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Management of Obstructive Sleep Apnea with a Mandibular and Tongue Advancement Splint (MTAS) in a Completely Edentulous Patient. A Clinical Report

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Abstract

Treatment of obstructive sleep apnea (OSA) in dentate patients using a mandibular advancement splint (MAS) from mandibular repositioners has been documented in detail. Nevertheless, studies about completely edentulous patients with OSA are sparse. This clinical report describes a clinical and laboratory method for producing a functional splint combining an MAS and a tongue-retaining device with an individualized tongue tip housing and discusses the rationale for using such a device.

Obstructive sleep apnea (OSA) is caused by the complete or partial blockage of the airway due to the collapse of soft tissue in the pharynx.[1] The most common complaints are loud snoring, disrupted sleep, and excessive daytime sleepiness. Patients with apnea may develop cardiovascular abnormalities, such as coronary heart disease, hypertension, and stroke, because of the recurrent nocturnal hypoxemia and hypercapnia.[2]

Airway obstruction can occur in many areas of the nasopharynx, oropharynx, and hypopharynx. More commonly, airway obstruction occurs in the oropharynx. Redundant peripharyngeal tissue reduces the size of the posterior airway, which increases the chance of obstruction during sleep. An elongated soft palate and enlarged uvula may further compromise the airway. The base of the tongue is a common site of hypopharyngeal obstruction in sleep apnea. Patients with a small or retracted mandible are at increased risk for obstruction. Occasionally, an enlarged tongue may cause obstruction. In this setting, obstruction occurs when the base of the tongue impinges on the airway just above the glottis.[2]

Due to the multifactorial nature of this condition, its management should be multidisciplinary. The team may include a thoracic physician, ear-nose-throat surgeon, and a prosthodontist. The treatment modalities consist of both surgical and nonsurgical methods. The nonsurgical approaches to treatment include weight loss and reduction in smoking and alcohol consumption in combination with continuous positive airway pressure (CPAP) and intraoral device therapy.[2]

Treatment of OSA in dentate patients with a mandibular advancement splint (MAS) is well documented,[3-6] but for edentulous patients, a search of the literature revealed few reports.[7] The goal of the MAS is to advance the mandible and tongue base, increasing the space between the base of the tongue and the posterior pharyngeal wall in a dentulous OSA patient. In the meantime, the tongue may also be advanced with the use of a tongue-retaining device (TRD) in an edentulous OSA patient. These appliances subsequently assist in reducing the obstruction.[7] It has been reported that oral appliances may cause worsening of OSA in a small number of subjects.[8] It is imperative, then, that patients with MAS or TRD are regularly recalled and ideally should also undergo polysomnography with the MAS or TRD in situ to ensure that a satisfactory therapeutic benefit has been achieved.[9]

It is useful to classify the appliances by mode of action into one of two categories. MAS functions to repose and maintain the mandible in a protruded position with a vertical opening between 5 and 7 mm during sleep.[2,6,8] This position serves to open the airway in several different ways: by indirectly pulling the tongue forward by virtue of its attachment to the geniotubercles, by increasing the baseline genioglossus muscle activity, and by stabilizing the mandible and hyoid bone to prevent jaw

opening and retrolapse of the tongue. TRD functions by directly holding the tongue in a forward position and opening the airway through forward movement of the base of the tongue, increasing the baseline genioglossus muscle activity and stabilizing the tongue to prevent obstructive collapse during sleep. The most important indications for a TRD are patients with lack of tooth support, complete edentulism, or macroglossia.[9,10,11]

This clinical report presents the fabrication and description of a new functional appliance—a combination of the characteristics of MAS and TRD with an individualized tongue tip housing for an edentulous patient.

Clinical Report

A 56-year-old woman was referred from the Council of Sleep-Respiration Disorders of the Ege University Medical Faculty Hospital with a history and diagnosis of intrusive snoring and obstruction. The patient history was taken with the following areas of interest:

- Snoring (the characteristics of snoring, such as frequency, loudness, effect on sleep of others);
- Daytime drowsiness (daytime drowsiness in situations, i.e., refreshed/unrefreshed on awakening, effect on daily activities, cognitive impairment, motor vehicle accidents, or near misses while driving);
- Quality of sleep (i.e., number of times awakened during night, wake gasping and choking, witnessed apneas);
- Usual sleep position (i.e., snoring in all positions or only on back);
- Additional information (information related to systemic diseases, such as hypertension, morning headache, sour taste, and dryness in mouth, temporomandibular joint (TMJ) symptoms, excessive daytime sleepiness, change in weight, and nasal congestion).

Dental examination of the patient consisted of the following: study casts, panaromic radiograph, and cephalometric and jaw relationships (i.e., retrognathia according to the jaw casts and extraoral view). In the TMJ evaluation, palpation and auscultation were applied. Muscle palpation and motion range of the jaw, such as maximum opening (40 to 60 mm) and lateral and protrusive movement (> 8 mm) were also evaluated.

