Case Report

Implant-Supported Oral Appliance: A Novel Treatment for Edentulous Patients with Obstructive Sleep Apnea-Hypopnea Syndrome

Pin-Feng Huang, D.D.S.
Resident Doctor, Dental Department
Shin-Kong Wu Ho-Su Memorial Hospital
Taipei, Taiwan

Wen-Chien Chang, D.D.S
Clinical Professor, Taipei Medical University
Visiting Doctor, Dental Department
Shin-Kong Wu Ho-Su Memorial Hospital
Taipei, Taiwan

Po-Ya Yang, D.D.S
Visiting Doctor, Dental Department
Shin-Kong Wu Ho-Su Memorial Hospital
Taipei, Taiwan

Chih-Ling Chang, D.D.S. M.S. PhD.
Assistant Professor, School of Dentistry
National Yang-Ming University Taipei, Taiwan
Director and chief, Dental Department
Shin Kong Wu Ho-Su Memorial Hospital
Taipei, Taiwan

Corresponding author:
Chih-Ling Chang, D.D.S. M.S. PhD.
Director and Chief, Dental Department
Shin Kong Wu Ho-Su Memorial Hospital
Taipei, Taiwan
No.95, Wen Chang Road, Shih Lin Distric,
Taipei City, Taiwan
Tel: +886-2-2833-2211 ext. 2182
Fax: +886-2-2838-9321
Email: cclpyy2001@yahoo.com.tw

Abstract:

Obstructive sleep apnea-hypopnea syndrome (OSAHS) is the most common type of sleep apnea and is caused by obstruction of the upper airway. The literature illustrated that people with healthy dentition wearing the oral appliances (OAs) to treat OSAHS are well when making the right diagnosis. However, patients with edentulous ridges may also require treatment with OAs when they suffer from OSAHS. Implant-supported overdentures have shown better stability and retention than conventional overdentures. As such, if an OA is designed for combination with implants during its fabrication, then the desired stability and retention can be achieved. This case report describes our experiences with using an implant-supported OA in the treatment of an edentulous OSAHS patient.

Key words: Implant-supported overdenture, Oral appliances, Obstructive sleep apnea-hypopnea syndrome.

Introduction:

Obstructive sleep apnea-hypopnea syndrome (OSAHS) is the most common type of sleep apnea and was first described in the medical literature in 1965[1]. It is caused by obstruction of the upper airway, and the symptoms may include loud snoring, restless tossing and turning during sleep, and nighttime choking. Because of the resulting poor sleep quality, an OSAHS patient may also experience excessive daytime sleepiness, problems with memory and concentration, feelings of fatigue, and personality changes. OSAHS is also considered to be one of several potentially treatable contributors to systemic hypertension, and has been associated with coronary artery disease, stroke, congestive heart failure, and atrial fibrillation.[2,3] All of these factors can add up to an increased risk of motor vehicle accidents[4], impaired quality of life[5], and even a reduced life span.

When OSAHS is diagnosed correctly, successful treatment of the disorder may be possible. Continuous positive airway pressure (CPAP) is believed to be the most effective therapy for patients with severe OSAHS. Because of specific aspects of CPAP treatment, such as the use of a mask in-

terface, sealed tubing, and a device connected to a power source, the acceptability of CPAP among patients is somewhat limited, which can lead to suboptimal treatment adherence[1]. Therefore, oral appliances (OAs) have become an alternative treatment for OSAHS.

OAs are designed to reposition the lower jaw slightly forward relative to its natural, relaxed position. This repositioning holds the tongue farther away from the back of the airway, and may thus be enough to relieve apnea or improve breathing.

At the same time, when treating a sleep apnea patient who is also edentulous, it is not only necessary that any dentures but also any OA provided to the patient are satisfactory in terms of meeting the patient's chewing, esthetics, and phonetics needs. In order to achieve the desired retention and stability in such cases, osseointegrated implants may be the optimal option.

Relatedly, while OAs are regarded as an alternative treatment for severe OSAHS in patients who cannot tolerate CPAP, there is still insufficient data regarding the use of OAs to treat OSAHS in edentulous patients. This case report presents an example of the use of an implant-supported OA in the treatment of an edentulous patient with severe OSAHS.

