■ CASE REPORT

Effect of a Maxillary Appliance in an Adult with Obstructive Sleep Apnea: A Case Report

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ABSTRACT: Patients who arrive at the dental office with a diagnosis of obstructive sleep apnea (OSA) are often managed with a mandibular advancement device (MAD). However, the use of MADs has been associated with temporomandibular joint (TMJ) issues. The authors describe a case report of a 64-year-old male who was treated with a novel, maxillary oral appliance. The baseline sleep study indicated an apnea-hypopnea index (AHI) of 25.6/hour with 28 episodes of snoring, and 30.9 oxygen desaturation events/hour. The patient wore the maxillary oral appliance for 10-12 hours/day and night. The midpalatal screw mechanism of the appliance was advanced once per week for six months. By the end of this time, the minimum intra-premolar width increased from 27 mm to 30 mm; the minimum intramolar width increased from 35 mm to 37 mm, and the AHI dropped to <5/hour. During this phase of treatment, the episodes of snoring decreased to 18, and the oxygen desaturation events also decreased to 5.5/hour. After a total of 14 months, the AHI remained at <5/hour, the episodes of snoring decreased further to 12, and the oxygen desaturation events decreased to 5.2/hour. Therefore, by achieving a >80% decrease in the AHI, less snoring and an improvement in oxygen saturation after 14 months, the use of a maxillary oral appliance appears to have reached resolution of OSA in an adult male.

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Obstructive sleep apnea (OSA) represents a significant healthcare issue due to the numerous medical consequences associated with the condition. In a previous study,[1] the authors demonstrated that adults with OSA showed a 7-10% narrowing of the upper dental arch when compared to matched, non-OSA controls. It is theorized that this narrowing may have occurred at an earlier age, but may not have been suspected as being a predictor for the later onset of OSA. Recently, Vučinić, et al.[2] investigated early detection of OSA. In their study, they analyzed maxillary features in children with mouth-breathing, concluding that maxillary morphology in mouth-breathing children showed characteristics also present in adults with OSA, such as a narrow maxilla. Similarly, Huynh, et al.[3] investigated facial and dental associations with sleep-disordered breathing in children. In that pediatric cohort, the primary features included: a narrow palate, adenotonsillar hypertrophy, a high mandibular plane angle, and severe crowding inter alia. In another study in children, Kim and Guilleminault[4] reported that over 90% of their study sample had craniofacial risk factors associated with OSA, including a narrow nasomaxillary complex, and a high and/or narrow hard palate associated with a small mandible. For the

management of OSA, Marino, et al.[5] evaluated the effects of rapid maxillary expansion (RME) in preschool children. They surmised that young children with bimaxillary retrognathia could benefit from RME. However, there is doubt as to whether midfacial development can be performed in adults for the correction of OSA. Therefore, the aim of this study was to determine whether midfacial redevelopment using maxillary oral appliance therapy could be of benefit in this particular adult case.

Patient History

A 64-year-old male presented for a face-to-face evaluation with a pulmonologist/sleep physician. His social history revealed good overall health, no alcohol intake, and no other bad habits, such as smoking or drug abuse. His medical history was unremarkable with a body mass index (BMI) of 27 [weight = 165 lb (74 kg); height = 5'6" (170 cm)] and a neck circumference of 16.5" (42cm). The patient volunteered that he averaged about eight hours sleep per night, but an overnight sleep study was performed and read by a sleep physician. A diagnosis of moderate obstructive sleep apnea (OSA) was recorded. For treatment, continuous positive airway pressure (CPAP) was recommended; however, the patient stated that he was "interested in finding an alternative to treat OSA." Subsequently, the patient was referred to a dental office with a diagnosis of OSA.

In the dental office, an intraoral examination revealed an inter-premolar width of 27 mm and an intramolar width of 35 mm (**Figure 1**). Using radiographic assessment, no other intraoral abnormalities were detected. An ambulatory sleep study was conducted using a type III device (Embletta, Embla Systems, Broomfield, CO). The sleep study was read and reviewed by a board certified sleep physician, and the patient was subsequently diagnosed with moderate OSA, with an AHI of 25.6/hr. There were also 28 episodes of snoring and 209 oxygen desaturation events. Due to intolerance to continuous positive airway pressure (CPAP) therapy and the risk of developing temporomandibular joint dysfunction, the patient consented to maxillary oral appliance therapy.

