MAXILLOMANDIBULAR ADVANCEMENT FOR TREATING OBSTRUCTIVE SLEEP APNEA

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ABSTRACT

Maxillomandibular advancement is an invasive but effective surgical option in the treatment of obstructive sleep apnea (OSA) for patients who have severe AHI index or with OSA that has been refractory to other surgical methods. Maxillomandibular advancement achieves enlargement of the nasopharyngeal, retropalatal, and hypopharyngeal airway by physically expanding the facial skeleton through Le Fort I maxillary and mandibular sagittal split osteotomies. Although MMA is known to be reserved for patients with craniofacial dysmorphism, patients with normal osseous structure are often surgical candidates and have similarly good outcomes.

Key words: sleep apnea, maxillomandibular advancement, orthognatic surgery

INTRODUCTION

Obstructive sleep apnea (OSA) is defined as a sleep-related breathing disorder characterised by respiratory pauses of at least 10 s, secondary to partial (hypopnoeic) or complete (apnoeic) obstruction of the pharyngeal airway, which is occluded due to a loss of muscle during sleep, which leads to its narrowing or total obstruction (Knudsen).

OSA is a sleep disorder that affects 4% of adults aged 30-60 years, obese men being 8 to 10 times more affected than women, due to androgenic pattern of body fat distribution (1-3). This condition is characterized by repetitive partial or total collapse of upper airways during sleep, leading to hypoxia and symptoms like sleep fragmentation, snoring, daytime sleepiness, headaches, attention disorders and fatique which all contribute in the reduction of the quality of life. Untreated, OSA is known to be associated with cardiovascular disease, metabolic syndrome, stroke and even premature death.

Some of the anatomic predisposing factors to OSA are nasal septum deviation, chronic nasal congestion, decreased nasopharyngeal volume, craniofacial abnormalities (maxillary retrognathia, mandibular retrognathia, increased lower face vertical dimension), elongation of the soft palate, macroglossia, tonsil hypertrophy and inferior position of the hyoid bone (4-6). For these patients, tongue tends to be lower and more posterior than normal, which leads to pharyngeal obstruction during sleep.

OSA is diagnosed by nocturnal polysomnography which evaluates sleep arhitecture, oxygen saturation and sleep disorder breathing (7). The latter is

measured by apnea-hypopnea index (AHI) which represents the number of apnea/hypopnea per hour of sleep and it is used to determine the severity of OSA: mild (AHI 5-15), moderate (AHI 15-30) and severe (AHI over 30) (7).

There are many treatment strategies used to manage this condition. Continuous positive airway pressure (CPAP) is an immediate, fast, and conservative treatment for OSA but it is not well tolerated by most patients (8). Intraoral devices appliance is another conservative option indicated in moderate OSA cases, with surgical contraindication, or for patients that are refusing CPAP. However, it is associated with maloclusion and temporomandibular joint disorders (9). Other treatment modalities target the reduction of Body Mass Index (weight loss or bariatric surgery), as obesity is a primary contributing factor to OSA (10).

Surgical techniques such as uvulopalatopharyngoplasty, septoplasty, laser-assisted uvuloplasty, hyoid suspension, and partial glossectomy are mainly performed in cases of mild and moderate severity, but they have a high rate of recurrence and intraoperative and postoperative complications (11).

MAXILLOAMANDIBULAR ADVANCEMENT- A SURGICAL APPROACH FOR OSA

Orthognathic surgery is widely used to correct maxillofacial deformities and over the past years it has become a technique of interest for treating OSA.

Maxillomandibular advancement (MMA) is the most effective and predictable procedure used for treating OSA, having a success rate of 65-100% (12).

Some authors suggest that MMA could be considered as a second stage procedure, only after patients undergone phase one surgery represented by uvulopalatopharyngoplasty associated or not with other complementary treatments: genial advancement, hyoid repositioning, tonsillectomy or nasal surgery. But rather than subjecting a patient to other surgeries prior to MMA, it has been advocated that MMA should be considered as a first-line surgical therapy for moderate to severe OSA (13). For some patients, concomitant genioglossus advancement (GGA) is also needed in order to provide additional expansion of the upper airway at the hypopharyngeal level (14). While MMA results in an increased anteroposterior airway space, the additional genioplasty produces greater expansion at the hypopharynx level which could improve the surgical outcome (15).

After patients' initial evaluation (medical history, sleep analysis, clinical examination and imaging studies) surgeons need to determine if the patient is a candidate for MMA, meaning fulfilling one of the following criteria: AHI greater than 15, failure of nasal continuous positive airway pressure therapy or craniofacial abnormalities.

