Implant-retained oral appliances: a novel treatment for edentulous patients with obstructive sleep apnea–hypopnea syndrome

Aarnoud Hoekema
Frist de Vries
Kees Heydenrijk
Boudewijn Stegenga

Authors’ affiliations:
Aarnoud Hoekema, Boudewijn Stegenga,
Department of Oral and Maxillofacial Surgery,
University Medical Center Groningen, University of Groningen, Groningen, The Netherlands
Frist de Vries, Department of Oral and Maxillofacial Prosthetics, Rijnstate Medical Center, Arnhem, The Netherlands
Kees Heydenrijk, Department of Oral and Maxillofacial Surgery, Medical Center Leeuwarden, Leeuwarden, The Netherlands

Correspondence to:
Aarnoud Hoekema
Department of Oral and Maxillofacial Surgery
University Medical Center Groningen
University of Groningen
Hanzeplein 1, PO Box 30.001
9700 RB Groningen
The Netherlands
Tel.: +31 50 361 3840
Fax: +31 50 361 1136
e-mail: a.hoekema@kchir.umcg.nl

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Abstract

Objectives: Mandibular repositioning appliances (MRAs) are a viable treatment alternative in patients with obstructive sleep apnea–hypopnea syndrome (OSAHS). Because these appliances require retention in the patient's dentition, edentulous patients generally do not qualify for this treatment. This study describes our experiences with an implant-retained MRA in the treatment of edentulous OSAHS patients.

Patients and methods: Six edentulous OSAHS patients were included in this study. Standard treatment consisted of the placement of four endosseous dental implants in the mandible and the construction of a new maxillary denture and a mandibular overdenture. Subsequently, an MRA was made. After a habituation and adjustment period, the effect of treatment was evaluated with polysomnography. Treatment was considered effective in cases where it yielded an apnea–hypopnea index \(<5\).

Results: Of the six patients included, two did not tolerate the MRA because of pressure-induced discomfort on the labial mucosa in the maxilla. These two patients were offered an implant-retained overdenture and MRA in the maxilla. One of the two patients proceeded with this secondary treatment. Of the five patients completing the follow-up polysomnography, effective OSAHS treatment was attained in four.

Conclusions: The results from this study suggest that an implant-retained MRA in the mandible is a viable treatment modality in edentulous OSAHS patients. Because the therapeutic effectiveness of this treatment may be compromised by excessive pressure of the MRA on the labial mucosa in the maxilla, we suggest that an implant-retained MRA in the maxilla be offered as a secondary treatment in selected patients.

The obstructive sleep apnea–hypopnea syndrome (OSAHS) is a prevalent sleep-related breathing disorder, affecting approximately 4% of the male and 2% of the female adults in the North-American population (Young et al. 1993). The condition is characterized by disruptive snoring and repetitive obstructions of the upper airway during sleep. Airway obstructions in OSAHS patients are either partial (hypopnea) or complete (apnea) and often result in [severe] oxygen desaturations. Patients have recurrent arousals from sleep as an attempt to restore upper airway patency. This results in activation of the sympathetic nervous system and sleep fragmentation (Malhotra & White 2002). The neurobehavioral consequences of sleep fragmentation include excessive sleepiness, an increased risk of accidents, and impairment of the quality of life (Teran-Santos et al. 1999; Patel et al. 2003; Giles et al.)
Patients and methods

Patient selection

All edentulous OSAHS patients treated with an MRA at the Medical Center Leeuwarden (the Netherlands) in the period January 2003 to January 2005 were included in this study (Table 1). Before treatment, all patients had been subjected to polysomnography and an upper airway examination. MRA therapy was indicated in mild OSAHS cases not qualifying for CPAP therapy (four male patients) or in patients declining CPAP therapy (two male patients). Written informed consent had been obtained from each patient before treatment was initiated.

Treatment procedure

Except for one patient, all subjects received four endosseous dental implants (Straumann AG, Waldenburg, Switzerland) in the interforaminal region of the mandible. Because one patient had previously (> 10 years ago) received a transmandibular implant (M + R Haren b.v., Haren, Groningen, the Netherlands), placement of endosseous implants was not required in this subject. The implants were placed by one surgeon (K. H.) under local anesthesia (Sutter et al. 1988). After a 2-month osseointegration period, the MRA could be constructed.

Before the MRA was constructed, a new maxillary denture and a mandibular overdenture were made (Batenburg et al. 1993). A bar construction was screwed onto the implants (Fig. 1a). This construction provided support for a clip attachment that was incorporated into the mandibular overdenture. When the denture was finished, it was duplicated in transparent acrylic.

MRA therapy was performed with a modified version of the Thornton adjustable positioner (Airway Management Inc., Dallas, TX, USA) (Pancer et al. 1999). This MRA consists of an adjustable construction that allows patients to titrate the amount of mandibular advancement. The construction was incorporated into the duplicated denture. In the maxilla, the MRA was retained by the suction force of the duplicate of the upper denture. In the mandible, the MRA was retained by the bar construction and a clip attachment that was incorporated into the duplicate of the lower overdenture (Figs 1a and 2a). Patients were instructed to wear the MRA instead of their dentures whenever they slept. When initiating MRA therapy, the mandible was adjusted to approximately 50% of the patient’s maximum advancement.

