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Sleep apnea and orthodontics

(Review Study)

A Project Submitted to

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Certification of the Supervisor

I certify that this project entitled "**Sleep apnea and orthodontics**" was prepared by the fifth-year student **Mena Mohammed Moslem** under my supervision at the College of Dentistry/University of Baghdad in partial fulfilment of the graduation requirements for the Bachelor Degree in Dentistry.

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Date

Dedication

This work is dedicated to my parents who have never failed to give me financial and moral support, for giving all my needs during the time we developed our system and for teaching me that even the largest task can be accomplished if it is done one step as a time. I dedicate this Project to all the people who have worked hard to help me to complete this project.

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By the name of God, it is by his grace that the current review has come to exist.

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Finally, I offer my regards and blessing to my family for their support and encouragement.

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List of abbreviations

abbreviations	Meaning
SRBDs	Sleep Related Breathing Disorders
OSAS	Obstructive Sleep Apnea Syndrome
AHI	Apnea Hypopnea Index
OSA	Obstructive Sleep Apnea
RDI	Respiratory Disturbance Index
UA	Upper Airway
BMI	Body Mass Index
CT	Computed Tomography
CBCT	Cone Beam Computed Tomography
2D	Two Dimensions
3D	Three Dimensions
COVID-19	Corona Virus Disease in 2019
RAAS	Renin Angiotensin Aldosterone System
ACE	Angiotensin Converting Enzyme
SARS COV-19	Severe Acute Respiratory Syndrome Coronavirus in 2019
GH	Growth Hormone
PAP	Positive Airway Pressure
CPAP	Continues Positive Airway Pressure
OA	Oral Appliance
RME	Rapid Maxillary Expansion
EMA	Elastic Mandibular Advancement
MRD	Mandibular Repositioning Device
RERAs	Respiratory Events Related Arousals
UAS	Upper Air way Stimulation
HNS	Hypoglossal Nerve Stimulation
FDA	Food and Drug Administration

Introduction

Sleep apnea is represented as the cessation of breathing on a regular basis while sleeping. This can occur for a brief period from a few seconds to more than a minute, and it can happen hundreds of times during a sleep cycle **(Ronald and Dennis, 2010).** Since much of the upper airway is part of the craniofacial complex, the orthodontist can observe the airway and modulate it in case of potential obstructions **(Graber, 2019)**. When nasal obstruction occurs, the body is forced to breathe through the mouth, this switching of breathing through mouth habitually makes the person more attributable to nasal obstruction and more likely to have sleep disorder **(Graber, 2017).**

The name "sleep apnea" comes from the fact that people with it stop breathing while sleeping, missing multiple cycles of respiratory activity before waking up gasping for breath. The issue is a blockage or severe narrowing of the airway, which can occur anywhere between the nostrils and the lungs but is most commonly found in the upper pharynx to midpharynx, where the tongue can intermittently block the pharyngeal airway when muscle relaxation causes the mandible to drop backward during sleep **(proffit, 2019)**.

Sleep disorders are not only common in the general population, but they also have the potential to have a considerable influence on both an individual's health and society. Sleep issues can affect a person's quality of life and daily performance in education, driving or operating machines, the workplace, and relationships. The dentist's involvement in identifying individuals at risk for sleep apnea and other sleep-related breathing disorders (SRBDs) including snoring is now well established. A dentist is just as likely as a physician to spot who is at risk for obstructive sleep apnea **(Ronald and Dennis, 2010).**

Stanford University Medical School has emphasized the importance of multidisciplinary collaboration in the treatment of breathing-related sleep disorders and that children with mild between obstructive sleep apnea syndrome commonly present with airway obstruction due to nasal septum deviation and a narrow upper jaw in several reports. It was also stated that the function of craniofacial anomalies and the influence of orthodontics in children with obstructive sleep apnea has often been overlooked until now, despite their impact on public health **(Christian, 2010).**

Aim of study

To study the etiological factors, pathogenesis,methods of detection of sleep apnea, the effect of sleep apnea on teeth and dentoalveolar bone, orthodontist role in detection and treating sleep apnea and to discuss the treatment methods of sleep apnea.