Case report:

A 70-year-old male patient presented to the prosthodontic department of SKH with the following chief complaint: "I have had sleep problems and complaints from my wife about my snoring for many years."

At that time, the patient had been edentulous and worn complete dentures for at least 22 years. He had also received regular dental check-ups for complete denture maintenance. In addition, he had previously been diagnosed with several systemic diseases, namely, severe sleep apnea, hypertension, and diabetes mellitus. The hypertension and diabetes mellitus were under medical control. As for the sleep apnea, however, although the patient's doctors had recommended CPAP therapy, the patient found that he could not tolerate it because he found it inconvenient.

Intraoral examination revealed that the alveolar ridges of the maxilla and mandible were moderately resorbed, especially in the mandible (Fig. 1), while the border and frenum attachments were relatively low and located too

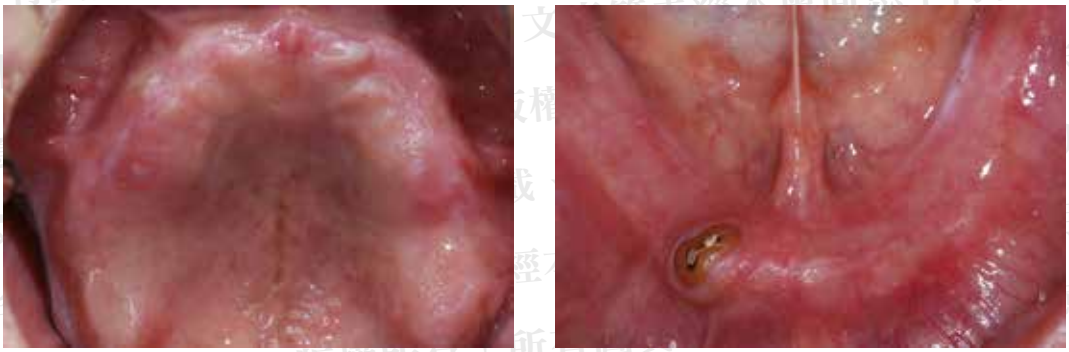

Figure 1: Preoperative view of the patient's maxillary and mandibular edentulous ridges.

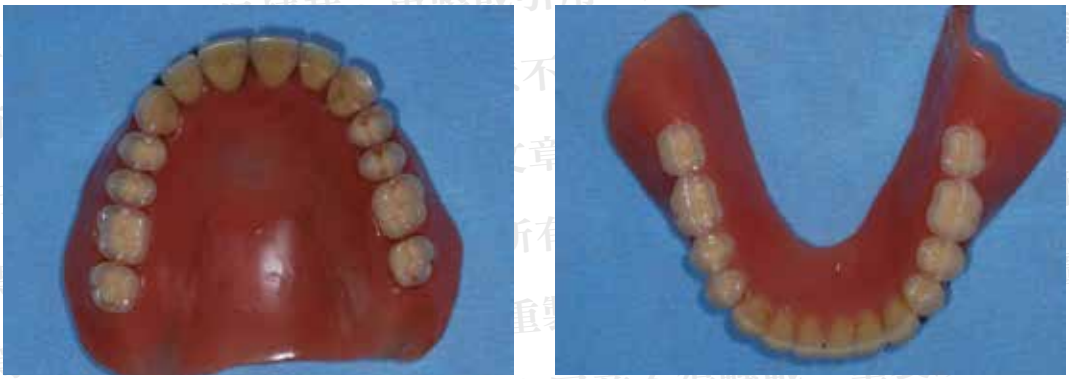

Figure 2: Occlusal view of previous maxillary and mandibular complete dentures

close to the crest of the residual ridges. It was further noted that the maxillary edentulous ridge had an ovoid shape while the mandibular appeared to have a tapered shape with a right canine residual root.

After a panoramic X-ray and dental CT scan (Kodent Dental Systems Co.,Ltd, Taiwan) evaluation and consultation with an oral surgeon, the risks and benefits implant and non-implant therapy were discussed with the patient. A definitive treatment plan using maxillary and mandibular four-implant supported overdentures was suggested and accepted by the patient.

To maintain fundamental functions such as chewing, and for esthetic reasons, the temporary prostheses were the previous denture after the evaluation of the fit of the tissue surface, occlusion and articulation, and fracture of denture base or teeth. The patient was satisfied with this previous complete denture (Fig. 2).