Neck size, obesity, oropharyngeal tissues, tongue size (i.e., enlarged tongue), length of soft palate, uvula size, tonsils, and crowding of the oropharyngeal area were other parameters of examination.

The patient had worn complete dentures for 15 years. The maxillary and mandibular residual ridges were seen as well formed.

A sleep study showed Apnea-Hypopnea Index (AHI) as 7.9/hour and minimum oxygen saturation as 83%. There was mild OSA in the patient. Lateral cephalographic analysis showed evidence of a retrognathic mandible. Radiographic examination also pointed at the tongue base collapse at rest, with an associated component from the lateral pharyngeal wall and uvula.

In this view, it was determined that a combination of both MAS and TRD should be fabricated to bring the mandible and tongue forward, which in turn would enlarge the posterior pharyngeal space.

Several conventional designs for edentulous patients have been reported—Snor-X, TRD, TRD with airway tubes and Tongue Stabilizer;[6,11] however, all of the mentioned appliances were devised to retain the tongue only. Therefore, since the patient was totally edentulous, fabrication of a tissue-borne MAS accompanying a TRD was planned. The plan was to hold the tongue forward by the negative pressure created in the tongue tip housing (vacuum bulb) on the anterior of the appliance. A combination of MAS and TRD was formed.

Maxillary and mandibular preliminary impressions were made with irreversible hydrocolloidal impression material (Cavex CA37, Haarlem, Netherlands) by using stock trays. Definitive impressions were made with ZOE impression material (Outline, Cavex) in border-molded (Green Stick Compound, Kerr Corp, Orange, CA) custom trays (Custom Tray Resin LC, Henry Schein Inc, Melville, NY). Autopolymerizing acrylic resin bases (Imicryl, London, UK) were fabricated on the casts. Wax (Modelling Wax, DeTreyDentsply, Colombes, France) occlusal rims were fabricated on the resin bases.

The maxillomandibular relation was estimated so as to maintain the 5 to 7 mm vertical opening—the inter-incisal distance of MASs described in the literature.[2,6,8,11-13] Centric relation position was marked on both wax rims bilaterally in the canine region (Fig 1). The patient was then asked to protrude maximally, and maximum protrusion position was marked bilaterally. The distance between the centric relation mark and the maximum protrusion mark on the maxillary rim was ascertained, and then 75% to 80% of the distance from the centric relation line was marked on the maxillary rim as the therapeutic position. The mandibular rim was then made to occlude so the centric relation line of the mandibular rim coincided with the therapeutic position mark on the maxillary rim (Fig 2). The maxillomandibular relationship was recorded at that position, and casts were mounted on a hinge-type articulator.

In a subsequent step, the anterior segment of the wax rims was roughly shaped as a housing (vacuum bulb) for the functional impression of the tongue (Fig 3). The wax housing (vacuum bulb) was filled with irreversible hydrocolloidal impression material (Cavex CA37) and was placed in the patient's mouth. The patient was then told to bite the device to hold it tightly and to insert her tongue into the housing (vacuum bulb) filled with irreversible hydrocolloid material. Therefore, the functional impression of the patient's tongue was provided to produce

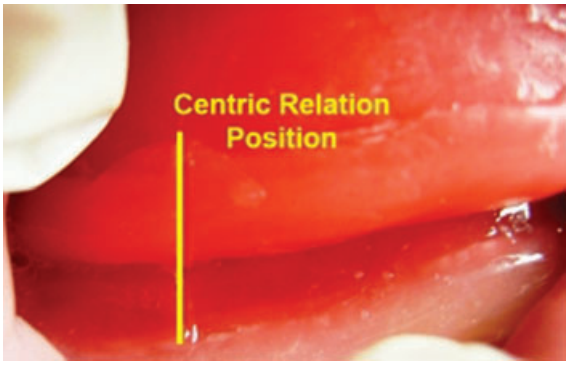

Figure 1 Centric relation.