CHAPTER 1: REVIEW OF LITERATURE

1.1 Definition

Is a condition involving intermittent collapse of the pharynx, usually at the level of soft palate, causing episodes of apnea during sleep **(Longmore, 2010).**

Muscle tone declines during sleep and thus, upper airway dilating muscles are unable to maintain pharyngeal patency. In severe cases, the patient wakes up briefly multiple times during the night to allow dilating muscles to re-open the airway. This results in severe sleep fragmentation leading to symptoms such as daytime somnolence, morning headaches and decreased cognitive performance **(Colledge *et al*., 2010)**.

1.2CLASSIFICATION OF SLEEP APNEA

Three types of apneas may be observed during sleep:

1.2.1 Obstructive sleep apnea

Occurs when airflow is absent or nearly absent but ventilator effort persists. It is caused by complete, or nearly complete, upper air way obstruction **(Graber, 2017).** Due to the rattling of the tongue and soft palate, Obstructive sleep apnea can cause snoring. It can also make a person feel as if they are unable to breathe when they wake up. The lungs function normally, and the body tries to breathe, but it is impossible to get enough air into the upper airway **(Zawn, 2021)**.

Obstructive sleep apnea gets more common as individuals become older, and it's more common in men, people who are overweight, pregnant women, and those who sleep on their backs **(Schmidt *et al*., 1990; Nagayoshi, 2011).**

1.2.2 Central sleep apnea

Central apnea occurs when both airflow and ventilator efforts are absent **(Graber, 2017).** It does not, however, develop as a result of upper airway obstruction. Rather, the source of the problem is neurological. In contrast to obstructive sleep apnea central sleep apnea causes no snoring since the body does not try to breathe. Instead, the person stops breathing because the brain and nervous system do not consistently provide a signal to do so (**Zawn, 2021).**

1.2.3 Mixed Sleep apnea

It is a mix of intervals during which no respiratory efforts occur (i.e., central apnea pattern) and intervals during which obstructed respiratory efforts occur (**Graber, 2017)**. In other words, it combines between obstructive sleep apnea and central sleep apnea. Sometimes, mixed sleep apnea syndrome is obvious in an initial sleep study. Other times, it becomes apparent after the apnea does not resolve with a typical continuous positive air way pressure machine or other traditional obstructive sleep apnea treatments **(Zawn, 2021).**

1.3 Methods of detection of sleep apnea

1.3.1 Apnea-Hypopnea Index (AHI)

The AHI is the total number of apneas and hypopneas per hour of sleep. The AHI is most commonly calculated per hour of total sleep and is the current defining measure of disease and disease risk **(O'Connor *et al*., 2009; Redline *et al*., 2010).** If AHI values are 4 or less, then the patient is within normal limits. OSA is mild when the AHI reflects 5 to 15 episodes per hour of sleep, moderate when the AHI reflects 15 to 29 episodes per hour of sleep, and severe when the AHI reflects 30 and higher episodes per hour of sleep **(Ruehland *et al*., 2009).**

1.3.2Respiratory Disturbance Index (RDI)

It is generally larger than the AHI, because the RDI considers the frequency of RERAs, whereas the AHI does not**.** The RDI is the total number of events (apneas, hypopneas) per hour of sleep. OSA severity is defined as mild when the RDI reflects 5 to 15 episodes per hour of sleep, moderate when the RDI reflects 15 to 30 episodes per hour of sleep, and severe when the RDI reflects 30 or more episodes per hour of sleep **(Berry *et al*., 2007).**

1.3.3 Reporting oxygen saturation

The oxygen desaturation index is the number of times that the oxygen saturation falls by more than 3% to 4% per hour of sleep. The percent of sleep time during which oxygen saturation is <90% quantifies the exposure to hypoxemia. This measures and mean oxygen saturation are associated with a risk for cardiovascular disorders and glucose intolerance **(Punjabi and Polotsky, 1985).**

1.4 Clinical presentation of sleep apnea

The most well-known symptoms are stentorian snoring and extreme sleepiness; however, both snoring and sleepiness may be denied or minimized by the patient, or they may be less noticeable than other symptoms including insomnia, weariness, or inattention.Given the ubiquity of sleep loss, sleepiness may develop into fatigue over time or sleepiness may be seen normal **(Graber, 2017).**