MMA advances the maxillomandibular complex with a LeFort I maxillary osteotomy and bilateral sagittal split of the mandibular ramus. Through facial skeleton expansion, there will be an increase in the posterior airway space intended to decrease the risk of pharyngeal collapse from negative pressure determined by inspiration, therefore decreasing the severity of OSA. The advancements reported and recommended are of 5–10-mm for the maxilla and 10–12-mm for the

mandible, in order to avoid surgical relapse (11,16).

Although the technique is similar, the characteristics of patients undergoing MMA for orthognathic reasons are different from those of patients undergoing MMA for OSA. Orthognathic patient is typically young with normal BMI, whereas OSA patient is more likely to be middle-aged, male and obese. It is essential for the surgeon to understand these differences in order to establish an effective presurgical treatment plan. The most important distinct parameters between the two groups are the goal of therapy, patient profile, medical condition and nevertheless, the amplitude of the surgical movement. For OSA patients usually larger surgical movements are required, 10 mm or even more.

Not only the severity of OSA influences the outcome of MMA. According to the literature, younger patients, lower preoperative weight, lower preoperative AHI, and greater degree of maxillary advancement are predictive for MMA success (17). The surgical success is defined as a post-operative AHI of less than 20 or a 50% reduction in AHI. On the other hand, the ``cure rate'' is defined as a postoperative AHI less than 5 (17). The postoperative airway dimensional changes usually show great improvements and are similar to non-OSA patients (18). There is a significant decrease in laminar and turbulent air flow at every level of the upper airway, specifically at the soft palate and base of tongue (19). This is due to expansion of the upper airway in anterior-posterior and lateral dimensions but also due to hyoid bone elevation (20).

Maxillomandibular advancement is an invasive surgical procedure with inevitable risks and postoperative complications that include hemorrhage, local infection, extrusion of plates, screw loosening, pain, swelling, malocclusion, poor cosmetic result, facial numbness, jaw stiffness, and postsurgical relapse of advancement (17). Facial paresthesia due to stretching or injury of the inferior alveolar nerve is the most common complication but it has been reported to resolve in 90% of patients in 12 postoperative months (21). Regarding the effectiveness and long-term safety, studies show that MMA determines a reduction in diastolic blood pressure, in subjective sleepiness and AHI value, with major improvements in the quality of life (22).

Soft tissue changes after MMA have a direct effect on lips and chin but patients' perception of facial aesthetics has been reported to be generally positive in 90% of cases (21). In order to maximize the therapeutic benefits of MMA surgery in the treatment of OSA, large advancements are often the surgical goal. In daily practice, an advancement of 12mm is frequently obtained in order to achieve maximal expansion of the pharyngeal space. Consequently, soft tissues will also be advanced and major aesthetic complaints develop and are related to excessive maxillomandibular protrusion, protuberant upper lip or prominent upper incisors. However, the primary goal for OSA patients is to reduce the signs and symptoms of this pathology, rather than achieving great esthetics. In contrast, patients with class II Angle, who are at high risk for OSA, may not have an obviously evident dentofacial deformity following MMA surgery; on the contrary, MMA will deal with functionality and also aesthetics.

CONCLUSIONS

1. After appropriate sleep apnea diagnosis and clinical and radiographic assessments, maxillomandibular advancement surgery can be a successful treatment modality for severe OSA. It is a stable long-term procedure that significantly improves sleep breathing through a decrease in postoperative AHI and subjective sleepiness. Due to its long-term high success rate, it should be considered as a first-line surgical therapy for OSA.
2. Although the primary purpose for MMA in OSA treatment is functional rehabilitation, it is important to achieve a balance between the therapeutic goals and the aesthetic outcomes.
3. It is important to careful evaluate the patient in order to perform a presurgical treatment planning which will lead to predictable results.