Table 1. Patient characteristics

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age (years)</th>
<th>Baseline AHI (No./h)</th>
<th>BMI (kg/m²)</th>
<th>Implantological procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>55</td>
<td>5.8</td>
<td>24.8</td>
<td>Four implants mandible</td>
</tr>
<tr>
<td>2</td>
<td>48</td>
<td>10.6</td>
<td>24.0</td>
<td>Four implants mandible</td>
</tr>
<tr>
<td>3</td>
<td>53</td>
<td>13.1</td>
<td>24.5</td>
<td>Four implants mandible</td>
</tr>
<tr>
<td>4</td>
<td>57</td>
<td>18.3</td>
<td>28.7</td>
<td>Four implants mandible</td>
</tr>
<tr>
<td>5</td>
<td>63</td>
<td>14.3</td>
<td>30.9</td>
<td>Transmandibular implant</td>
</tr>
<tr>
<td>6</td>
<td>58</td>
<td>18.3</td>
<td>28.4</td>
<td>Four implants mandible</td>
</tr>
</tbody>
</table>

AHI, apnea–hypopnea index; BMI, body mass index.

Fig. 1. Features of the bar constructions that provide retention for a mandibular repositioning appliance (patient 1). (a) Bar construction screwed onto the implants in the mandible, (b) bar construction screwed onto the implants in the maxilla.
Patients could accustom to this position during a 2-week period. Subsequently, patients were instructed to advance the mandible with 1–2 increments [i.e., 0.2–0.4 mm] each night. This titration was continued until symptoms of OSAHS [e.g., snoring, apneas and hypopneas, or excessive sleepiness] abated or until further advancement of the mandible resulted in discomfort. After the MRA was titrated, a second polysomnographic study was performed.

**Polysomnography**

Polysomnography at baseline and follow-up evaluations was conducted ambulatory in the patient’s home situation [Embla® A10 digital recorder, Medcare, Reykjavik, Iceland]. Standardized criteria were used to score apneas and hypopneas [AASM 1999]. All polysomnographic studies were evaluated and scored by one neurophysiologist.

**Outcome measures**

The apnea–hypopnea index [AHI] was used as the primary outcome measure. MRA therapy was considered effective in case it resulted in an AHI < 5. Secondary outcomes were changes in the minimum oxyhemoglobin saturation during sleep [MinSaO₂] and the desaturation index [i.e., the mean number of oxyhemoglobin desaturations > 4%/h sleep].

**Results**

The time interval between placement of the implants and initiation of MRA therapy varied from 6 months [four patients] to 10 months [patient 1]. In the sixth patient, who already had an implant-retained overdenture in the mandible [patient 5], MRA therapy could be initiated within a month. Besides the loss of one of the implants [patient 6], no complications were encountered after placement of the implants.

MRA therapy was well tolerated by four of the six patients. In the remaining two patients [patients 1 and 6], the MRA was not tolerated because of pressure-induced discomfort of the labial mucosa in the maxilla. However, advancement of the mandible was limited for the same reason in three patients who did tolerate the MRA [patients 2, 3, and 5]. Attempts to relieve the labial mucosa by trimming the acrylic of the upper appliance or by applying a silicone lining were unsuccessful in the two patients who did not tolerate the MRA. In order to resolve the pressure problems, these two patients were offered an implant-retained overdenture and MRA in the maxilla. Because this would require additional surgery, one patient declined further treatment [patient 6]. The other patient was treated under general anesthesia with a bone augmentation of the maxillary sinuses using autologous grafts from the right anterior iliac crest. After 3 months, six endosseous implants were inserted into the posterior region of the maxilla, and after another 3 months, two bar constructions were screwed onto the maxillary implants. These bar constructions provided retention for an overdenture and MRA in the maxilla [Figs 1b and 2b]. The pressure on the labial mucosa was relieved and the further course of MRA therapy was uncomplicated in this patient.

All five patients who completed the follow-up review displayed an improvement in the AHI as a result of MRA therapy (Table 2). Effective OSAHS treatment [i.e., AHI < 5] was attained in four patients. The MinSaO₂ showed a small improvement in three out of five patients. The desaturation index improved in all five patients. The deterioration in MinSaO₂ and modest improvement in the desaturation index in one patient [patient 4] could be explained by a chronic obstructive pulmonary disease.

Four out of the five patients who completed the follow-up review of MRA therapy reported a satisfactory improvement of their symptoms [e.g., snoring, excessive sleepiness]. Despite an adequate improvement of the AHI, the remaining patient complained of persistence in socially disruptive snoring [patient 2]. To resolve these complaints, additional advancement of the mandible was necessary. Because this again caused excessive pressure on the labial mucosa in the maxilla, an implant-retained MRA in the maxilla, as described earlier, was offered. This patient is currently contemplating this secondary treatment.

**Discussion**

Edentulous OSAHS patients are generally excluded from MRA therapy [Hoekema et al. 2004]. In the general Dutch popula-
In four out of five patients, the MRA therapy resulted in an AHI < 5. In the fifth patient, therapy was not effective. This may be related to the limitation in mandibular advancement that resulted from pressure of the MRA on the labial mucosa in the maxilla. Despite the disappointing effect on the AHI, the desaturation index improved substantially in this patient. Because the patient experienced a satisfactory improvement in symptoms, he refused secondary treatment.

The results from this study suggest that an implant-retained MRA in the mandible is a viable treatment modality in edentulous OSAHS patients. However, the therapeutic effectiveness of this treatment may be compromised by excessive pressure of the MRA on the labial mucosa in the maxilla. To overcome this limitation, we suggest that an implant-retained MRA in the maxilla be offered as a secondary treatment in selected patients. Additional studies evaluating the feasibility of this secondary treatment and the feasibility of an implant-retained MRA in OSAHS patients with more severe disease are of interest. It is advised that treatment with an implant-retained MRA is performed by an oral and maxillofacial surgeon and dentist experienced in treating patients with sleep-related breathing disorders.

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