Other common reports in adults include: **(Graber, 2017)**

• Physically restless sleep and reports of insomnia

• Morning dry mouth or sore throat from mouth breathing after recovering from apnea and/or hypopnea

• Morning confusion and headache from increased carbon dioxide levels

• Personality changes (irritability and distracted demeanor) and judgment changes as a result of sleepiness

• Night sweats, secondary to increased work of breathing

•Erectile dysfunction, especially in the setting of hyperlipidemia

1.5 Orthodontic examination

The following were the findings of a clinical orthodontic examination based on the authors' diagnostic criteria **(Gianni *et al.*, 1980; Di Malta *et al.*, 1992).**

1.5.1 Extraoral examination

Reveals the usual facial features of oral breathers, including:

- flattening of the center part of the face
- labial incompetence with hypotonia of the upper lip, and an increase in the nasal-labial angle as a result.

1.5.2 Intraoral examination

Presence in all cases of narrowness of the upper jaw with an ogival palate pattern resulting from a high and narrow palatal arch. This narrowness was clinically present in most of the treated cases with a malocclusion characterized by unilateral or bilateral crossbite and often by an anterior crossbite **(Christian, 2010).** The narrowness of the upper jaw was diagnosed clinically and confirmed by cephalometric assessment according to Ricketts parameters in posteroanterior cephalograms **(Langlade, 1979).**

1.5.3 Radiographs

were used in an orthognathic study, which comprised not only the standard examination, such as posteroanterior cephalographs and intraoral radiographs, but also CT scans. Except for CT Dentascan, all investigations were performed (1) prior to orthodontic therapy (pretreatment T0); (2) one month (T1) following therapy, with the device still in place; and (3) four months after the end of orthodontic treatment, which lasted six to twelve months**(Christian, 2010).**

1.5.4 Physical Characteristics

Obesity should be assessed when the patient first visits the clinic. Body mass index (BMI) and neck circumference are the greatest indicators for the presence of OSA, according to recent review papers offering clinical prediction models **(Sutherland *et al*., 2012).** BMI is computed by multiplying a person's weight in kilograms by the square of their height in meters (kg/m2). BMI is a straightforward method of calculating body fat based on weight and height; however, it is not always accurate because weight includes both muscles and fat **(Su-Jung and Ki Beom, 2020).** But, Neck size is an important predictor of sleep apnea and, in some cases, is a better predictor than body mass index, presumably because additional tissue can influence the size **(Graber, 2017)**.

1.6 Risk factors

1.6.1 Risk of orthodontic extraction of premolars in causing sleep apnea

An earlier study compared pre- and post-treatment cephalometric radiographs to see if there were any significant differences in nasopharyngeal dimensions and total airway length. There was no statistical difference between the pre- and post-treatment groups **(Sharma**

***et al*., 2014).**One possible explanation is that the position of the tongue during total retraction of anterior teeth during orthodontic treatment has no effect on nasopharyngeal dimensions. However, following orthodontic therapy, the velopharyngeal, glossopharyngeal, and pharyngeal airways narrowed after extraction treatment **(Rodgers, 2017).**

Another study found that when the incisors were fully retracted, the velopharyngeal and glossopharyngeal airway space decreased **(Bhatia *et al*., 2016).**

It is crucial to note that, while previously considered as an acceptable method, a 2D evaluation by cephalometric analysis is still relatively limiting and would benefit from 3D evaluations to estimate total airway space. In contrast to the previous study by **Valiathan *et al*.** in **2010** found no significant variation in oropharyngeal airway space between initial and final therapy in two separate groups, extraction and non-extraction. **(Valiathan *et al.*, 2010).**

To date there is no proof that orthodontic premolar extractions directly induce obstructive sleep apnea. Although a large number of research have looked at upper airway dimensions using cephalometry or CBCT, there is relatively little evidence on the association between orthodontic premolar extractions, respiratory function, and obstructive sleep apnea **(Hu Z *et al*., 2015).** As a result, it's critical to recognize that, even if premolar extractions and incisor retraction reduces certain dimensions within the upper airway, there's no evidence that this reduction would predispose the airway to collapse, resulting in OSA. More 3D studies that use diagnostic and assessment approaches while monitoring direct sites of airway blockages during sleep are considered essential (**Valiathan *et al.*, 2010)**.

