

SEMINAR FOR PHYSICIANS SEMINAR ZA LEKARE U PRAKSI

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Seminar for physicians
Seminar za lekare u praksi
UDK 616.31-76/-77:616.24-008.4
<https://doi.org/10.2298/MPNS2306171P>

A NEW DESIGN OF INDIVIDUAL MANDIBULAR ADVANCEMENT DEVICE IN THE TREATMENT OF OBSTRUCTIVE SLEEP APNEA

NOVI DIZAJN INDIVIDUALNOG INTRAORALNOG APLIKATORA U LEČENJU OPSTRUKTIVNE SLEEP APNEE

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Summary

Introduction. Mandibular advancement devices are used in the treatment of mild to moderate obstructive sleep apnea. We have created different types of devices over the years and come up with a design of an acrylic two-part adjustable device as the best one so far. **New design of the mandibular advancement device.** A 36-year-old male patient has been referred for polysomnography to the Sleep Medicine Center of the Institute of Pulmonary Diseases of Vojvodina due to primary problems in the form of drowsiness during the day, reduced concentration and witnessed cessation of breathing during sleep. By evaluating respiratory parameters, the patient was diagnosed with mild obstructive sleep apnea with an Apnea-Hypopnea Index of 10.3. Hygienic-dietary regimen of life and the use of mandibular advancement device were prescribed to the patient. Control polysomnography was performed six months after the use of the mandibular advancement device. Evaluation of respiratory parameters has registered the apnea-hypopnea index of 6.2 with predominant hypopneas. The average oxygen blood saturation was 94.4%. Snoring was mild and rare. Patient did not have any long-term side effects of the device and he got used to it easily. **Conclusion.** Mandibular advancement device is an effective way to treat obstructive sleep apnea in clearly indicated cases. Dentists who indicate and make it must be well educated, informed and they must cooperate with the sleep medicine centers to monitor the effectiveness of the therapy.

Key words: Sleep Apnea, Obstructive; Mandibular Advancement; Polysomnography; Treatment Outcome; Equipment Design; Dentist's Role; Sleep Medicine Specialty

Sažetak

Uvod. Intraoralni aplikatori se koriste u lečenju lakših i srednje teških oblika opstruktivne sleep apnee. Tokom godina kreirali smo različite tipove aplikatora i došli smo do dizajna dvodelnog aplikatora od akrilata. **Novi dizajn intraoralnog aplikatora.** Pacijent muškog pola, 36 godina star, upućen je na poligrafiju u Centar za medicinu sna Instituta za plućne bolesti Vojvodine zbog tegoba u vidu dnevne pospanosti, smanjene koncentracije i posvedočenih prekida disanja u toku spavanja. Evaluacijom respiratornih parametara pacijentu je dijagnostikovana opstruktivna sleep apnea lakšeg oblika sa apnea hipopnea indeksom od 10,3. Predložen mu je higijensko-dijetetski način života i upućen je stomatologu radi izrade intraoralnog aplikatora. Kontrolna poligrafija je urađena šest meseci od početka korišćenja intraoralnog aplikatora. Apnea hipopnea indeks se smanjio na 6,2 sa dominantnim hipopneama. Srednja vrednost saturacije krvi kiseonikom je bila 94,4%. Hrkanje je slabo i retko. Pacijent nije imao ništa od neželjenih efekata aplikatora i navodi da se na njega lako navikao. **Zaključak.** Intraoralni aplikator je efektivan način lečenja opstruktivne sleep apnee u jasno indikovanim slučajevima. Stomatolog koji ih indikuje i pravi mora biti dobro edukovan, informisan i mora imati saradnju sa centrom za medicinu sna radi praćenja efikasnosti terapije.

Glavne reči: opstruktivne sleep apnea; intraoralni aplikator; polisomnografija; ishod lečenja; dizajn opreme; uloga stomatologa; specijalista medicine sna

Introduction

Mandibular advancement devices (MAD) are medical devices applied in the mouth to treat obstructive sleep apnea. They can be individual custom made by the dentist or prefabricated heat molded devices adapt-

ed to the teeth by the patient. Individual custom made devices have better efficiency and are more acceptable by the patients [1, 2].

Obstructive sleep apnea (OSA) is the most significant sleep-related breathing disorder, and occurs as a result of decreased muscle tone in upper respiratory

Abbreviations

OSA	– obstructive sleep apnea
MAD	– mandibular advancement device
AHI	– apnea hypopnea index
ODI	– oxygen desaturation index



Figure 1. First designed one-part silicone mandibular advancement device

Slika 1. Prvi dizajnirani jednodelni intraoralni aplikator

tract. It represents at least five interruptions of breathing and/or other irregularities of ventilation during the hour of sleep (apnea-hypopnea index (AHI) > 5, or respiratory disturbance index (RDI) > 5) [3–6].

