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Different orthodontic treatment modalities on airway- Review

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ABSTRACT
Airway-focused orthodontics is a philosophy which triumphs everything else in contemporary orthodontics. The philosophy focuses on practice of clinical orthodontics aimed at achieving ideal jaw relationship, establish normal oral function and performance, optimal proximal and occlusal contact of teeth. The central aspect of function and performance is airway and breathing which, in fact, is hierarchically the most important function for humans. Ideal health and ideal facial development are dependent on correct tongue posture and nasal breathing. Therefore, contemporary protocols be it preventive, interceptive, or corrective orthodontics should factor upper airway improvement in addition to improving smile and facial appearance.
This review focused on airway dysfunctions and orthodontic treatment modalities.

I. INTRODUCTION

Upper airway assessment and its interactions with craniofacial growth and development have been of interest to ENT specialists, laryngologists, speech therapists, paediatricians and orthodontists. Upper airway obstruction tends to alter breathing, which can have a significant impact on the normal development of craniofacial structures, causing deficiencies in transverse maxillary growth, as well as cause the rotational growth of the back of the mandible. These anomalies require early detection, and it has been shown that the early diagnosis and treatment of obstructive sleep apnoea-hypopnea syndrome allows for an almost complete normalization of dentofacial morphology.[1] The mutual interaction between the pharyngeal structures and the skeletal relationship of a patient is a subject of interest for the orthodontists and maxillofacial surgeon. The evaluation of soft tissues including facial contours, neuromuscular function, tongue, tonsil, adenoids and nasal polyps should be an integral part of orthodontic diagnosis and treatment planning. The pharyngeal airway is an intricate structure. In conjunction with its surrounding structures, it is responsible for the physiologic processes of swallowing, vocalization, and respiration. The methods described to assess the airway include: nasal endoscopy, rhinomanometry, acoustic rhinomanometry, cephalometry, computed tomography (CT), magnetic resonance imaging (MRI) and cone-beam computed tomography (CBCT).[2,3]

Obstructive sleep apnoea (OSA) syndrome is characterized by temporary occlusion of the upper airway several times during the night which may result in hypoxia and sleep fragmentation. Also, there is chronic tiredness, day-time somnolence associated with snoring and intellectual deterioration.[4] A decrease in the upper airway dimension at the velopharyngeal level together with an increase in soft palate and tongue dimensions is also observed.

In orthodontics, upper airway alterations must always be evaluated clinically at the start of the treatment, as well as through lateral cephalograms or CBCT. Cephalometry provides a 2D reconstruction of three-dimensional structures, so the information provided is limited. The CBCT shows 3D structures, the construction of projections on different planes, and allows us to measure the volume of different structures, so it provides a large amount of diagnostic information. However, it is not a routine examination and involves a larger radiation dose[5].

Airway-focused orthodontics is a philosophy which triumphs everything else in contemporary orthodontics. The philosophy focuses on practice of clinical orthodontics aimed at achieving ideal jaw relationship, establish normal oral function and performance, optimal proximal and occlusal contact of teeth. The central aspect of function and performance is airway and breathing which, in fact, is hierarchically the most important function for humans. Ideal health and ideal facial

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development are dependent on correct tongue posture and nasal breathing.[6] Therefore, contemporary protocols be it preventive, interceptive, or corrective orthodontics should factor upper airway improvement in addition to improving smile and facial appearance. Today, orthodontic profession is crucial and integral part of the interdisciplinary team in the management of upper airway sleep disorders, thus well poised to become a part of mainstream health profession.

TREATMENT MODALITIES FOR OBSTRUCTIVE SLEEP APNEOA

General measures:

- Weight control
- Avoidance of alcohol and sedatives
- Sleep position
- Sleep apnea, no driving and operation of heavy equipment.

Specific measures:

- Nasal continuous positive airway pressure
- Mandibular advancement appliances and removable appliances.

Surgical measures:

- Uvuloplasty
- Midline glossectomy
- Maxillomandibular osteotomy and advancement

Continuous Positive Airway Pressure

CPAP treatment for OSA was first introduced in 1981 by Sullivan and colleagues (Sullivan et al., 1981).154 The treatment mechanism consists of a positive air pressure delivered through a mask applied over the nose (or nose and mouth) working as a pneumatic airway splint during sleep. CPAP is regarded as the golden standard for treatment of OSA and it has been proven that CPAP treatment effectively diminishes upper airway obstruction during sleep. CPAP is a mechanical device that applies mild air pressure in order to keep the airways open. CPAP typically is used by patients who have breathing problems, such as sleep apnoea, but may also be used in preterm infants whose lungs have not fully developed and are diagnosed with respiratory distress syndrome or bronchopulmonary dysplasia. It consists of a mask or other device that fits over the nose or nose and mouth with straps to keep the mask in place while it is being worn. A tube connects the oral or nasal mask to a positive air pressure pump. The CPAP mask is worn only during sleep. CPAP is considered reversible therapy as are the oral appliances, but patients using the CPAP Treatment 58 or oral appliances must be periodically monitored for any changes in dental occlusal relationships and/or temporomandibular joint integrity.