The previous complete denture was duplicated in order to make surgical templates (Ortho-Jet®, Lang, USA) that could be used to determine the optimal implant positions over the right and left canines and molar sites on the maxilla and mandible.

The surgical templates simulated the final dental prostheses and allowed the surgeon to visualize potential technical constraints. Thereafter, a radiological guide derived from the prosthetic model could be obtained. In this case, gutta-percha radiopaque material was used for the initial evaluation of implants along the axis of orientation.

Furthermore, using 3D software (Implant-Max®, Saturn Imaging Inc., Taiwan), additional relevant information regarding the implants was obtained, allowing the implantation process to be planned accurately and securely (Fig. 3). Stereolithography (SLA) is a computer-driven process that creates precise models using lasers and epoxy resin. According to the analyzed 3D positions, the optimal sizes of the individual implants size were selected, and then the surgical guide was prepared from the digital planning data via stereolithography. This ensured the full and accurate realization of the planning in the patient's mouth.

Eight dental implants (Ankylos® C/ implants, Dentsply, USA) were inserted under local anesthesia by one surgeon. The implants were designed to be inserted in the canine and molar regions of the maxilla and mandible. The insertion procedures were carried out using a one-stage technique. Post-operative analgesics, antibiotics, and 0.2% chlorhexidine digluconate mouth rinses were prescribed. Soft liner was applied after selectively relieving the maxillary and mandibular dentures at the implant sites.

The patient also received oral hygiene instructions. Prosthetic procedures were then started after a 3-month healing period. At that time, the patient's periodontal condition was stable, and the implants were all surrounded by healthy keratinized gingiva.

A preliminary impression was taken and

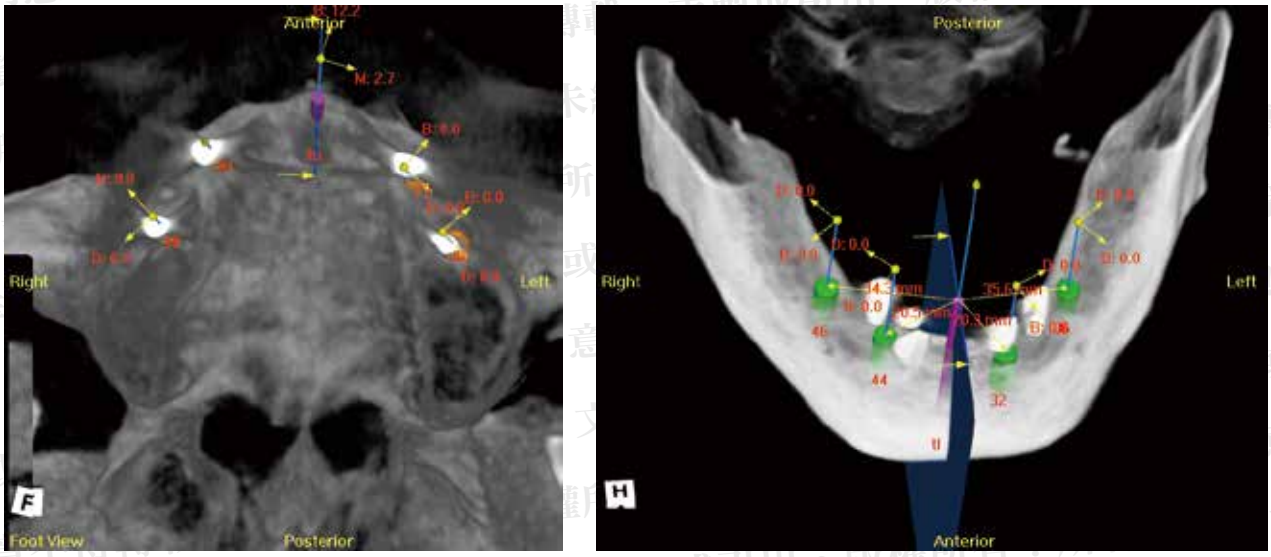

Figure 3: Image used to check the parallelism of the implants, as well as the 3D view used for confirmation

custom resin trays with openings for transfer posts and screws (Ankylos® C/ Transfer Post & Screw, Dentsply, USA) were fabricated. The transfer posts were inserted into the connection taper of the implants and attached with transfer screws of the desired length. The transfer screws were tightened using a hand torque (Fig. 4).