The treatment of obstructive sleep apnea is carried out by a multidisciplinary team. The gold standard in therapy is the continuous positive airway pressure machine (CPAP). MAD are used in the treatment of mild to moderate OSA, but sometimes also in severe cases when there is CPAP intolerance [7–9].

Obstructive sleep apnea is a serious, potentially life-threatening condition. Epidemiologic studies show that sleep apnea increases cardiovascular diseases risk factors including hypertension, obesity, and diabetes mellitus. OSA is also responsible for serious illnesses such as congestive heart failure, stroke, arrhythmias, and bronchial asthma [10]. It is important to offer patients with OSA adequate individual therapy which will be the most effective for the case and acceptable by the patient. MAD treatment in well indicated cases reduces AHI values by at least 50%; the treatment is deemed successful (success being defined as an AHI < 5) in

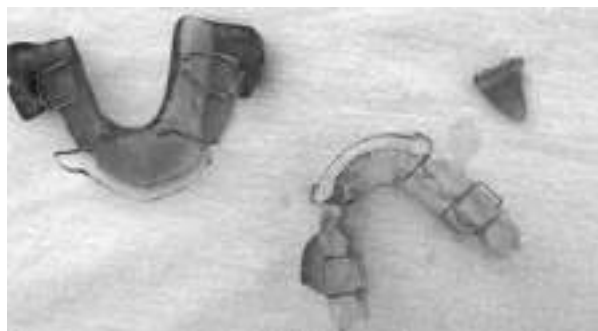


Figure 2. Cracked two-part mandibular advancement device made of acrylate and wire

Slika 2. Polomljeni dvodelni intraoralni aplikator napravljen od akrilata i žice



Figure 3. New two-piece mandibular advancement device made of acrylate

Slika 3. Novi dvodelni intraoralni aplikator napravljen samo od akrilata

17–75% of patients, while AHI values are < 10 in 30–94% of the patients [11].

Over the years, we have made different designs of individual MADs realizing their advantages and disadvantages. We have checked the efficiency of the devices with control polysomnography. We have also done regular dental check-ups to diagnose any side effects or inconvenience felt by the patient, aiming to give the best therapy needed. The first device was a one-part silicone device (**Figure 1**). It had a slit between the teeth of the lower and the upper jaw to allow breathing through the mouth, if necessary, but did not allow any movements of the lower jaw. The second designed MAD was a two-part device combining wire elements and acrylate parts with good effects but have often cracked and the wire elements were damaging the teeth (**Figure 2**).

We then designed a two-piece acrylate only MAD (**Figure 3**). This device had good results in reducing the AHI and giving the needed long-term comfort to the patients.

New design of MAD

A 36-year-old male patient was referred for polysomnography to the Sleep Medicine Center of the Institute of Pulmonary Diseases of Vojvodina due



Figure 4. Upper part of the new mandibular advancement device made of acrylate

Slika 4. Gornji deo novog intraoralnog aplikatora napravljenog od akrilata



Figure 5. Lower part of the new mandibular advancement device made of acrylic

Slika 5. Donji deo novog intraoralnog aplikatora napravljenog od akrilata

to primary problems in the form of drowsiness during the day, reduced concentration and witnessed cessation of breathing during sleep.

The Epworth sleepiness scale was 11, the Stop Bang questionnaire 3, body mass index 28.7, neck circumference 37 cm and waist circumference 96 cm. The comorbidities of the patient were allergic rhinitis, nasal septum deviation and gastroesophageal reflux disease (GERD).

By evaluating the respiratory parameters after the polysomnography, the patient was diagnosed with mild obstructive sleep apnea with AHI = 10.3 with

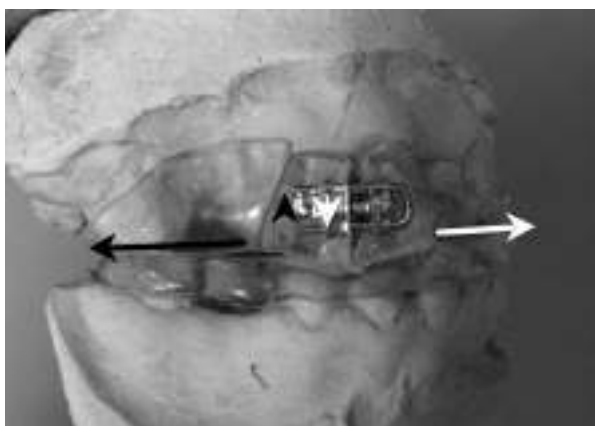


Figure 6. Movements of the lower jaw depending of the patient's need. In the so-coled "the thorn" of the device lower part of the device there is a lock that allows you to move the part of the "thorn" so it pushes the lower jaw forward or backward depending on the need. We push the lower jaw forward if the symptoms of OSA start to reappaer. We move the jaw backwards in case the patient has problems in the temporomandibular joint that do not go away.

