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Oral and Maxillofacial approach for the treatment of Obstructive Sleep Apnea - Review

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Abstract

Obstructive Sleep Apnoea – Hypopnea Syndrome (OSAHS) is a potentially serious sleep disorder in which breathing repeatedly stops and starts during sleep. It is associated with significant co-morbidities affecting millions of people around the world. Many of these individuals remain undiagnosed while those who are diagnosed often exhibit poor compliance with the nightly use of Continuous Positive Air Pressure (CPAP), a very effective non-invasive modality. The growing failure and discomfort reported by the patients brought light into the possibility of other options such as oral appliance therapy and surgical therapy, with an absolute cure rate in moderate to severe OSAHS seen with Maxillo-Mandibular Advancement (MMA) surgery. The article reviews various Oral and Maxillofacial management options for the treatment of OSAHS with their success rates.

Keywords: Obstructive Sleep Apnoea – Hypopnea, Maxillo-Mandibular Advancement, Distraction Osteogenesis, Continuous positive airway pressure

INTRODUCTION

American Academy of Sleep Medicine defines obstructive sleep apnea (OSA) as a sleep- related breathing disorder that involves a decrease or complete halt in airflow despite an ongoing effort to breathe. It is a common disorder affecting 4% of males and 2% of the female population between the third and sixth decade of life [1] but it is documented that most of the cases remain undiagnosed. It is a serious disorder affecting the health and well- being of millions of patients worldwide. It is a risk factor for most of the cardiac, hepatic and renal problems [2]. Most patients with a history of stroke, arrhythmias, hypertension, diabetes and liver and kidney failure are knowingly or unknowingly associated with obstructive sleep apnea. It results in poor concentration, impairs job management and quality of life and affects the patient on an individual, community and professional level [3].

Patency of the airway, in most patients, is compromised due to structural and skeletal defects and are more prone to dental problems like mircognathia, retrognathia, adenotonsillar hypertrophy *etc*. Obesity also contributes to the decrease in pharyngeal airway space by increasing fat deposition around the neck or superficially in the tongue.

STUDY CRITERIA

A systematic search of the databases was done in PubMed, Scopus, Google Scholar and Cochrane Central Register of Controlled Trials and Cochrane Database of Systemic Reviews. The collected lists of articles were reviewed further. The criteria for exclusion included reviews, preexisting congenital maxillofacial abnormalities and reviews without a well-defined criterion for the success of procedure and articles which used upper airway surgical procedure alone. Only the articles that used maxillomandibular advancement or distraction osteogenesis were included in this review (Table 1).

ETIOLOGY AND PATHOGENESIS:

The pharynx is the most common site of obstruction [28, 29]. This is due to the large tongue size, small airway and abnormal anatomy which causes a difficulty in breathing thus lowering the blood oxygen saturation until the carotid sinus is stimulated resulting the patient waking up to restore normal breathing. This cycle is repeated as soon as the patient falls asleep, with the tongue collapsing back to block the airway. This apneic episode can go on from 5 – 100 times a night or even more. The average number of episodes per hour of sleep is called Apnea-Hypopnea Index (AHI) and is classified into mild (5-15), moderate (15-30) and severe (>30) [30]. These episodes are frequently associated with snoring, but snoring is not a diagnostic factor for OSA.

CLINICAL FEATURES:

The common clinical features to identify obstructive sleep apnea could be broadly classified into nocturnal (witnessed pauses in breathing, loud persistent snoring, restless sleep, frequent visits to the bathroom, choking or gasping for air) and diurnal (daytime sleepiness, poor concentration, early morning headaches, irritability, impotence, falling asleep during routine activities, emotional instability, decreased sexual activity) signs and symptoms [3].

DIAGNOSIS

Examination should include assessment of systolic and diastolic blood pressure, neck girth, evaluation of upper airway to assess the status of uvula, soft palate, tonsils and tongue size, low level of hyoid bone or maxillo-mandibular deficiency [31].

- Mallampati Score (Grade 1 – 4) evaluates the size of the tongue in relation to the oral cavity. An increased score suggests that tongue could be the cause of obstruction [32].
- Epworth sleepiness scale is a questionnaire used as a

subjective measure of a patient's daytime sleepiness. Other questionnaires include the Berlin questionnaire and the STOP-BANG Questionnaire (score of ≥ 3 is considered high risk) [33].

- Multiple Sleep Latency Test (MSLT) is carried to assess the rate at which the patient falls asleep. Patients with excessive daytime sleepiness will have an abnormal MSLT and will have an average sleep latency during the MSLT of less than 5 to 8 minutes [34].
- Lateral cephalometric radiographs are used to assess the size of the posterior airway space, the length of the soft palate and the distance from the mandible to the hyoid bone which are beneficial for decisions concerning surgical management. Cephalometric analysis is highly recommended in OSA patients in diagnosis and treatment planning [35].
- Three-dimensional models of the airway recreated from cone-beam computed tomography (CBCT) scans are used to assess anatomic constrictions [36].
- Mueller's maneuver is a diagnostic technique to detect airway narrowing. It is performed by attempting to inhale against pinched-off nose and closed mouth with a fiber optic Naso pharyngoscope in place. The resulting negative inspiratory pressure will cause the walls of the upper airway to collapse in the narrowed airway [37].
- Polysomnography is the gold standard test. It is a detailed overnight sleep study which records many functions like brain activity, oxygen saturation, heart rhythm, breathing rate, muscle activity and eye movements. Respiratory disturbance index (RDI), AHI and oxygen desaturation index (ODI) are used as a screening and diagnostic test [38].
- Substitute to polysomnography in patients with a probability of moderate to severe OSA, a variety of portable devices which are used for in-home, monitoring the airflow, thoraco-abdominal movements and blood oxygenation are available [39].