REFERENCES

1. Schendel SA, Broujerdi JA, Jacobson RL. Three-dimensional upper-airway changes with maxillomandibular advancement for obstructive sleep apnea treatment. Am J Orthod Dentofacial Orthop, 2014; 146: 385-393.
2. Wiegand L, Zwilich CW (1994) Obstructive sleep apnea. St. Louis, Mosby
3. Redline S, Kump K, Tishler PV, Browner I, Ferrette V. Gender differences in sleep disordered breathing in a community based sample. Am J Respir Crit Care Med. ,1994; 149:722-726.
4. Baik UB, Suzuki M, Ikeda K, Sugawara J, Mitani H. Relationship between cephalometric characteristics and obstructive sites in obstructive sleep apnea syndrome. Angle Orthod. 2002; 72: 124-134.
5. Dempsey JA, Veasey SC, Morgan BJ, O'Donnell CP. Pathophysiology of sleep apnea. Physiol Rev. 2010. 90:47---112.
6. Caprioglio A, Zucconi M, Calori G, Troiani V. Habitual snoring, OSA and craniofacial modification. Orthodontic, clinical and diagnostic aspects in a case control study. Minerva Stomatol. 1999;48:125-137.
7. Kapur VK, Auckley DH, Chowdhuri S, et al. Clinical practice guideline for diagnostic testing for adult obstructive sleep apnea: An American Academy of Sleep Medicine Clinical Practice Guideline. J Clinical Sleep Med, 2017; 13 (3): 479- 504.
8. Weaver TE, Grunstein RR.Adherence to continuous positive airway pressure therapy: The challenge to effective treatment. Proc Am Thorac Soc, 2008; 5: 173.
9. Dal-Fabbro C, Chaves CM Jr., Bittencourt LRA, Tufik S. Avaliação clínica e polissonográfica do aparelho BRD no tratamento da Síndrome da Apneia Obstrutiva do Sono. Dental Press J Orthod, 2010; 15: 107-117.
10. Peppard PE, Young T, Palta M, Dempsey J, Skatrud J. Longitudinal study of moderate weight change and sleep-disordered breathing. JAMA, 2000; 284:3015- 3021.
11. Blumen M, et al. Traitement chirurgical du SAHOS. Recomm Pour Prat Clin Sur Prise En Charge Syndr d'apnées Hypopnées Obstr Sommeil L'adulte 2010;27(Supplement 3):S157–S165.
12. Waite PD, Wooten V, Lachner J, Guyette RF. Maxillomandibular advancement surgery in 23 patients with obstructive sleep apnea syndrome. J Oral Maxillofac Surg, 1989; 47: 1256–1261.
13. Chillo JE, Datillo DJ. Orthognathic surgery for obstructive sleep apnea. SEminar in Orthodontics, 2019; 25(3): 218-229.
14. Maganzini AL, Alhussain IY. Treatment of obstructive sleep apnea with combined orthognathic-orthodontic approach assessed by nocturnal polysomnography. N Y State Dent J. 2008;74(3):36–40.
15. Torres HM, Valladares-Neto J, Torres AM, Freitas RZ, Silva MA. Effect of genioplasty on the pharyngeal airway space following maxillomandibular advancement surgery. J Oral Maxillofac Surg. 2017;75(1):189. e1-189.e12.
16. Ubaldo ED, Greenlee GM, Moore J, Sommers E, Bollen A-M. Cephalometric analysis and long-term

outcomes of orthognathic surgical treatment for obstructive sleep ap- noea. Int J Oral Maxillofac Surg 2015;44:752–759

17. Holty JE, Guilleminault C. Maxillomandibular advance- ment for the treatment of obstructive sleep apnea: a sys- tematic review and meta-analysis. Sleep Med Rev. 2010;14:287.
18. Butterfield KJ, Marks PL, McLean L, Newton J. Linear and volumetric airway changes after maxillomandibular advancement for obstructive sleep apnea. J Oral Maxillo- fac Surg. 2015;73(6):1133–1142. https://doi.org/ 10.1016/j.joms.2014.11.020.
19. Sittitavornwong S, Waite PD, Shih AM, et al. Computational fluid dynamic analysis of the posterior airway space after maxillomandibular advancement for obstructive sleep apnea syndrome. J Oral Maxillofac Surg. 2013;71(8):1397– 1405. https://doi.org/10.1016/j.joms.2013.02.022.
20. Hsieh YJ, Liao YF. Effects of maxillomandibular advance- ment on the upper airway and surrounding structures in patients with obstructive sleep apnea: a systematic review. Br J Oral Maxillofac Surg. 2013;51(8):834–840. https://doi.org/10.1016/j.bjoms.2012.11.010.
21. Li KK, Powell NB, Riley RW, Troell RJ, Guilleminault C. Long-term results of maxillomandibular advancement surgery. Sleep Breath. 2000;4(3):137-140.
22. Boyd SB, Walters AS, Waite P et al. Long-term effectiveness and safety of maxillomandibular advancement for obstructive sleep apnea. J Clin Sleep Med, 2015; 11(7): 699-708.