CPAP

CPAP treatment also seems to reduce cardiovascular mortality, for example Young et al. (2008) reported from a study with 18-year follow up that OSA subjects with CPAP treatment had an adjusted all-cause mortality hazard of 3.0 compared to 3.8 for OSA subjects without CPAP treatment. Another study showed that CPAP treatment reduced the risk of fatal and non-fatal

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cardiovascular events (Marin et al., 2005).155 CPAP treatment reduces daytime sleepiness regardless of severity of OSA. Weaver et al. (2012)156 showed in a recently published article that CPAP treatment in sleepy patients (ESS>10) even with only mild or moderate OSA (AHI 5-30) improved functional outcome. CPAP treatment also seems to reduce the risk for traffic accidents in OSAS patients[6].

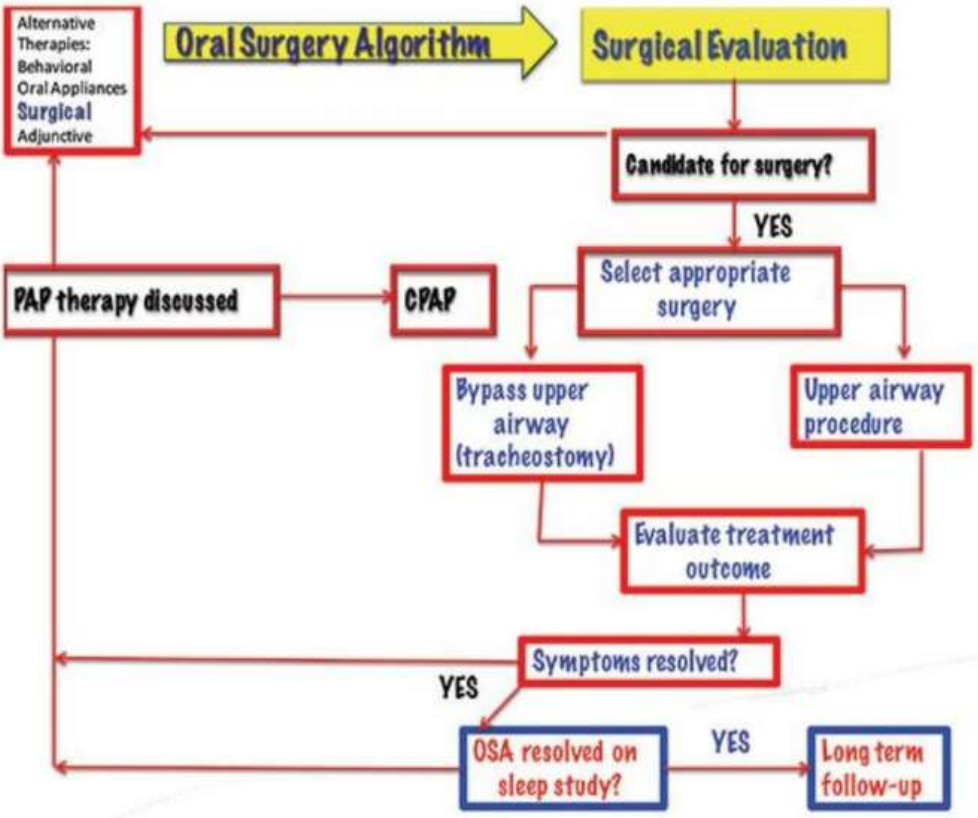

Figure 5: Surgical algorithm. (Adult obstructive sleep apnea task force for the American Academy of Sleep Medicine. Clinical guideline for the evaluation, management and long-term care of obstructive sleep apnea in adults. J Clin Sleep Med. 2009;5(3):263-276.)