Slika 6. Pomeranje donje vilice u zavisnosti od pacijentovih potreba. U tzv. trnu donjeg dela intraoralnog aplikatora nalazi se bravica čijim okretanjem se omogućavaju njegovi pokreti u zavisnosti od potrebe. Pomeramo donju vilicu više napred u slučaju da se ponovo pojavljuje opstruktivna apnea. Pomeramo donju vilicu nazad u slučaju da pacijent ima tegobe u temporomandibularnom zglobu koje ne prolaze.

dominant hypopnea expressed especially during back sleep (AHI supine 14.8 and AHI non supine 7). The average oxygen blood saturation was 94.2, the lowest 89% and the oxygen desaturation index (ODI) was 13.5. Snoring of mild intensity was present in all body positions, especially during back sleep. The heart rate during the night was an average of 63 beats per minute. Hygienic-dietary regimen of life and the use of MAD were prescribed to the patient.

After taking the impressions of the upper and lower jaw and determining the maximum comfortable protrusion, a new design of MAD was created for the patient.

The device consisted of two parts, one for the upper jaw and one for the lower jaw. It was made of acrylic. The upper part in the molar region had a rectangular bulge with the front surface slanted backwards (**Figure 4**). The lower part had a so-called 'thorn' in the region of the premolar with the back surface tilted forward to touch the front of the rectangular bulge on the upper part of the device (**Figure 5**). Touching and sliding on each other, these surfaces enable the device to function as a whole. The sliding allows limited jaw movements. The most important role of the MAD is to hold the lower jaw in the maximum comfortable protruding position and prevent it from returning to central occlusion and retruded position. In so-called 'thorn' of the device lower part there is a lock that allows the therapist to move the part of the 'thorn' so that it pushes the lower jaw forward or backward depending on the need. The lower jaw is pushed more forward if the symptoms of OSA begin to appear again. The jaw is moved back in case the patient has persisting problems in the temporomandibular joint (**Figure 6**).

The patient quickly and easily got used to the MAD. There was increased secretion of saliva while wearing it and a feeling of transient tingling of teeth upon waking up. These side effects passed in a week. The patient stated that this MAD was comfortable, he felt more rested and all his cognitive functions had improved.

Control clinical examination and control respiratory polysomnography six months after using the MAD showed good results of the device new design.

Evaluation of the respiratory parameters registered light OSA with AHI 6.2 with predominant hypopneas. The average oxygen blood saturation was 94.4%, the lowest 84%, ODI 8.3/h. Snoring was mild and rare. During the night, the average heart rate was 50 per minute.

Discussion

The MAD design can be improved further in regard to the side effects and its use in cases of missing group of teeth and mobile prosthetic replacements [6, 7].

In our case, the patient had a full and healthy dental arch, with a 2 mm second class occlusion that is favorable when making the MAD. Unfavorable is the presence of a third-class occlusion and the edge-to-edge teeth arrangement. The effect of the MAD is then significantly reduced and the side ef-

fect in terms of teeth displacement by the device influence is more expressive [14, 15].

MADs are also made in the absence of individual teeth or group of teeth or even complete edentulousness; however, the possibility of poorer adaptability and lesser device stability must be emphasized to patients. Also, if there are irregularities in the teeth position, the retention of the device may be reduced. The patient in the presented case had a dental arch without crowding or rotated teeth.

As MADs are mainly used in mild and moderate cases of the disease, these patients sometimes do not have any symptoms of OSA [8, 16]. This is one of the

additional reasons why the MAD must be designed to be better accepted by the patients and not to lead to any side effects.

Conclusion

Mandibular advancement devices is an effective way to treat obstructive sleep apnea in clearly indicated cases. Dentists indicating and making mandibular advancement devices must be well educated, informed and they must cooperate with some of the sleep medicine centers to monitor the effectiveness of the therapy.

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Rad je primljen 15. IX 2023.

Recenziran 10. XI 2023.

Prihvaćen za štampu 15. XI 2023.

BIBLID.0025-8105:(2023):LXXVI:5-6:171-174.