Treatment

After obtaining informed consent, a DNA appliance (BioModeling Solutions, LLC, Beaverton, OR) was prescribed for the patient. The DNA appliance system is designed to correct maxillo-mandibular underdevelopment in both children[6] and adults.[7-8] The acrylic-based DNA appliance used in this case had six (patented) anterior 3-D axial springs, a midline screw, posterior occlusal coverage, retentive clasps, a labial bow, and a beaded extension for OSA (**Figure 2**). The DNA appliance was worn during the late afternoon, early evening and at nighttime (for approx. 10-12 hrs. in total), but not during the daytime and not while eating, partly in line with the circadian rhythm of tooth eruption,[9] although this only occurs in children. The appliance was adjusted every 4-6 weeks, and the midline screw was turned 0.25 mm

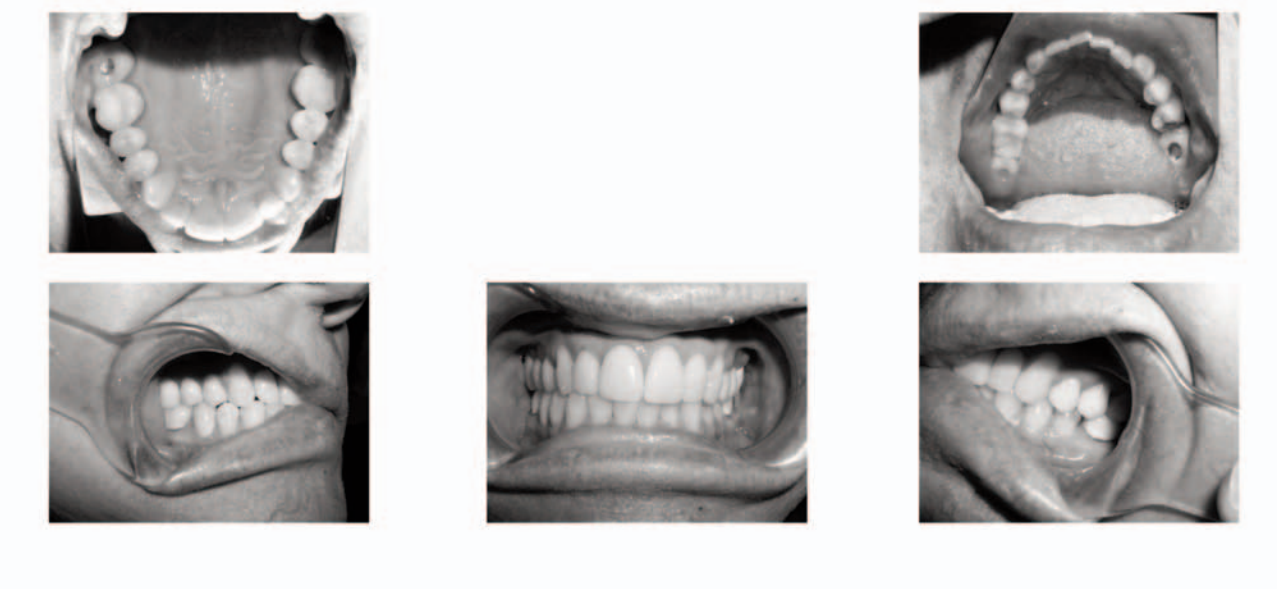

Figure 1
Intraoral examination revealed that the patient's overjet and overbite appear to be within normal limits, but there is crowding in the lower arch.

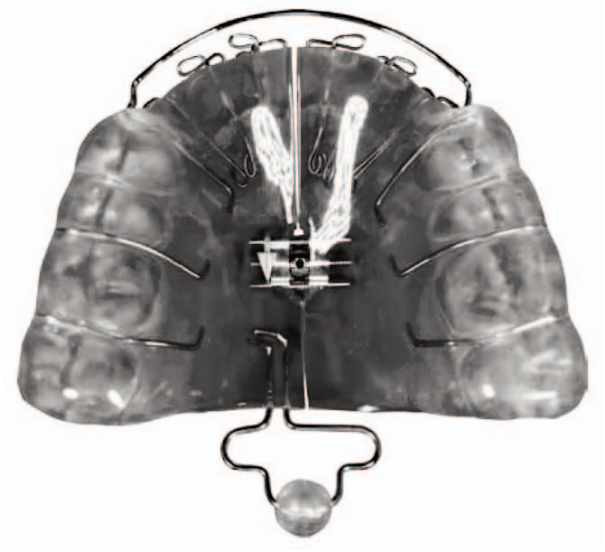

Figure 2
The acrylic-based DNA appliance (BioModeling Solutions, LLC, Beaverton, OR) used in this case, consisted of six (patented) anterior 3-D axial springs, a midline jackscrew, posterior occlusal coverage, retentive clasps, a labial bow, and a beaded extension for snoring/OSA management.

once per week. A post-treatment home sleep study was repeated after six months without the appliance in situ during the sleep test. A final post-treatment home sleep study was repeated after 14 months without the appliance in the mouth.

