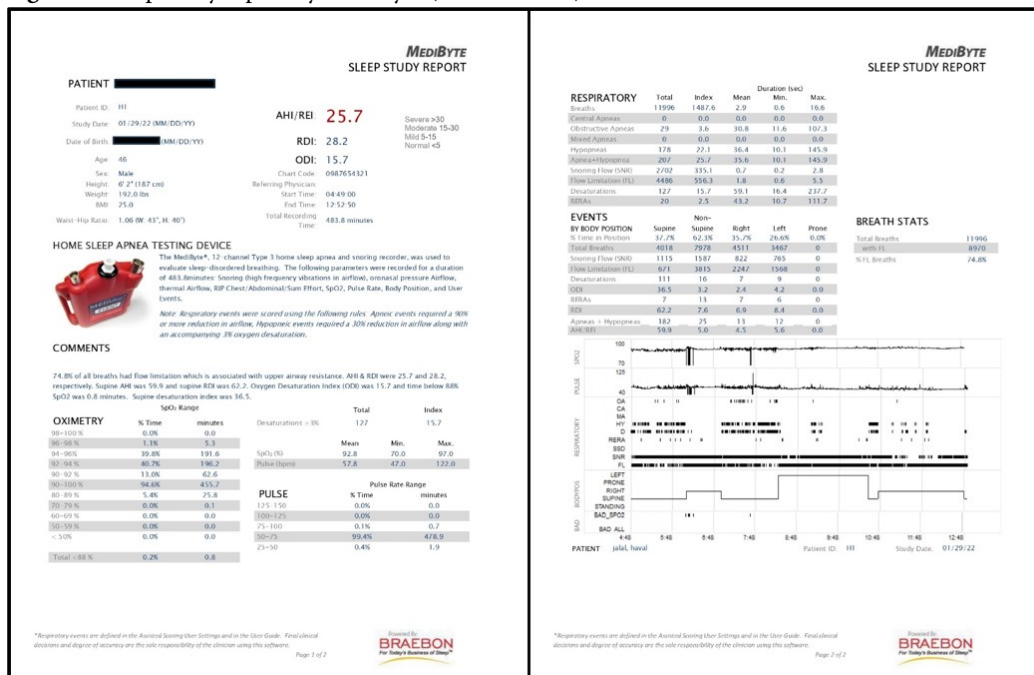


Figure 2. The MSi Mandibular Snoring Inhibitor is an anti-snoring device that is designed for patients who suffer from snoring or sleep apnea (DB Orthodontics, n.d.)



Table 2. paired sample test used to evaluate the significance of changes (P. Value > 0.01, N.S.).

Paired Samples Test											
Variables		Paired Differences					t	df	Sig. (2-tailed)	Significance	
		Mean	Std. Deviation	Std. Error Mean	99% Confidence Interval of the Difference						
					Lower	Upper					
1	AHI_REI	29.25	4.47	0.85	-2.8	2.8	-2.48	18.0	<0.001	non	0.022
2	RDI	13.48	4.75	1.06	11.25	15.70	12.68	18.0	0.81	Sig.	0.001018
3	ODI	0.28	4.99	1.12	-2.06	2.62	0.25	18.0	<0.001	non	0.8
4	SPO2	-11.85	3.7	0.83	-13.58	-10.12	-14.3	18.0	<0.001	Sig.	0.000125
5	PULSE 50_75	-1.74	1.66	0.37	-2.51	-0.96	4.79	18.0	<0.001	non	0.0131
6	DESATURATION3B	18.35	10.85	2.36	13.40	23.30	-7.39	18.0	<0.001	Sig.	0.000733
7	OA	15.05	7.76	1.74	11.42	18.68	8.67	18.0	<0.001	Sig.	0.000497
8	Hypopnea	36.95	14.5	3.25	30.16	43.74	11.38	18.0	<0.001	Sig.	0.00062