The tray was placed over the transfer posts, and any contact between the post and the tray was avoided to allow the tray to rest firmly on the denture-bearing mucosa. The screw for each post was positioned above the relevant opening in the tray.

The final impression was taken with polyether (ImpregumTM PentaTM Soft, 3M ESPE, USA) material. After the impression material had set, the transfer screws were undone and removed from the impression along with the transfer posts. The transfer posts were connected to implant analogs (Ankylos® Balance C/ implant analog, Dentsply, USA) in the impression tray, and the master casts were then poured.

The overdenture abutments (Ankylos® SynCone C/5° abutments, Dentsply, USA) were selected according to sulcus height and the angulation necessary to compensate for the axial divergence of the implants. To check the parallelism, a parallelization gauge (ANKYLOS® Parallel Gauge for SynCone®, Densply, USA) was placed on all the abutments, and the angled abutments were then adjusted to a common parallel direction of insertion in the parallelometer. Once the abutments had been aligned and attached, a transfer key was fabricated.

A transfer key can be fabricated entirely from quick-curing synthetic material. In this case, however, a custom metal key was provided (Fig. 5). As a clinical step, the abutments were placed into the implants according to the customized transfer key. A pick-up impression was taken for the metal framework combined

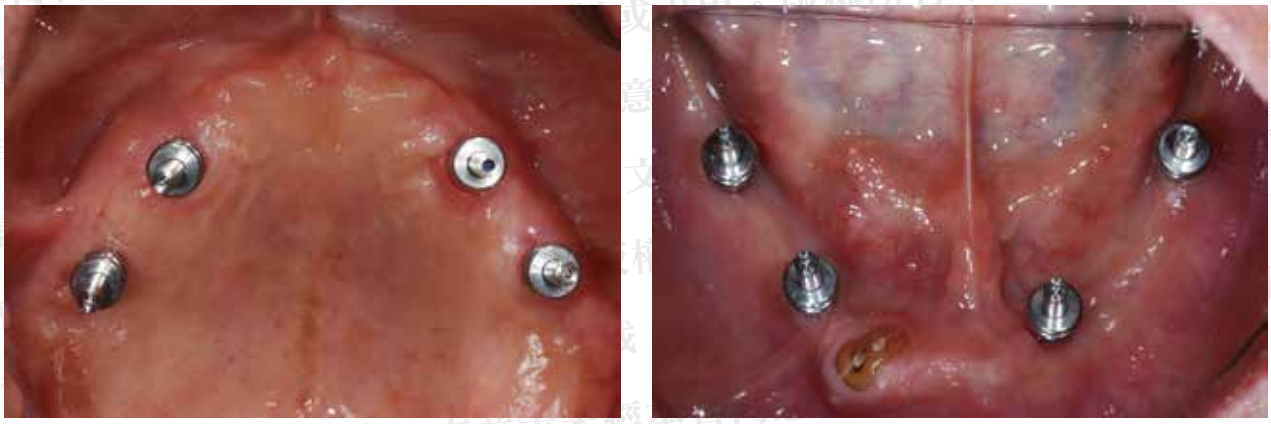

Figure 4: The transfer posts and screws mounted on implants in maxillary and mandibular ridges