Mandibular Advancement Devices[7]

Oral appliances to be used during sleep are usually designed to have full arch coverage in the maxilla and mandible for mandibular repositioning. With this design, the maxilla acts as an anchor to the protrusive repositioning of the mandible, and the mandible and tongue are held forward (protrusively) to improve posterior airway patency with the patient in a supine sleeping position. Tongue-retention appliances are designed for both arches (discussed previously) if tongue retention is desired while protrusively repositioning the mandible.9 As previously mentioned, oral appliances are more efficacious in treating patients having AHI scores of < 5 per hour (none/minimal) to AHI scores of > 15 but < 30 per hour (moderate).

A mandibular advancement device (MAD) for the treatment of OSA was first introduced in 1985 by Soll and George. The MAD protrudes the mandible thus creating both an increased volume of the pharyngeal airway and increased airway stability through an increased muscular tone (Soll and George, 1985).[7] Even though MADs have been found to have a positive long-term impact on several OSA symptoms such as excessive daytime sleepiness, morning headaches and daytime naps in compliant patients (Marklund and Franklin, 2007) they seem to be somewhat less effective than CPAP in reducing both excessive daytime sleepiness and AHI. POSA is a positive predictor for MAD treatment efficacy (Chung et al., 2010).

The ideal properties of removable appliances include simplicity of delivery, low bulk, lip seal maintenance, sufficient tongue space, non-interference with sleep, low cost, and lateral freedom. The patients selected for these types of appliances need to have certain features for the appliance to exhibit the best possible results. These include reduced lower anterior facial proportions, normal relation between maxilla and mandible, high position of hyoid, normal soft palate area and tongue proportion, and relatively normal post-palatal and post-lingual airway.

Mandibular Advancement Appliance – Custom-made oral appliances are proven to be more effective than over-the-counter devices, which are not recommended as a screening tool or as a therapeutic option.

Advancement appliances are manufactured in different materials and sold under different trade names. Their main purpose is to place the mandible in a forward position so that the size of the airway passage is increased. Kyung et al.[8] measured the pharyngeal size and shape differences between pre- and post-trials of a mandible-protruding oral appliance using cine computerized tomography. They found that the oral appliances appeared to enlarge the pharynx to a greater degree in the lateral than in the sagittal plane at the retropalatal and retroglossal levels of the pharynx, thus suggesting a mechanism for the effectiveness of oral appliances that protrude the mandible.

Ngiam and Kyung[9] investigated the efficacy of orthodontic microimplant-based mandibular advancement treatments for the treatment of severe snoring and OSA in adult

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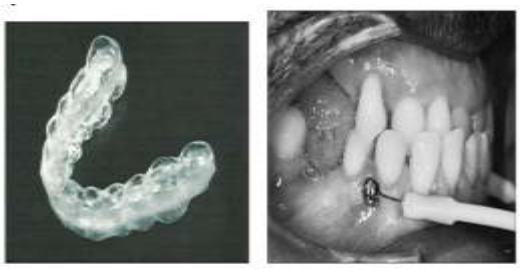
patients. They found that favourable reductions in sleep variables highlight the potential of microimplant-based mandibular advancement therapy as an alternative treatment modality for OSA patients who cannot handle the continuous positive airway pressure and oral appliance therapy. Referring to these studies, it is clear that the advancement appliances have given very favourable results in the treatment of OSA.



Maxillary expansion[10]

Maxillary expansion was shown to reduce upper airway obstruction during sleep in young adults with mild or moderate obstructive sleep apnea. Rapid Maxillary Expansion (RME) produced a numerically parallel expansion of the mid palatal suture and a triangular shape of expansion with the base facing anteriorly when percentage change was calculated. In regard to the airway, a moderate increase of the cross sectional area adjacent to the hard palate was observed. This cross sectional area increase was highly dependent on the expansion between the 1st molars. The RME effect on the airway diminished as it moved further away from the mid palatal suture possibly due to the compensation generated by the surrounding soft tissues in a 3D frame. The treatment with the X-bow appliance in Class II patients resulted in favorable increase in the oropharyngeal airway dimensions and volume. In one of the study it was found that rapid maxillary expansion and facemask (RME/FM) therapy did not affect at all the volume of maxillary sinuses and actually inhibited the normal expected increase of the volume of the pharynx when compared with a control group comprising normal individuals.

At long-term evaluation by (Lombardo et al 2020) a significant increase in airway size and a significant decrease in adenoid size were found in the treated group as well as an improvement in the pharynx dimension. During active treatment the treated group showed a significant improvement in lower airway size and in lower pharynx dimension. A significant decrease in adenoid size was also found[11].

The incidence of improvement in nasal airway obstruction after RME depends on the nasal airway condition (nasal mucosa hypertrophy and obstructive adenoids). In patients with nonpathologic nasal airway conditions, the obstruction may be sufficiently improved with RME. Furthermore, to some extent, RME may be effective in treating nasal mucosa hypertrophy. However, because of obstructive adenoids, RME was ineffective in patients with nasal airway obstruction[12].