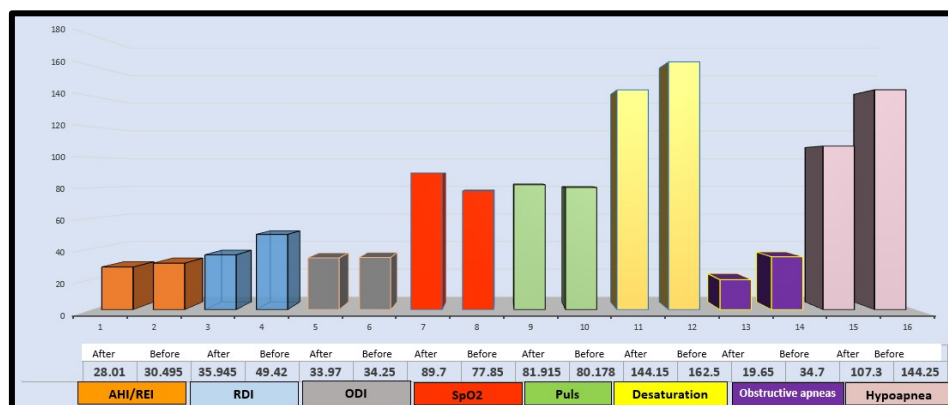


Figure 3. Different physiological records change before and after treatment.

collapse of the upper airway thereby retaining hyoid bone in its highest position; normalization of palatal area approximately and size still within normal limits and post-lingual areas still patent remain relatively.

Interestingly, these appliances come in various commercial names made from different materials. What they do is bring forward the mandible so that there is a wider passage for air (Kulshrestha et al., 2016 & Venema et al., 2021).

The MSi Mandibular Snoring Inhibitor (Fig.2) is an anti-snoring device indicated for individuals who experience snoring or suffer from obstructive sleep apnea. Thus these guidelines such as NICE update in 2021 concerning Anti-Snoring Mandibular Advancement Devices which can be used as therapy choices for Obstructive Sleep Apnea (OSA). It has been welcomed by health institutions whose aim is to provide improved treatment options tailored to individual patients. Something additional may be provided to your patients which could add more value to their sleep quality.

These lab adjustments are sometimes very infuriating. This appliance eliminates other anti-snoring devices out in the market only through that ten millimeters' protrusion towards anteriority in a workflow-efficient manner. The skeletal screw design makes it easy to clean because although comfortable and slim profile with rounded edges. Every time, Bite Right does ascertain every bite jig without failure. Appliances were not returned for adjustments after the initial fit since it was launched due to its mechanism. Appliances were not returned for adjustments after the initial fit since it was launched due to its mechanism. To reach out to Laboratory Technicians from DB Orthodontics' in-house laboratory just dial up Studio 8. Patient care pack includes OSA Screening Questionnaire and GP Cover Letter to help sleep specialist referral and screening for obstructive sleep apnea (OSA). You can get support such as leaflets, posters or digital marketing images for your website and social media pages among much more. These are some of the features integrated into this design:

- Durability – It is designed to bear heavy forces exerted by bruxism patients, e.g., three-bar hook support.
- Fits are predictable. Just easy to use.
- Outstanding performance – With quite amount of extra adjustment; built for longevity; all parts replaceable individually; 2-year guarantee.
- Easy hygienic design can be maintained by patients easily.
- It offers some lateral and or excursive movements, hence comfortably worn during the adaptation period.
- Easy design that takes less time to make. (Agarwal & Gupta 2016).