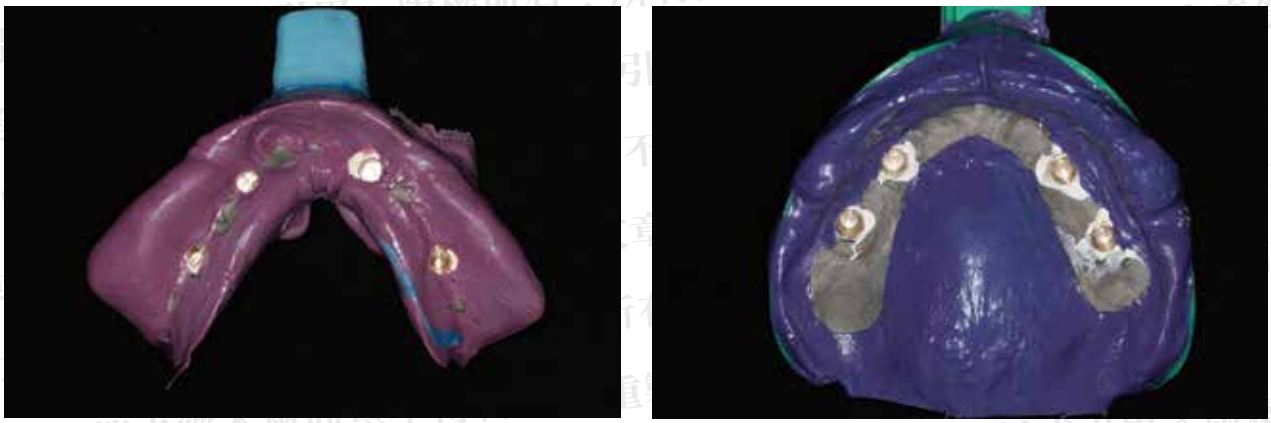

Figure 5: Maxillary and mandibular pick-up impressions of the tapered caps with cast metal frameworks.

with the tapered caps (ANKYLOS® Taper Cap Degulor, Densply, USA). The casts were poured and set, then the tapered caps were removed one by one from the metal framework by removing the temporary cement and embedded in framework with self-cured resin. The definitive prostheses were done by the copy of the previous interim which the patient adapted. During the delivery of the definitive prostheses, the overdenture abutments were placed and tightened to 25 Ncm with a torque controller (Fig.6). After insertion, the adaptation of the base was examined with disclosing material. Once the adaptation had been checked, the occlusion and articulation were also examined.

The patient was taught to remove the overdenture and to clean the prostheses and his intraoral abutments. A few days after delivery, the first check-up was performed, and peri-implant radiographs were taken to record peri-implant bone levels at the outset of the functional period.

The upper and lower four-implant supported removable overdentures provided ideal stability and allowed for easy removal and cleaning of the prosthesis (Fig.7). After finishing the fabrication of the overdentures, the OA could then be constructed. As in the denture making process, individual trays were made and tapered caps were used to cover the abutments. Thereafter, a pick-up impression was

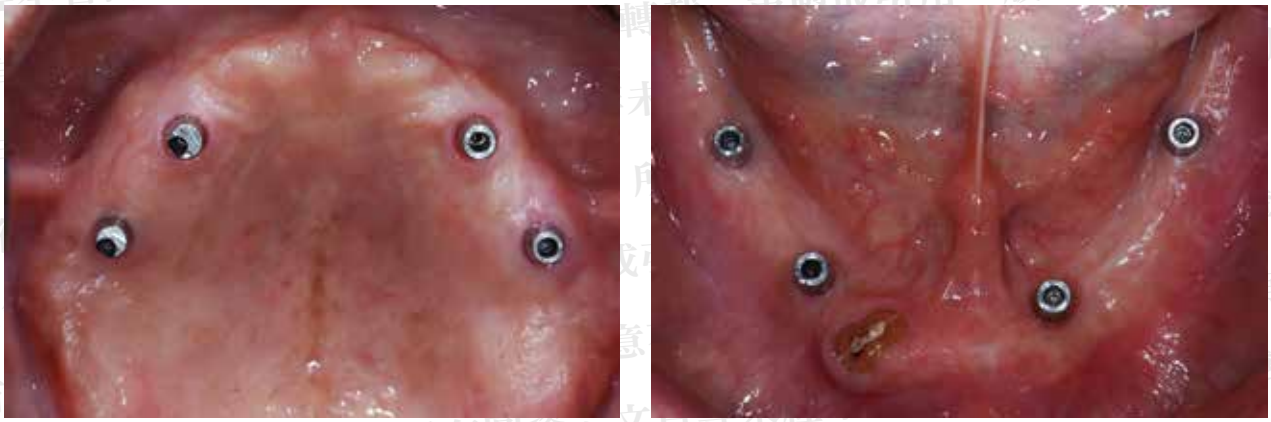

Figure 6: Occlusal view of connected abutments on maxillary and mandibular arches

Figure 7: Finished definitive dentures and extraoral view of the patient with complete dentures

taken to determine the relations of the tapered caps with the implant positions (Fig. 8). The casts were then poured and transparent acrylic resin (Hygenic® Coltene Whaledent, Inc, USA) splints were fabricated and combined together using self-cured acrylic resin(Ortho-JetTM Acrylic Resin, Lang, USA), with a venting hole left in the front side that allowed air to pass through (Figs. 9 and 10). When the OA therapy was applied, the mandible was protruded to approximately 75% of the patient's maximum advancement. In both the maxilla and mandible, the OA was retained by SynCone caps that were incorporated into the duplicate of the overdentures. The patient was instructed to wear the OA instead of his dentures whenever he slept. After three months, a post-operative polysomnographic study (PSG) was performed. The AHI data was decreased from 33 to 3, and the severity was from severe to normal.