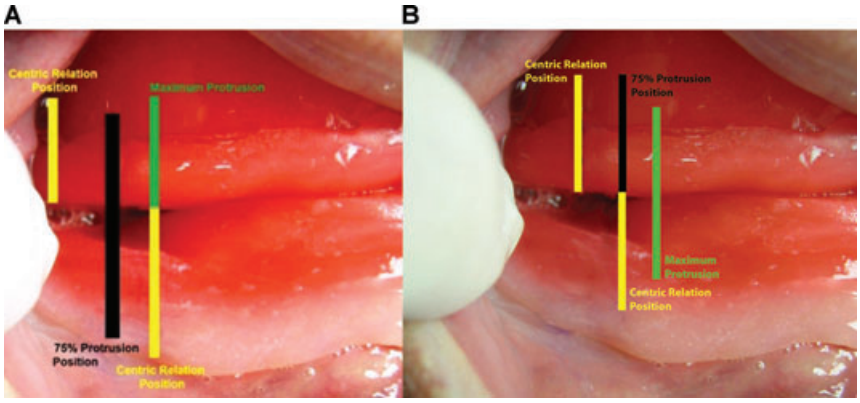

Figure 2 A, B Jaw relation at maximum protrusion. *Yellow lines* indicate centric relation marks, *green line* indicates maximum protrusion, and *black line* indicates 75% of maximum protrusion. Henceforth, mandibular centric relation mark *(yellow line)* and 75% protrusive position line *(black line)* coincided.

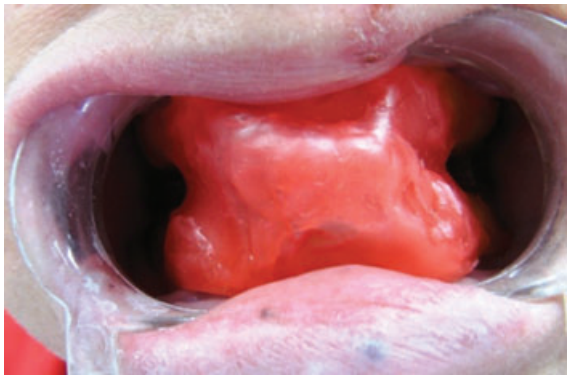

Figure 3 Frontal view of the wax rim, enlarged for the tongue impression.

an individual vacuum chamber (Fig 4). The splint, including the tongue impression, was flashed and processed with autopolymerized acrylic resin (Imicryl) in the second step. This monoblock appliance was trimmed and polished in the conventional manner. Instructions on use and care were provided at insertion of the mandibular and tongue advancement splint

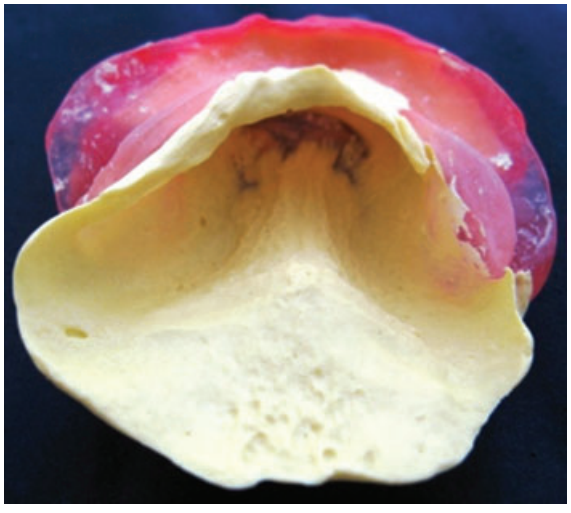

Figure 4 Tongue impression.

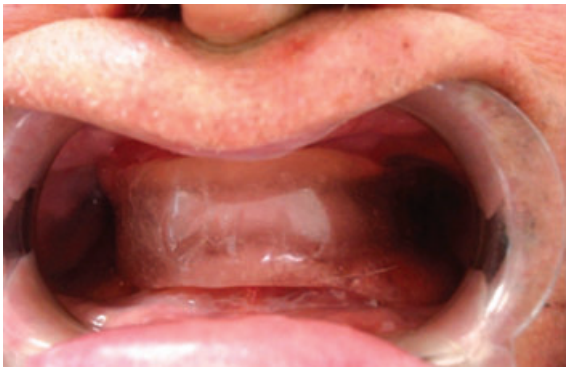

Figure 5 Frontal view of the MTAS.

(MTAS). The patient was advised to wear the appliance for least 6 hours during the night, and was recalled 1 week later (Fig 5).

The patient reported a favorable sleeping pattern and no dislodgement of the appliance during sleep. Furthermore, the patient has undergone a polysomnograph with the appliance in situ for an objective measurement of respiration during sleep. The patient's AHI decreased to 3.5. Her minimum oxygen saturation increased to 96%. Finally, her discomfort was reduced.

At the 1- and 6-month recalls, the patient reported her sleep had improved at night and her daytime somnolence had diminished. The appliance did not disturb the patient. Compliance was very high.

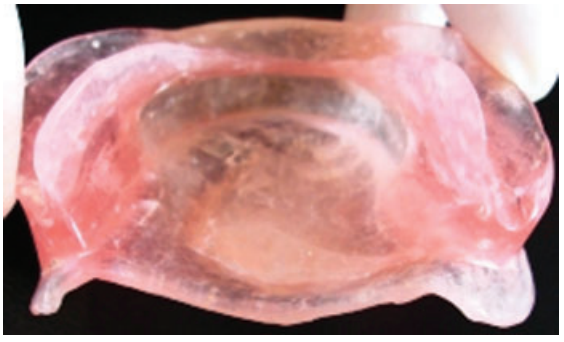

Figure 6 Intaglio view of the MTAS.