Table 1: Studies reporting the surgical techniques for the treatment of OSAS

Serial No.	Author	Year	Number of Patients	Surgical technique
1.	Waite et al. [4]	1989	23	MMA -Success Rate – 96%
2.	Riley et al. [5]	1993	91	MMA - Success rate – 98%
			239	Phase 1 (UPPP and/or genioglossus advancement with hyoid myotomy suspension) Success rate – 61%
3.	Hochban et al.[6]	1994	21	MMA -96%
4.	Yao et al. [7]	1998	19	Genioglossus advancement with/without hyoid suspension myotomy. Success rate – 68%
5.	Prinsell et al.[8]	1999	50	MMA - Success Rate – 100%
6.	Cohen SR.[9]	1999	11	Maxillo-mandibular Distraction osteogenesis
7.	Bettega et al.[10]	2000	44	Phase 1 : Genioglossus advancement with/without hyoid myotomy and suspension. Success rate – 22.7%
			20	Phase 2 : MMA - Success rate – 75%
8.	Carmen et al.[11]	2000	7	Distraction Osteogenesis
9.	Li et al.[12]	2000	175	Phase 1: Success rate – 49.15%
				MMA after phase 1 failure: Success rate – 97%
10.	Wagner et al.[13]	2000	21	MMA - Success Rate – 70.5%
			20	Mental Transposition Success Rate – 25%
11.	Li et al.[14]	2000	19	MMA - Success Rate – 94.74%
12.	Hendler et al.[15]	2001	40	MMA -Success Rate – 86%
13.	Li et al.[16]	2002	5	Distraction Osteogenesis
14.	Goh and Lim.[17]	2003	11	Modified MMA
15.	Wang et al.[18]	2003	79	Distraction Osteogenesis Success Rate – 69.6%
16.	Guilleminault and Li.[19]	2004	6	MMA
17.	Dattilo and Drooger.[20]	2004	42	Phase 1 (Hyoid suspension, palatal surgery and genioglossus advancement) Success Rate – 80%
			15	MMA - Success Rate – 95%
18.	Smatt and Ferri [21]	2005	18	MMA -Success Rate – 84%
19.	Dort et al.[22]	2006	33	Mandibular repositioning appliance Success rate – 49%
20.	Dekeister et al. [23]	2006	25	MMA
21.	Valiathan et al.[24]	2010	12	Distraction osteogenesis
22.	Li.[25]	2011		MMA - Success rate – 89%
23.	Bruno et al. [26]	2011	44	MMA
			9	Distraction Osteogenesis
24.	Varghese et al. [27]	2012	24	MMA

MMA - Maxillomandibular Advancement

TREATMENT

The treatment options for OSA ranges from non-invasive to invasive. The non-invasive treatment options include life style modification, postural training and oral appliance therapy. Invasive therapy includes surgeries such as uvulopalatopharyngoplasty (UPPP), laser assisted uvulopalatoplasty (LAUP), hyoid suspension and tongue base reduction, while the common oral and maxillofacial approaches include genioglossus advancement (GGA), advancement genioplasty, maxillomandibular advancement and distraction osteogenesis [40].

The definitive and accepted treatment for OSA is Continuous positive airway pressure (CPAP) but has a high non-compliance rate (5-50% in 1st week to 12-25% within 3 years) [41]. The side effects include the stuffy dry nose, nasal irritation, claustrophobia, the noise of the machine, disturbed sleep, unintentional removal of the apparatus during sleep, difficulty initiating sleep and gastric disorders. Studies comparing oral appliances (OA) and CPAP have shown that the former is less effective (15-55% success). Owing to the side effects of CPAP, patients prefer oral appliances [42].

The implementation of various surgical treatments is based on the individual patient because of the multifactorial etiologies. The surgical procedures can be divided into 2 stages. Stage I includes UPPP and GGA, with or without hyoid myotomy. Stage II includes MMA and is carried out where stage I surgeries may not change the status of the patient.

With the increase in age, body mass index (BMI), neck size and RDI the response to treatment also decreases [43]. The main aim of the surgical therapy is to cure the disease but it is accompanied by complications such as the post-operative pain, discomfort, edema, risk of surgery and the uncertainty of the success of the procedure [44].

From a maxillofacial point of view, the three main surgical procedures for the treatment of sleep apnea are Genioglossus advancement with/without hyoid myotomy, Distraction osteogenesis, Maxillo-mandibular advancement.