Findings

The patient's post-treatment body weight/BMI was found to be stable at 165 lbs/26 BMI. **Figure 3** shows the pretreatment, upper study model and the upper arch six months post-treatment. There was improved maxillary morphology with the minimum intra-premolar width increasing from 27 mm to 30 mm and the minimum intramolar width increasing from 35 mm to 37 mm. The pre-treatment sleep study indicated an overall apnea-hypopnea index (AHI) of 25.6/hr (**Table 1**). After six months, the post-treatment sleep study indicated an 86% reduction in overall AHI to 3.5/hr, allied with an 87% improvement in the oxygen desaturation index (ODI) without the appliance in the mouth during the sleep study. The number of episodes of snoring also decreased from 28 to 18. **Figure 4** shows the post-treatment condition after oral appliance therapy. After 14 months, the final sleep study indicated an overall 82% reduction in overall AHI to 4.5/hr, allied with an 87.9% improvement in the oxygen desaturation index, and a further decrease in the number of episodes of snoring from 18 to 12. These results are summarized in **Table 1**.

Discussion

Historically, the management of OSA has included various therapies, such as CPAP, maxillo-mandibular advancement surgery, and mandibular advancement devices. Although other appliance designs have been utilized in the past, such as tongue-restraining devices,[10]

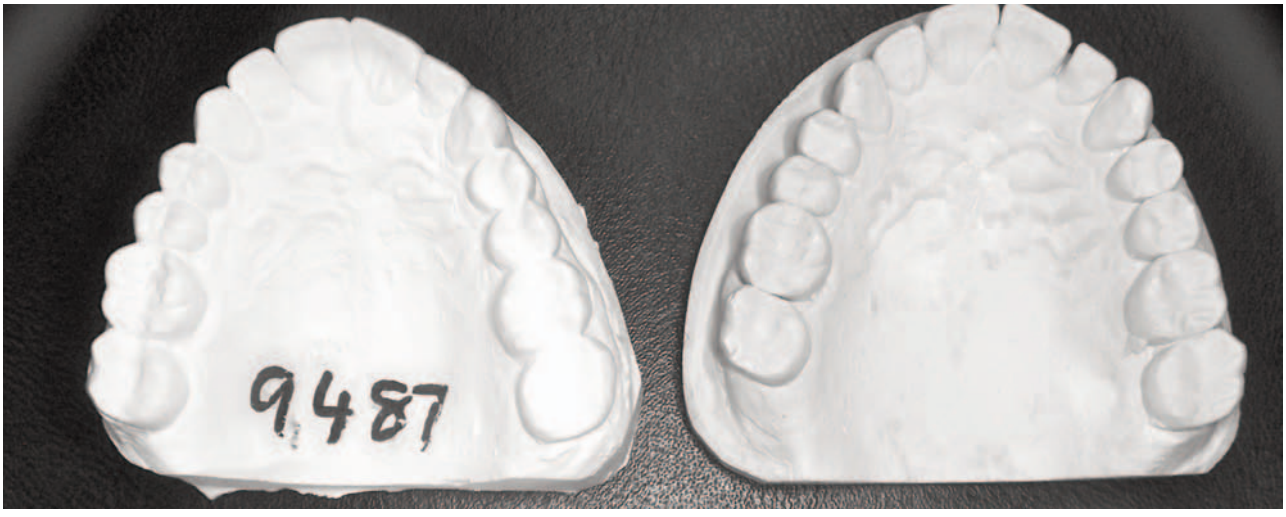

Figure 3
In the pretreatment, upper study model (9487), the minimum intra-premolar width is 27 mm and the minimum intramolar width is 35 mm. In the six months post-treatment upper study model, there is improved maxillary morphology with a minimum intra-premolar width of 30 mm and a minimum intramolar width of 37 mm.