Methodology

700 patient visited khanzad teaching hospital in Erbil diagnosis department, city with different complication regarding sleeping

time, after applying ethical form for all patients an explaining that their data might be used in future study and get their approval, 500 patient from them where included in the study according inclusion criteria they were asked to complete the STOP-bang questioner as first checking tool, as a result a no of them are seem to be at high and moderate risk for sleep apnea, 25 patient who are at moderate risk level and willing for treatment are subjected to sleep study, by using at home use polysomnograph , type 3 portable monitors (MediByte®) which is able to record deferent parameters like (AHI/REI, RDI, ODI, spO2%, Puls50-75%, Desaturation<3%, Obstructive Apneas, Hypopneas, Flow Limitation), after taking the result from the patients 20 patient where diagnosed with moderate risk of sleep apnea result = 15-30 (Severe >30, Moderate 15-30, Mild 5-15, Normal <5) so they were elected to be treated with mandibular advancement device represented by MSi (Mandibular Snoring Inhibitor) which fabricated by qualified orthodontic technician (Fig. 1,2)a gradual adjustment of the MSi is recommended (one turn of the screw; 0.5mm advancement a week) until the optimum position is found. Although we recommend 0.5 mm every two weeks to get a final of 3mm at the end of three months to ensure better patient acceptance and comfortability, after 90 days with the use of MSi, all the patients were subjected to 2nd polysomnograph study where the result is compared to assist the efficiency of treatment after first three months.

Results

After comparing the sleep study of all patients on two occasions and with three months Intervale, using the MSI with 3mm advancement only, we evaluate the significance of the changes using spass version 28.0 provided by IBM Corporation, of some variables (table 2) to assist the efficiency of the appliance on improving the patient physiological records.

Discussion

The treatment of patients suffering from obstructive sleep apnea by using a mandibular advancement device (MSi) shows a noticeable effect after the first three months of usage. The MSi protrudes the mandible forward at the rate of 1 mm each month, which seems to be more comfortable for the patient and gives much time for adaptation rather than the recommended 0.5mm and lessens the degree of morning spasm usually associated with the use of MSi.

The polysomnography records show a significant change in the RDI (Respiratory Disturbance Index), which reduced from 49.42 to 35.94, still considered significant. The ODI Oxygen Desaturation Index shows a significant difference (34.25 to 33.97), spO2%(blood oxygen levels) shows a noticeable change (77.85 to 89.7), Respiratory desaturation which refers to a situation where your blood oxygen saturation drops below the normal level (162.5 to 144), obstructive apnea (repeated breathing interruptions during sleep), decrease from (34.7 to 19.65)

which is about 15 %, hypopnea(, partially blocked airflow during sleep drops from 144.25 to 107.3. change in the means of AHI/REI between baselines. After three months of recording (30.5 to 28 events) the pulse rate in rate 50-75 shows a change in rate (80.17 to 81.91), which is a non-significant change.

The results are promising as the changes obtained only after three months, catenation with the usage of appliance looks to have many advantages as other studies support the improvement after one year or even five years of follow-up.

These early results might encourage the patient to continue the treatment as he will feel the difference soon and may even make them change his total lifestyle, like losing weight and quitting smoking.

Conclusion

Based on this study's results, several conclusions can be drawn. A three-month period shows satisfactory improvement in apnea patients. An advancement of 0.5 mm every two weeks is better accepted by patients compared to weekly advancements. The Respiratory Disturbance Index (RDI) exhibits the greatest mean difference. While all other records indicate significant differences and improvement, the Apnea-Hypopnea Index (AHI)/Respiratory Event Index (REI) and pulse rate do not show significant changes.

Author contributions

H.J.R. and Z.Q.O. conceived and designed the manuscript. H.J.R. acquired, analyzed, and interpreted the data. All authors drafted the manuscript. H.J.R. and Z.Q.O. revised it. All authors contributed equally and read and approved the final version of the manuscript.

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Competing financial interests

The authors have no conflict of interest.