Discussion:

Obstructive sleep apnea-hypopnea syndrome (OSAHS) is the most common type of sleep apnea. According to a study by Morgenthaler et al in 2006.[6], the prevalence of OSA, CSA, and complex sleep apnea syndrome, in a 1-month sample, were 84%, 0.4%, and 15%, respectively. However, a lack of awareness among the general public and health profession means that an estimated 80~90% of people with OSAHS are as yet undiagnosed.[7] As a result, a large number of studies have investigated the causes of and treatment options for OSAHS.

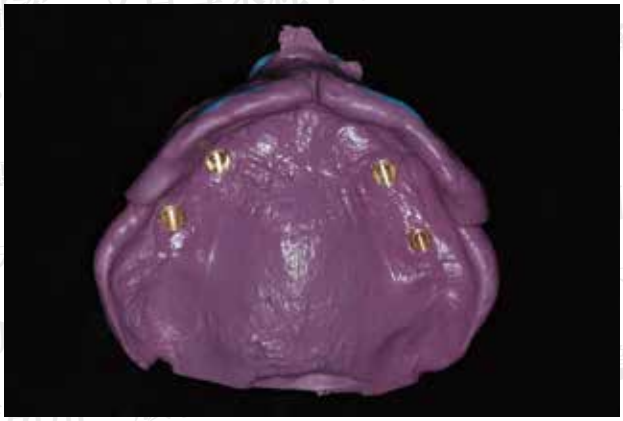

Figure 8: Pick-up impression to catch the SynCone cap

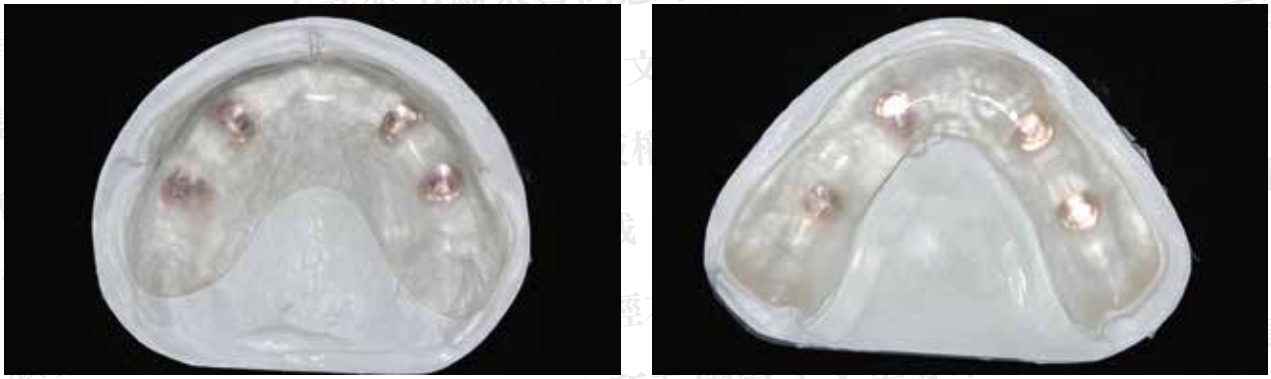

Figure 9: Maxillary and mandibular transparent acrylic baseplates

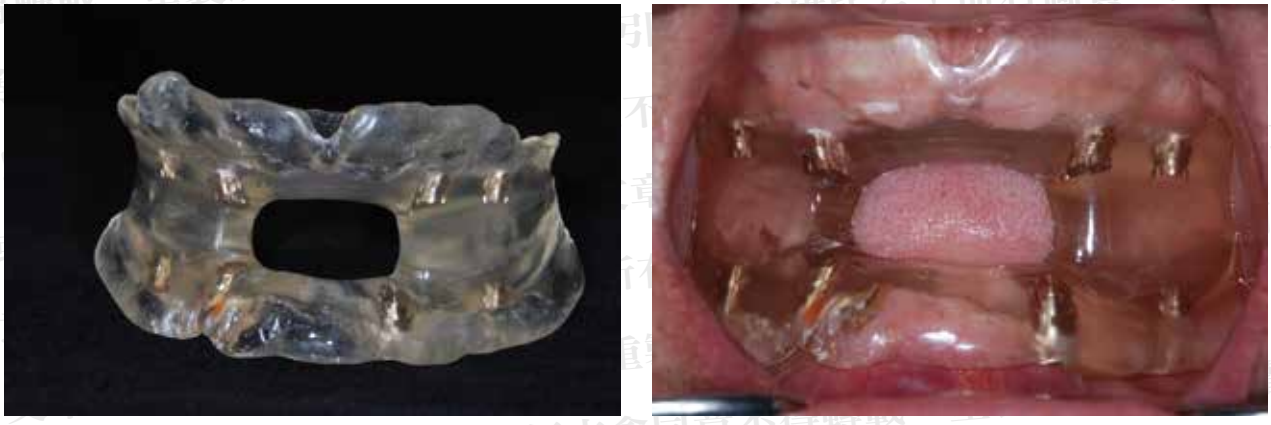

Figure 10: Finished oral appliance and intraoral view of the appliance on maxillary and mandibular arches

The presence or absence of OSAHS must be determined before initiating treatment. Thereafter, a baseline is established in order to determine the effectiveness of any subsequent treatment. In diagnosing OSAHS, the standard process is to use PSG to measure multiple parameters, such as EEG,ECG,EMG, air flow, blood oxygen saturation, apnea, and snoring levels, among others, and then make an appropriate treatment decision.[2] The apnea-hypopnea index (AHI) is an average that represents the combined number of apneas and hypopneas that occur per hour of sleep. The standard severity levels of the AHI are mild (an AHI of 5~15), moderate (an AHI of 15~30), and severe (an AHI of more than 30), respectively. The initial AHI of the patient in this case was 33, indicating a diagnosis of severe sleep apnea.

CPAP therapy is regarded as the treatment of choice for OSAHS, especially in moderate to severe cases. On the other hand, the modification of oropharyngeal patency by OAs that protrude the mandible has been suggested as an effective alternative treatment for OSAHS, especially in mild to moderate cases.