Surgical Treatment

In 1981, Fujita et al. introduced Uvulopalatopharyngoplasty (UPPP) as a surgical treatment for OSA. A traditional full UPPP comprises resection of the uvula together with parts of the soft palate and the tonsils. Since it was introduced, it has dominated the surgical procedures in the treatment of OSA. The procedure has been reported to be associated with several adverse effects including peri- and postoperative death, bleeding, respiratory compromise, and other postoperative difficulties such as difficulty in swallowing. Additionally, the efficacy of the procedure has not been proven (SBU, 2007).

The AASM states in their Practice parameters for the surgical modifications of the upper airway for obstructive sleep apnoea in adults that UPPP as a sole procedure with or without tonsillectomy, does not reliably reduce the AHI when treating moderate to severe OSAS and therefore both CPAP and MAD should be offered to the patient before UPPP (Aurora et al., 2010).[160] Tracheostomy is a highly effective surgical treatment to abolish apnoeas and hypopneas since the tracheostoma bypasses the collapsible pharynx. The AASM recommends that tracheostomy, even though considered very effective, should only be considered when other options do not exist, have failed, are refused or when deemed necessary by clinical urgency (Aurora et al., 2010).[14] The reason for this is of course the significant negative side effects that are associated with a tracheostoma.

Maxillo-mandibular advancement therapy (MMA) includes a surgical reposition of both the mandible and the maxilla in an anterior direction resulting in an increased volume of the airway. There is limited evidence of the effectiveness of this method and therefore (even though published articles with lower quality of evidence shows that the procedure is quite effective) and therefore the AASM states that MMA is indicated only in patients with severe OSA where neither CPAP nor MAD works (Aurora et al., 2010).[14]

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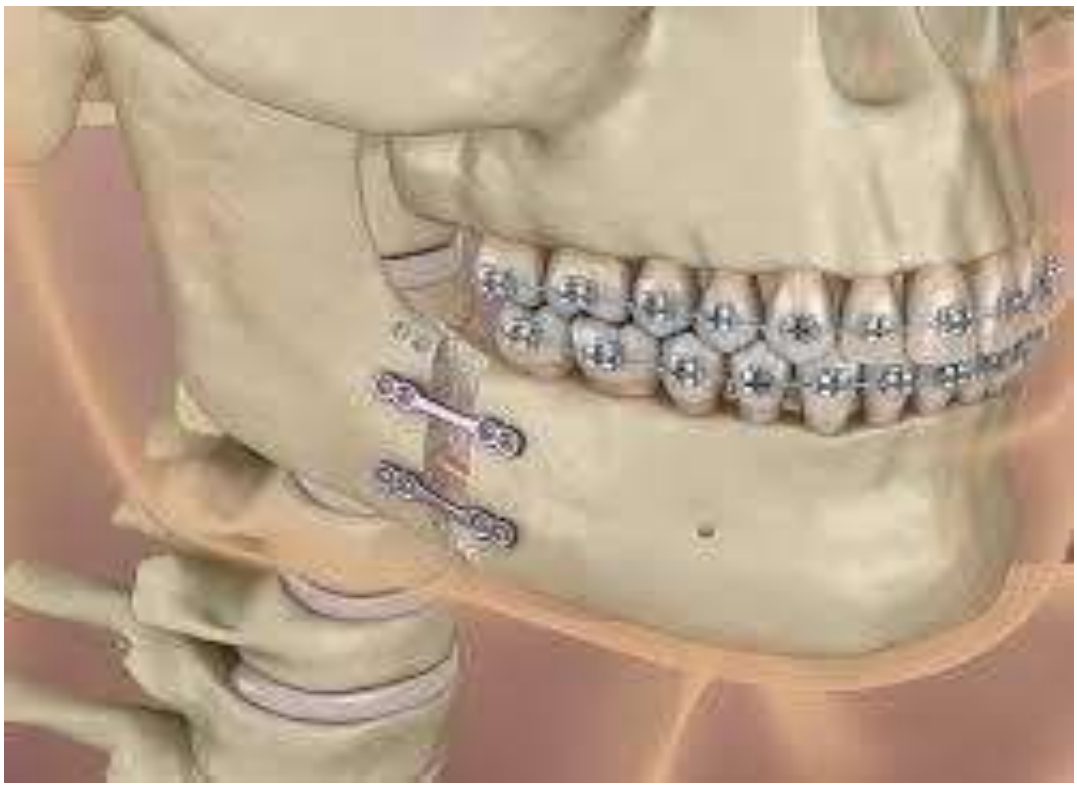

Weight Reduction

Bariatric surgery seems to give substantial reductions in the AHI and in one report surgery resolved or improved OSA in 83.6%. One recently published trial of 60 obese patients randomized to either a conventional weight loss program or bariatric surgery (follow-up 2 years) could not show any significant differences in AHI reduction between groups even though weight loss was markedly greater in the surgery group (Dixon et al., 2012). Other findings from this study were a great variability in the individual effect and that much of the benefit was associated with mild weight loss.

