Int. J. Oral Maxillofac. Surg. 2017; xxx: xxx–xxx
http://dx.doi.org/10.1016/j.ijom.2017.07.003, available online at http://www.sciencedirect.com

International Journal of Oral & Maxillofacial Surgery

Clinical Paper
Orthognathic Surgery

Maxillomandibular advancement as the initial treatment of obstructive sleep apnoea: Is the mandibular occlusal plane the key?

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Abstract. Maxillomandibular advancement (MMA) can be effective for managing obstructive sleep apnoea (OSA); however, limited information is available on the predictor surgical variables. This study investigated whether normalization of the mandibular occlusal plane (MOP) was a determinant factor in curing OSA. Patients with moderate or severe OSA who underwent MMA were evaluated by preoperative and postoperative three-dimensional (3D) scans and polysomnograms. The postoperative value of MOP and the magnitude of skeletal advancement were the predictor variables; change in the apnoea–hypopnoea index (AHI) was the main outcome variable. Thirty-four subjects with a mean age of 41 ± 14 years and 58,8% female were analysed. The Epworth Sleepiness Scale (ESS) was 17.4 ± 5.4 and AHI was 38.3 ± 10.7 per hour before surgery. Postoperative AHI was 6.5 ± 4.3 per hour ($P < 0.001$) with 52.94% of the patients considered as cured, and 47.06% suffering from a mild residual OSA with ESS 0.8 ± 1.4 ($P < 0.001$). 3D changes revealed a volume increase of 106.3 ± 38.8%. The mandible was advanced 10.4 ± 3.9 mm and maxilla 4.9 ± 3.2 mm. MOP postoperative value was concluded to be the best predictor variable. Treatment planning should include MOP normalization and a mandibular advancement between 6 and 10 mm. The maxillary advancement would depend on the desired aesthetic changes and final occlusion.

Key words: maxillofacial surgery; maxillomandibular advancement; obstructive sleep apnoea syndrome; orthognathic surgery; sleep-disordered breathing; counterclockwise rotation occlusal plane; mandibular occlusal plane; mandibular distraction osteogenesis.

Accepted for publication 5 July 2017

0901-5027/000001+09

Obstructive sleep apnoea syndrome (OSA) is a medical condition with an estimated prevalence of 4–6% in the adult population as defined by an apnoea and hypopnoea index (AHI) of ≥5 events per hour[1]. OSA is related to cardiovascular and metabolic diseases, among others, and is potentially life threatening. Campos-Rodríguez et al.[2] identified a 10% absolute increase in mortality rate for OSA patients who did not use continuous positive airway pressure (CPAP).

The standard management of OSA is CPAP therapy[1], but empirical studies have suggested that CPAP compliance is low, ranging from 30% to 60%[3–5]. Most patients report that they are uncomfortable using the device and the majority of patients would prefer alternative treatment options.

Maxillomandibular advancement (MMA) is the most effective surgical therapy for adult patients with OSA[6–11] outside the tracheostomy treatment option. The treatment consists of osteotomies of the mandible and the maxilla, producing simultaneous advancement of the maxillomandibular complex. This procedure enlarges the pharyngeal space by expanding the skeletal framework, and thus reducing the risk of pharyngeal collapse during negative pressure inspiration[12,13].

It is currently used for patients with dentofacial deformities requiring orthognathic surgery. Patients with a severe obstructive disease, in whom all applicable conservative therapies have failed or proved intolerable[14] can also benefit from MMA surgery. However, the procedures are difficult to perform, requiring very specific surgical experience. In addition, careful surgical planning and postoperative follow-up are two important elements to consider and ensure long-term stability.

MMA is a revolutionary alternative to conventional treatments for OSA, but there are no well-defined studies about the surgical variables that predict AHI normalization and/or the minimum amount of skeletal advancement that can lead to OSA resolution. This study reports on the surgical treatment outcomes of the 34 subjects with moderate to severe OSA after MMA, with special attention to treatment planning and 3D pharyngeal changes. The study's primary objective was to determine the type and amount of skeletal movements as predictors to correct the AHI and pharyngeal airway space volume (PAS-VOL) changes.