Discussion

The primary objective in fabricating this appliance was to increase the space between the base of the tongue and the posterior pharyngeal wall. This was achieved by protrusion of the mandible and by increasing the occlusal vertical dimension (OVD). Therefore, the material used was selected to be hard and rigid enough to hold the tongue and mandible in the therapeutic position. Rigidity reported in the literature varies according to patient comfort and compliance.[14]

Retention sources may also vary among appliances, including wire clasping, friction grip from rigid, semi-rigid, or very flexible materials, and teeth.[15] An MAS needs teeth for retention. At least ten teeth in each arch are required for most mandibular repositioning appliances.[15] As the patient in this case was totally edentulous, the method of retention for the MTAS included friction grip from a rigid material. Namely, the appliance did not depend on teeth for retention. As a result, a tissue-borne MAS accompanying a TRD was fabricated. Proper retention of the appliance in the patient's mouth is critical for effective function. Additionally, the rigidity of the material influences the retentive efficacy. For such retention, certain adjustment procedures of the appliance in situ also become necessary. These procedures vary according to appliance construction, type of material, operator convenience, and efficiency.[14-17]

Concurrently, although total edentulousness in maxillary and mandibular arches is considered a contraindication for oral appliance therapy, our patient reported no problems with the stability of the appliance. One reason for this stability might be the lower amount of alveolar bone resorption. Another contributing factor may have been the increase in OVD. Robertson suggested that an increase in interocclusal distance from the physiological rest position was necessary to make sure that dislodgement did not occur at night.[18]

The MTAS was non-adjustable. Accordingly, downward and anterior mandibular displacement was provided by the combination (MAS + TRD). Namely, it rotated the mandible 5 to 7 mm downward. The MTAS had an average (generally 6 mm) of vertical opening (estimated inter-incisal distance) from 5 to 7 mm. Separately, it moved the mandible forward. Namely, the mandible was advanced anteriorly at least 75% to 80% of maximum protrusion. The appliances described in the literature[2,6-8,11-20] have an average vertical opening of 3 to 17 mm. For example, most of the MASs have an average of 5 to 10 mm of inter-incisal distance. Studies to date have objectively addressed mandibular protrusion and inter-incisal distance parameters.[2,6,8,11-20]

With the MTAS, the mandible was retained in protrusive position and was rigidly stabilized to increase its effectiveness. According to the reviewed literature,[8,16] the differing design variations allow for differing degrees of mandibular movement while the appliance is in place. Fixation rigidity is still controversial among authors.[8,16] Some clinicians find increased effectiveness when the mandible is rigidly stabilized,[8] and others find that a slight degree of mobility enhances TMJ comfort.[16] In the present study, the mandible and tongue were positively locked into the appliance, to prevent them from retruding. Also, the tongue-tip housing was individualized to improve the negative pressure (vacuum) efficacy. Therefore, the two arches of the appliance were connected throughout to hold the mandible and tongue in a protrusive and open position.

Finally, MAS and TRD were produced as a one-piece appliance (Fig 6). Thus, the mandible and tongue were rigidly and firmly held by the total structure of the appliance.

The authors concur with Johal and Battagel[2] and Yoshida[12,13] that increasing the OVD and mandibular protraction would increase the space between the base of the tongue and the posterior pharyngeal wall.[19-21] At the same time, the tongue-tip housing (vacuum bulb) was also important to ensure that the tongue did not disengage from the appliance and fall back during sleep, thus negating the purpose of the appliance.

The advantage of this technique is its simplicity, as the clinical procedures are similar to those for fabricating conventional MASs.[19,20] Moreover, since the tongue impression of the patient is taken, and a vacuum housing for the tongue exists, there is also tongue-retaining equipment in the appliance as there is with TRDs. So the combination of mandibular advancement and tongue retaining was produced with individual tongue tip housing. There was no difficulty in inserting and removing the appliance from the mouth, and the patient did not find the appliance formidable to wear. This assisted in improved patient compliance.

Ventilation holes or airway tubes may be necessary for patients who have nasal airway obstruction such as adenoid vegetation, septum deviation, etc;[19,20] however, vent hole and/or holes or airway tubes were not employed in the appliance. Namely, the patient was able to breathe comfortably through the nasal airway.

Conclusion

A combination MAS and TRD device (an MTAS) was developed for a completely edentulous patient with sleep apnea. After 6 months, the patient reports high compliance, improved sleep, and diminished daytime somnolence.

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