Even though both dietary weight loss and bariatric surgery have been shown to be effective in reducing OSA severity, many patients have residual OSA leading the authors of a recently published meta-analysis to recommend that weight reduction programs should be considered as adjunct rather than curative therapy for OSA (Anandam et al., 2012).

Positional Therapy [15]

Several methods and devices have been used to hinder POSA patients to sleep in the supine position. In 1985 Cartwright et al. evaluated an auditory supine position warner in 10 men with POSA and found a significant reduction in AHI and number of oxygen desaturations. In another study a "positioner" device- (i.e., a soft vest attached to a board placed under the pillow eliminating the possibility to supine sleep) was tried in 23 patients with POSA. Of these, 18 patients were compliant and a majority lowered their AHI to <10. The mean ESS score decreased but 50% of the patients reported increased snoring (Loord and Hultcrantz, 2007).[17] Jokic et al. (1999) compared positional treatment (sleep with backpack) with CPAP in 13 patients with POSA and found that CPAP was more effective in lowering the AHI and increasing minimum oxygen saturation. No difference was found concerning sleep architecture, ESS, MWT, or quality of life measures.

A thoracic anti-supine band improved AHI in POSA patients but to a lesser extent than CPAP (Skinner et al., 2008).A supine vibration alarm attached to the sternum was found to significantly reduce the AHI albeit with persisting snoring in 15 POSA patients (Bignold et al., 2011)[17].

II. CONCLUSION

OSA is characterized by breathing and sometimes pronounced body and arm movements. The victim may wake up suddenly with choking sensations, gasping Conclusion 83 for air, or in a sweat, other symptoms may be frequent napping during the day, especially in inappropriate places (like meetings, or while driving), memory problems, lack of concentration, high blood pressure. Many of these symptoms can also be

caused by many other conditions, so diagnosis may be difficult. Orthodontic diagnosis may discover anatomic conditions that could cause this condition. Enlarged tonsils or adenoids in a lateral cephalometric radiograph, or maxillary width deficiency and narrow nasal cavity in a P.A. radiograph, are indications for questioning the patient about other symptoms. All orthodontists should consider incorporating OSA screening into their history-taking and examination of patients. When an orthodontist has a clinical suspicion that a patient may have OSA, it is strongly recommended that referral to a physician be made; a sleep medicine physician is preferred. The definitive diagnosis of OSA should be made by a physician. Individual orthodontists may elect to participate Conclusion 84 in the treatment and monitoring of OSA patients as appropriate and permissible under applicable laws, standards of care, and insurance coverages:

1. It is strongly recommended that orthodontists be familiar with the signs and symptoms of OSA.
2. It is strongly recommended that orthodontists screen patients with regard to the signs and symptoms of OSA. A thorough history and clinical examination are critically important in that they establish the presence of preexisting conditions, a basis for diagnosis, the need for referral, and a baseline for evaluating the effects of treatment.
3. It is strongly recommended that the orthodontist refer patients with risk factors for OSA to a physician for further evaluation and a definitive diagnosis. A sleep medicine physician is preferred.
4. It is recommended that the orthodontist refer pediatric patients with nasal obstruction or adenotonsillar hypertrophy to an otolaryngologist.
5. It is recommended that the orthodontist refer adult patients to an otolaryngologist when nasal obstruction or adenotonsillar hypertrophy is present.
6. The decision for an orthodontist to participate in the treatment of OSA is a choice that should be made based on interest as well as training, skills, experience, laws, standards of care, and insurance coverage applicable to the orthodontist.
7. If involved in the treatment of OSA, an orthodontist should monitor OA treatment efficacy
8. An orthodontist may elect to manage adverse side effects of OA therapy.
9. No orthodontic treatments have been shown to cause or increase the likelihood of OSA. Rather, some forms of orthodontic treatment have been shown to be important in the treatment of OSA.
10. Interdisciplinary treatment of OSA helps to serve the best interests of patients with OSA.

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