1. Genioglossus Advancement with/without Hyoid Myotomy (GAHM)

The surgical management is directed towards either reduction in tongue mass or the advancement of the attachment of the tongue. Powell and colleagues described the principles for radiofrequency ablation of the tongue [45].

The attachment of genioglossus and geniohyoid muscles are repositioned by genioglossus advancement. The digastric muscles are also repositioned anteriorly resulting in a more anterior post-operative position of the tongue and change in the position of the geniohyoid muscles which pulls the hyoid bone superiorly [46].

Genioglossus advancement is implicated for the management of patients with a RDI above 15 per hour of sleep and ODI to less than 87% that flounder CPAP or are reluctant to use CPAP on a continuing basis [47]. An incision is made on the labial side of the gingivolabial sulcus. The mandibular bone is exposed down to the inferior border and osteotomy is performed. The fragment is advanced, rotated and the fragment is secured to the inferior border. When hypopharynx is the site of obstruction GAHM is indicated over GGA alone. This procedure may be done in conjunction with UPPP or MMA in patients with multiple sites of obstruction [45].

2. Distraction Osteogenesis (DO)

Distraction osteogenesis is a based on manipulation of healing bone, stretching an osteotomized area before calcification has occurred in order to generate the formation of additional bone and investing soft tissue. First developed by Ilirazov, for the correction of various deformities of the limbs and was later adapted for maxillofacial deformities [48].

DO is classically divided into four phases viz., surgery, distraction, consolidation and hardware removal. In the first phase after osteotomy site is planned distraction device is placed either extraoral or intraoral depending on the clinical scenario. Following a latency period of 4 days, the distraction device is activated at the rate of 1 mm/day till the desired length is achieved. After 2 months of consolidation, the distractor device can be removed. Lu et al., described DO as a reliable surgical method to improve the narrow upper airway in young patients, especially those with severe craniofacial deformities. Distractions of up to 25mm have been reported and relapse after distraction may be less significant than relapse after conventional MMA [49].

Even though DO is an alternative to MMA or used along with MMA to improve the condition, it is better to advance the mandible using DO instead of MMA because the procedure can be stopped once the estimated distance of distraction is obtained, gradual and incremental movement provides accommodation of the soft tissues and hence, improves the stability of the newly formed bone, less chance of inferior alveolar nerve damage and thus permanent paresthesia and temporomandibular joint damage can be avoided [26].

But, there are many drawbacks for DO such as prolonged treatment time, two operations (one each for the application and removal of the appliance), newly formed bone is weak and the presence of the distractor hinders proper mastication and speech and high patient compliance is required [50].

3. Maxillo-mandibular Advancement (MMA)

The MMA is considered as a phase 2 therapy due to its aggressive nature. It has consistently provided results which make it the most predictable surgical management. The best candidates for the surgery are the ones with severe maxillofacial skeletal deformities, particularly maxillomandibular arch retrusion. It causes an expansion in the skeletal framework which includes the nasal pharyngeal and hypo pharyngeal airway thus leading to airway expansion and reduces lateral pharyngeal wall collapse.

Implications for MMA are patients with resolute OSA without compelling pharyngeal obstruction, patients with significant maxillomandibular deficiency, young patients who require permanent resolution of OSA, patients with inclination for competent single- stage surgery [10]. Maxillary advancement with LeFort 1 osteotomy pulls forward the velum and velopharyngeal muscles while

mandibular advancement with a bilateral sagittal split osteotomy (BSSO) and genioplasty advances the tongue and suprahyoid muscles. During MMA, the maxilla is generally advanced first with the mandible advanced into occlusion. Because many MMA patients have retrognathic mandible, the mandible is generally advanced more than the maxilla. The average age for MMA is higher than those for traditional orthognathic surgeries which puts the patient at a higher risk of anesthesia and surgery related complication vowing to the differences in parameters such as vascular supply, bone healing and stability [51]. The immediate post-operative edema is a serious concern in the outcome of MMA. Mild to moderate lateral pharyngeal edema and ecchymosis of the pyriform sinus and aryepiglottic fold have been seen in a number of patients.

There is a 75 - 100% success rate with a 90% improvement in the quality of life in those who had MMA [52]. Success is defined as a reduction in the overall AHI by more than 50% and Lin HC et al noticed that the overall AHI reduced to less than 20% in 64% of the subjects [53].

Limitations of the procedure includes extent of advancement which is no longer than 10mm – 12mm due to soft tissue limitations, the tendency to relapse with longer advancement, invasive and complex surgery, complications such as potentially profuse bleeding, infection, paresthesia, change in occlusion and aesthetic changes.

CONCLUSION

OSA is a common disorder but not diagnosed routinely. It is a life long illness which involves multidisciplinary approach for the diagnosis and management. Medical professionals are becoming constantly aware of its existence and health impact. The field of sleep apnea surgery has swiftly advanced with contemporary instrumentation and surgical techniques. The dentists must also recognize this disorder by early evaluation and prudent approach for their patient. The treatment plan for the patient is specifically modified in relation to the status of the patient, underlying illness and austerity of OSA to achieve a harmonious state which requires continuous follow- up.

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