References

- Agarwal, L., & Gupta, A. (2016). Role of orthodontist in obstructive sleep apnea-an orthodontic review. *J Orthod Endod*, 2(3), 7.
- Braebon. Available at: <https://www2.braebon.com/products/medibyte> (Accessed: 14 May 2024).
- Braebon. Available at: <https://www2.braebon.com/products/medibyte> (Accessed: 29 May 2024).
- Bruyneel, M., & Ninane, V. (2014). Unattended home-based polysomnography for sleep disordered breathing: current concepts and perspectives. *Sleep Medicine Reviews*, 18(4), 341-347.

- Chattu, V. K., Manzar, M. D., Kumary, S., Burman, D., Spence, D. W., & Pandi-Perumal, S. R. (2018, December). The global problem of insufficient sleep and its serious public health implications. In *Healthcare* (Vol. 7, No. 1, p. 1). MDPI.
- Chung, F., Yegneswaran, B., Liao, P., et al. (2008). STOP questionnaire: A tool to screen patients for obstructive sleep apnea. *Anesthesiology*, 108(5), 812.
- DB Orthodontics. (n.d.). MSI Mandibular Snoring Inhibitor. Retrieved from <https://dbortho.com/products/msi-mandibular-snoring-inhibitor>.
- Kim, H. S., Son, J. H., Chung, J. H., Kim, K. S., Choi, J., & Yang, J. Y. (2021). Nasal airway function after Le Fort I osteotomy with maxillary impaction: A prospective study using the Nasal Obstruction Symptom Evaluation scale. *Archives of Plastic Surgery*, 48(1), 61-68.
- Kirsch, D. B. (2011). There and back again: a current history of sleep medicine. *Chest*, 139(4), 939-946.
- Kulshrestha, R., Tandon, R., King, S., Rohmetra, A., & Singh, R. V. (2016). Obstructive sleep apnea in orthodontics: An overview. *International Journal of Orthodontic Rehabilitation*, 7(3), 115.
- Marbach, F., Elgizouli, M., Rech, M., Beygo, J., Erger, F., Velmans, C., ... & Kuechler, A. (2020). The adult phenotype of Schaaf-Yang syndrome. *Orphanet Journal of Rare Diseases*, 15, 1-11.
- Mendonça, F., Mostafa, S. S., Ravelo-García, A. G., Morgado-Dias, F., & Penzel, T. (2018). Devices for home detection of obstructive sleep apnea: A review. *Sleep Medicine Reviews*, 41, 149-160.
- MSI (Mandibular Snoring Inhibitor). (n.d.). DB Orthodontics Limited. Retrieved from <https://dbortho.com/products/msi-mandibular-snoring-inhibitor>.
- Nagappa, M., Liao, P., Wong, J., Auckley, D., Ramachandran, S. K., Memtsoudis, S., ... & Chung, F. (2015). Validation of the STOP-Bang questionnaire as a screening tool for obstructive sleep apnea among different populations: a systematic review and meta-analysis. *PloS One*, 10(12), e0143697.
- Nunn, C. L., Samson, D. R., & Krystal, A. D. (2016). Shining evolutionary light on human sleep and sleep disorders. *Evolution, Medicine, and Public Health*, 2016(1), 227-243.
- Obstructive sleep apnea. The Official STOP-Bang Questionnaire Website. (n.d.). Retrieved from <http://www.stopbang.ca/>
- Raveendran, R., & Chung, F. (2015). Ambulatory anesthesia for patients with sleep apnea. *Ambulatory Anesthesia*, 143-151.
- Venema, J. A. U., Rosenmöller, B. R., De Vries, N., de Lange, J., Aarab, G., Lobbezoo, F., & Hoekema, A. (2021). Mandibular advancement device design: a systematic review on outcomes in obstructive sleep apnea treatment. *Sleep Medicine Reviews*, 60, 101557.
- Zampogna, E., Bertolotti, G., Ambrosino, N., Bello, G. L., Cherubino, F., Ianni, A., ... & Giordano, A. (2021). The Mageri daily activity profile: a tool to assess physical activity in patients with chronic obstructive pulmonary disease. *Monaldi Archives for Chest Disease*, 91(4).