OAs are often preferred by patients but may not be as effective as CPAP. The primary indication for the use of OAs is snoring that has not responded to weight loss or sleep position changes in the context of mild to moderate OSAHS. One study found that OAs had similar treatment efficacy to CPAP for mild to moderate OSA[8]. According to a 2006 study by Kushida, the success rates of OA treatment for mild, moderate, and severe OSA were 81%, 60%, and 25%, respectively, in level I studies. Relatedly, the use of CPAP is indicated whenever possible for patients with severe OSAHS prior to any consideration of OAs. Nonetheless, while the success rate for OA treatment of severe OSAHS is only 25%, it is reasonable to consider using OAs to treat severe OSAHS patients who cannot tolerate CPAP and refuse upper airway surgery[2].

There are also other treatment options that can be used to treat obstructive sleep apnea. For example, avoiding alcohol, smoking, and the use of medications that relax the central nervous system (for example, sedatives and muscle relaxants) is recommended, while weight loss is also recommended to those patients who are overweight. In addition, physical training, even without weight loss, can improve sleep apnea.

Edentulism is a debilitating and irreversible condition and is described as the "final marker of disease burden for oral health". Although the prevalence of complete tooth loss has declined over the last decade, edentulism remains a major disease worldwide, especially among older adults.[9]

Several types of OAs have been developed for the management of OSAHS, including the Herbst appliance, Klearway appliance, Thornton adjustable positioner, and tongue retaining device. However, these appliances have all exhibited poor stability in edentulous patients. As such, in order to improve a given patient's chewing ability and stabilize and retain the given OA in the edentulous ridges, osseointegrated implants may be needed.