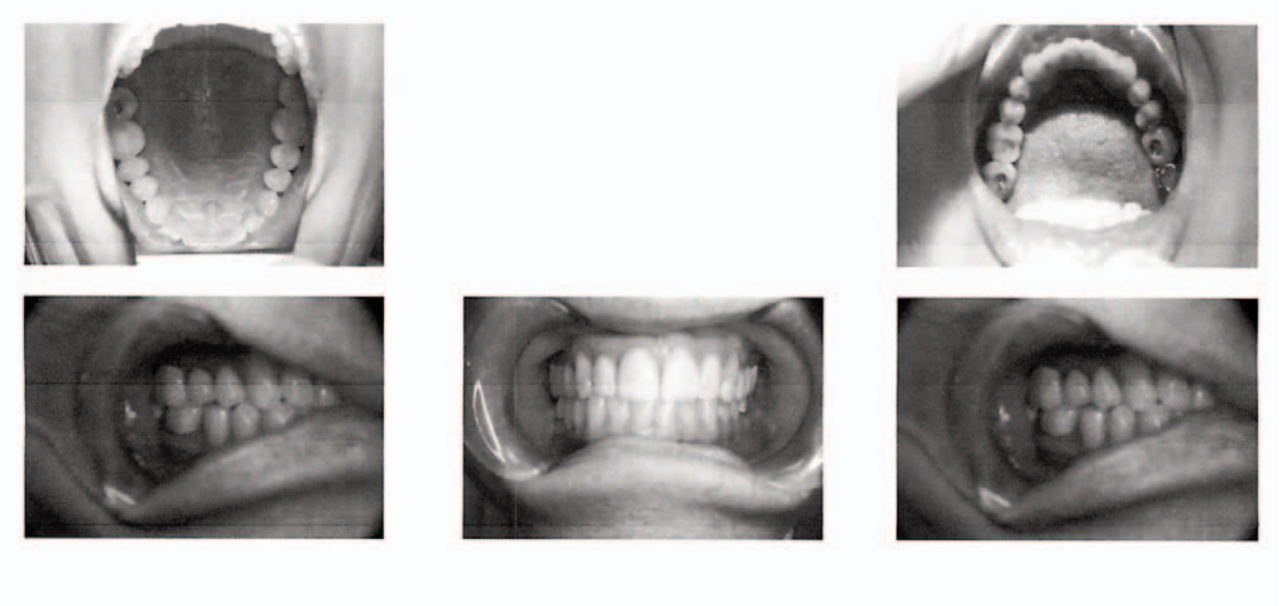

Figure 4
The post-treatment, intra-oral examination condition shown after 14 months of DNA appliance therapy. The overjet and overbite appear to have remained within normal limits, but the crowding in the lower arch appears to have been resolved through the use of the maxillary appliance alone.

Table 1
Summary of Clinical Changes at 6 and 14 Months

	Baseline	6 months	Change (%)	14 months	Change (%)
AHI	25.6	3.5	86.3	4.5	82.4
ODI	43.0	5.5	87.2	5.2	87.9
Snoring	28	18.0	35.7	12.0	57.1

AHI: apnea-hypopnea index
ODI: oxygen desaturation index
Note: All sleep studies were performed without the appliance in situ.

the use of maxillary oral appliance therapy has not been fully explored. Seto, et al.[11] investigated maxillary morphology in adults with and without OSA. They found that 50% of adults with OSA had evidence of posterior crossbites, while all had significantly reduced inter-canine, inter-premolar, and inter-molar distances, suggesting that patients with OSA have narrower, tapered, and shorter maxillary arches. In a similar study in Chinese adults, Tong, et al.[12] investigated the contribution of craniofacial architecture to the severity of OSA. Their study disclosed that maxillary deficiency, retrognathia, and hyoid bone malposition were the important contributing factors in the severity of OSA in adults. Therefore, the use of a maxillary oral appliance may be preferred over a mandibular advancement device in some cases, such as the one reported here.

There have been reports of side effects associated with the use of MADs. These side effects include disturbance of the TMJ,[13] changes in occlusion,[14] and changes in jaw/facial profile.[15] In contrast, Louis, et al.[16] evaluated soft tissue changes that occur with maxillary advancement surgery in patients with OSA. They found that the nasolabial angle did not change significantly. Therefore, maxillary development does not appear to affect the facial profile adversely. The authors found a similar result in this particular case, even though a nonsurgical

approach to maxillary development was used in the case reported here. Indeed, Dempsey, et al.[17] investigated the contribution of craniofacial dimensions on the upper airway in males with OSA. They found that the single most important cephalometric variable in predicting the severity of AHI was the horizontal dimension of the maxilla. Therefore, this case report appears to support the notion that maxillary development in adults may be beneficial in the amelioration of OSA.

Despite the above contentions, variation in craniofacial phenotype does occur, and this heterogeneity could have an impact on OSA. Lee, et al.[18] explored ethnic differences in craniofacial structures and obesity in patients with OSA. They reported that Asian patients had more severe OSA compared to their Caucasian counterparts. The craniofacial heterogeneity included a shorter cranial base, maxilla and mandible, reflecting the earlier work of Singh, et al.[19] Thus, for the same degree of OSA severity, Caucasians were more obese, whereas the Asians exhibited more craniofacial restrictions. Therefore, in addition to midfacial development, the cranial base may need to be targeted in various craniofacial phenotypes.[20-21] Therefore, this case report supports the concept of maxillary oral appliance therapy in adults, but further studies in other ethnicities may elucidate the management of OSA, using a midfacial development protocol.

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