1.6.2 Sleep apnea and covid-19

Several mechanisms have been proposed to explain the link between obesity, cardiovascular disease and Covid-19, including low-grade chronic inflammation, chronic hypoxemia and oxidative stress and involvement of the renin angiotensin aldosterone system (RAAS) linked to expression of ACE2, the cellular receptor of SARS-CoV-2. However, the contribution of these mechanisms to Covid-19 pathology remain to be resolved **(Lighter *et al*., 2020)**. Intermittent hypoxemia is one of the main pathologic features of OSA and could potentially worsen hypoxemia caused by Covid-19.OSA is also related to chronic inflammatory state and is associated with increased levels of proinflammatory markers such as ferritin, interleukin-6 and leptin, which may contribute to the risk for cytokine storm in Covid-19**(McSharry and Malhotra, 2020)**. Hypercoagulability is another pathophysiologic feature shared by both Covid-19 and OSA **(Ip MS *et al*., 2000; McSharry and Malhotra, 2020).**

1.6.3 Obesity and sleep apnea

Obesity becomes a major risk factor for development of a type of sleep disorder called Obstructive Sleep Apnea and progression **(Zaman, 2019)**. Due to fat deposition in the tissues of upper airway, it leads to smaller lumen and increased chances of collapsibility of the airway, further developing apnea. Also, the fat which deposits around abdomen reduces chest compliance and functional residual capacity in lungs leading to slight increase in the oxygen demand. Visceral obesity is the most common found in people suffering from OSA **(Zaman, 2019)**.

1.6.4 Acromegaly and sleep apnea

Acromegaly is a disease characterized by the excessive secretion of growth hormone **(Chanson and Salenave, 2008).** Patients with acromegaly present with several characteristics than can contribute to development of sleep disturbances **(Bottini *et al*., 2003).** The proliferation of soft-tissue in the upper airway contributes to airway narrowing and may lead to partial or complete airway obstruction during sleep **(Mickelson *et al*., 1994).**

It has been reported a prevalence of sleep hypoxemia in 41% of acromegaly patients, and many agree that the prolonged exposure to low oxygen levels may be the underlying cause for increased mortality rate in those patient seep **(Rodrigues *et al*., 2007).**

The transsphenoidal pituitary surgery remains the main treatment option for GH-secreting tumors. It remains unclear whether the treatment of acromegaly via transsphenoial pituitary surgery can have long-term beneficial effects in reducing the severity and morbidity of OSAS **(Chanson and Salenave, 2008).**

1.6.5 Pleomorphic adenoma and sleep apnea

Pleomorphic adenoma is a benign salivary gland tumor known for its pleomorphic appearance under light microscopy **(Agius *et al*., 2018).** Up to 2005 only 30 cases of obstructive sleep apnea caused by head and neck tumors have been reported **(Rada, 2005).**

In rare occasions, obstructive sleep apnea is a result of anatomical abnormalities such as a mass in the upper aerodigestive tract. Apart from obstructive sleep apnea, tumors of this location may also cause dyspnoea, dysphagia and airway obstruction(http://www.springer.com/medicine/surgery/journal/12663).

1.7 Memory and sleep apnea

Sleep is known to play a role in memory formation of newly learned information **(Harand *et al*., 2012).** The disruption of normal sleep architecture (disrupting sleep cycles and stages) produced by frequent arousals induced by apneas and hypopneas is referred to as sleep fragmentation **(Cheshire *et al*., 1992).** Among the most common ailments affecting older adult's quality sleep are insomnia, sleep-disordered breathing encompassing obstructive sleep apnea **(Monjan, 2010).**

1.7.1 The Effect of OSA on Verbal Memory

The ability to recall verbal information immediately after it was presented was significantly impaired in individuals with OSA compared to both controls and norms. The effect found in the present study is likely to be due to two factors: analyzing verbal immediate recall independently of short-term working memory, verbal learning, and cued recall; and the greater number of studies included, thus adding more power to the present analysis. In addition to difficulties recalling information immediately, individuals with OSA were significantly impaired when recalling verbal information following a delay compared to controls or norms. Impaired delayed recall can result from inefficient storage of information impeding retrieval, poor retention of information in long-term memory, or difficulties with retrieving information once stored **(Wallace *et al*., 2013).**