According to a 2006 study by Hoekema et al.[10], insertion of the implants in both the upper and lower arches will achieve the desired support. Four unsplinted implants supporting an overdenture can be a treatment option in both the maxilla and mandible, although the use of such implants in the maxilla has little support in the literature thus far. According to a 2007 study by Cavallaro[11], a minimum of four textured-surface implants at least 10mm long and 3.75mm wide may be sufficient to retain overdentures via individual attachments. This case demonstrated that osseointegrated implants can be utilized in an unsplinted manner to retain both a maxillary overdenture with partial palatal coverages and a mandibular overdenture. This was attempted because the patient wanted the palatal coverage to be reduced, although there are no published studies thus far that have compared implant survival rates for full and partial palatal coverage.

According to the previous literature, protrusion bite is taken about six to ten mm of forward distance or fifty to seventy-five percent of the maximum the patient could protrude.[12] The advantage of an increased level of protrusion is a greater reduction in respiratory events, but the disadvantage is a greater level of occlusal change.

For this case, a regular recall system was applied. During overdenture follow-ups, the status of the alveolar process was checked intraorally along with peri-implant-related items such as plaque and calculus accumulation, the condition of the mucosa, sulcus depths, and bleeding. The evaluation of the overdenture included the fit of the tissue surface, occlusion, and articulation, and fracture of denture base

or teeth. At the 1-year follow-up, the patient presented a satisfactory clinical situation and a favorable peri-implant bone level. For the OSAHS follow-up, PSG was performed with the OA in place after final adjustments of fit about 3 months after the initial fitting. The patient's AHI was decreased from 33 to 3, and the bed partner give a more accurate reflection of the improvement in the subjects' snoring and can add further understanding to the improvement in other symptoms, such as moodiness. In previous studies, bed partners have reported that their partners' snoring was improved when using OAs.

Reconstructive implant-supported prostheses and OAs can have a positive effect for edentulous patients. The good final result seen in this case may be attributed to the integrated treatment planning and the obedience to a step by step novel treatment protocol.

References

1. Chan AS, Lee RW, Cistulli PA. Dental appliance treatment for obstructive sleep apnea. Chest 2007; 132: 693-9.
2. Kushida CA, Morgenthaler TI, Littner MR, Alessi CA, Bailey D, Coleman J Jr, et al. Practice parameters for the treatment of snoring and Obstructive Sleep Apnea with oral appliances: an update for 2005. Sleep 2006; 29: 240-3.
3. Monahan K, Redline S. Role of obstructive sleep apnea in cardiovascular disease. Curr Opin Cardiol 2011; 26: 541-7
4. Haraldsson PO, Carenfelt C, Diderichsen F, Nygren A, Tingvall C. Clinical symptoms of sleep apnea syndrome and automobile accidents. ORL J Otorhinolaryngol Relat Spec 1990; 52: 57-62.
5. Johnston CD, Gleadhill IC, Cinnamond MJ, Gabbey J, Burden DJ. Mandibular advancement appliances and obstructive sleep apnoea: a randomized clinical trial. Eur J Orthod 2002; 24: 251-62.
6. Morgenthaler TI, Kagramanov V, Hanak V, Decker PA. Complex sleep apnea syndrome: is it a unique clinical syndrome? Sleep 2006; 29: 1203-9.
7. Ahrens A, McGrath C, Hägg U. A systematic review of the efficacy of oral appliance design in the management of obstructive sleep apnoea. Eur J Orthod 2011; 33: 318-24.
8. Lim J, Lasserson TJ, Fleetham J, Wright J. Oral appliances for obstructive sleep apnoea. Cochrane Database Syst Rev 2006; 25: CD004435. Updated in 2008 with no change to conclusions.
9. Elam E, de Souza RF, Kabawat M, Feine JS. The impact of edentulism on oral and general health. Int J Dent 2013; 2013:498305. doi: 10.1155/2013/498305. Epub 2013 May 8.
10. Hoekema A, de Vries F, Heydenrijk K, Stegenga B. Implant retained oral appliances: a novel treatment for edentulous patients with obstructive sleep apnea–hypopnea syndrome. Clin Oral Impl Res 2007; 18: 383-7.
11. Cavallaro JS Jr, Tarnow D. Unsplinted implants retaining maxillary overdentures with partial palatal coverage: report of 5 consecutive cases. Int J Oral Maxillofac Implants 2007; 22: 808-14.
12. Ferguson KA, Cartwright R, Rogers R, Schmidt-Nowara W. Oral appliances for snoring and obstructive sleep apnea: a review. Sleep 2006; 29: 244-62.