In this study, the hypothesis was that normalization of the mandibular occlusal plane is mandatory to effectively enlarge the upper airway when MMA is performed and should thus be included in the treatment planning to cure the disease. In the cases where the amount of skeletal advancement is better defined, a more rational surgical planning regime will be possible enabling the scope of the technique that is not limited to treating retrognathic patients.

Material and methods

The study population comprised all the patients presenting for the evaluation and management of OSA. Data were collected between December 2007 and January 2015 at the Nisa Pardo de Aravaca Hospital's Department of Oral and Maxillofacial Surgery in Madrid, Spain.

It was designed as a prospective cohort study that aimed to follow up the selected patients over 12 months after intervention. No patient received any concomitant surgical adjunctive procedure, before or after MMA. All patients signed an informed consent for surgery, and specific consent for 3D scan examination, photographs, and 3D virtual planning. Permission from Institutional Review Board Human Studies Committee was obtained.

Diagnosis of OSA was according to current guidelines, and severity was defined as the following: mild (AHI 5–14 per hour), Moderate (15–29 per hour), and severe (>30 per hour)[1].

The following criteria were used to select the study participants: patients had to be adults with moderate to severe OSA (AHI ≥ 15 per hour); refusal to begin or continue treatment with CPAP; health conditions compatible with this surgery; normal anatomy of the mandibular ascending ramus and the temporomandibular joint (TMJ).

A thorough review of the patients' mandibular anatomy was completed prior to surgery. An ascending ramus length >50 mm (distance measured from the condylion to the gonion in a 3D scan) was required to perform a bilateral sagittal split osteotomy of the mandible. Patients with severe ramus hypoplasia and/or condylar resorption were considered as inadequate candidates for receiving conventional MMA. Intraoral mandibular distraction osteogenesis was indicated and performed in this group of patients as it has been suggested in previous studies[15] and were excluded of this series.

Additional criteria in the cohort selection included acceptance of customized morphing software simulation; the patient's acceptance of corrective orthodontic treatment pre- and postoperatively and complete retention after removing the braces during a minimum of a 2-year follow-up with a good dental hygiene track record.

Patients were excluded from the study if they had central sleep apnoea diagnosed by a neurophysiologist, were active smokers, had previous uvulopalatopharyngoplasty (UPPP), or complete edentulism (toothless or had extremely bad remaining teeth) and/or severe TMJ disease in stages IV–V of Wilkes classification.

Other demographic variables collected included age, sex, body mass index (BMI), treatment with CPAP, and using a mandibular advancement device (MAD) as additional parameters for describing all patients selected for the study.

In terms of the OSA, AHI, mean blood oxygen saturation (SaO_2), oxygen desaturation index (ODI), and the value of the Epworth Sleepiness Scale (ESS) were recorded for all patients before 6 six months after MMA. The ODI was observed to be 3% or more oxygen desaturation lasting 10 seconds or more per hour. Each patient underwent hospital-based nocturnal polysomnography (PSG) preoperative and 6 months postoperatively.

OSA assessments

The PSG results from the standard PSG locations from electroencephalogram (F3, F4, C3, C4, O1, O2, A1, and A2), electrooculogram, and electromyogram recordings were obtained with standard procedures by means of Cadwell Easy 2 (Cadwell, Kennewick, WA, USA) digital data acquisition system using a sampling frequency of 512 Hz. Airflow and thoracoabdominal effort were recorded quantitatively by nasal pressure cannula, thermistor, and respiratory inductance plethysmography. The studies were done following the American Academy of Sleep Medicine standard diagnostic guidelines by an experienced doctor in sleep medicine[1].

Surgical planning

Each selected patient underwent a preoperative anaesthesia evaluation. Hypertension, obesity, and diabetes were not considered as absolute contraindications for this surgery.

Standardized preoperative aesthetic evaluation based on clinical facial analysis (CFA) was performed for all patients using Arnett principles[16].

A 3D computed tomography scan was captured with an i-CAT machine (Imaging Sciences International, Hatfield, PA) be-

Please cite this article in press as: Rubio-Bueno P, et al. Maxillomandibular advancement as the initial treatment of obstructive sleep apnoea: Is the mandibular occlusal plane the key?, *Int J Oral Maxillofac Surg* (2017), http://dx.doi.org/10.1016/j.ijom.2017.07.003