1.7.2 The Effect of OSA on Visual Memory

Visual memory was distinguished from visuo-spatial memory in the current meta-analysis. Visual memory requires participants to recall visual material. Individuals with OSA showed intact visual immediate recall compared to norms and controls. At least two studies are required to conduct a meta-analysis, and this criterion was not reached for any other aspect of visual memory **(Wallace *et al*., 2013).**

1.7.3 The Effect of OSA on Visuo-spatial Memory

Similar to the verbal domain, the effect sizes for visuo-spatial memory were comparable for the immediate-recall and delayed-recall domains. This suggests individuals with OSA have an encoding deficit that affects recall of both visuo-spatial and verbal information. Taken together, the visual and visuo-spatial memory analyses reveal evidence of intact immediate visual recall but impaired immediate and delayed visuo-spatial recall in OSA compared with controls **(Wallace *et al*., 2013).**

1.8 Treatment options

1.8.1 Life style and behavioral modification

Weight loss to a BMI of 25 kg/m2 or less, exercise, positional therapy during sleep, and avoidance of alcohol or sedatives before bedtime are all lifestyle alterations or behavioral treatments that can aid in OSA treatment **(Epstein *et al*., 2009).** Weight loss alone has not shown success in solving OSA; therefore, it should always be accomplished in conjunction with other therapy **(Timothy *et al*., 2006).** Sleeping in a supine position can affect the size and patency of the airway, enabling all structures to collapse. A way of keeping the patient sleeping in a nonsupine position is known as positional therapy. Positional therapy does not always work; as a result, polysomnography should be done in both the supine and nonsupine positions before choosing whether it will be used as a primary or secondary therapy for a patient. Objects such as tennis balls, pillows, or a backpack can be used to keep the patient from sleeping in a supine position **(Pevernagie *et al*., 1995).**

1.8.2 Molar crossbite correction and sleep apnea

It was found The likelihood of additional alleviation of a constricted airway after maxillary expansion and orthodontic therapy is of particular relevance for a sleep apnea patient with a clinical presentation of a narrow maxilla and accompanying bilateral molar crossbite **(Allen *et al*., 2003; Ennedy *et al*., 2005).**

The application of orthodontic system Fastbraces, a new technology system of braces that uses torque to facilitate root up righting and thus alveolar bone remodeling and development, thereby correcting transverse discrepancies, also correcting an associated anterior open bite in a short treatment time **(Viazis *et al*., 2016).** Because of the link between upper airway structure and sleep-disordered breathing, particularly obstructive sleep apnea, there is a growing body of study and interest in upper airway shape and dimensions **(Katyal *et al*., 2013; Flores *et al*., 2013).**

When comparing sleep apnea and healthy patients, the analysis and upper airway measurement of landmarks on cephalograms shows a definite tendency for sleep apnea patients to have reduced airway dimensions **(Young *et al*., 1993; Kim *et al*., 2004).** Despite the patients may did not have any signs or symptoms of sleep apnea, compared pre and post therapy cephalograms show a wider upper airway opening between the dorsum of the tongue and the posterior pharyngeal wall. While additional clinical research is necessary this treatment presents a possible adjunctive benefit to the sleep apnea **(Viazis *et al*., 2016).**

1.8.3 Positive airway pressure

Continuous positive airway pressure therapy is highly efficacious and currently the reference standard of treatment in preventing airway collapse. Early Continuous positive airway pressure systems and masks were cumbersome and intrusive, but newer systems are light, less noisy, and easier to use. Nonetheless, many patients find the system difficult to tolerate **(Yetkin *et al*., 2008; Weaver and Grunstein, 2008).**

Delivered as continuous, bilevel or autotitrating modes. The airway pressure can be applied through nasal, oral, or oronasal mask. PAP therapy is also indicated for improving sleepiness and quality of life and as an adjunctive therapy to lowering blood pressure in patients with OSA who also have hypertension **(Graber, 2017).**

Figure 1: An example of a PAP device without a humidifier **(Ronald and Dennis, 2010).**

Figure 2: An example of a PAP device which incorporates a built-in heated humidifier **(Ronald and Dennis, 2010).**

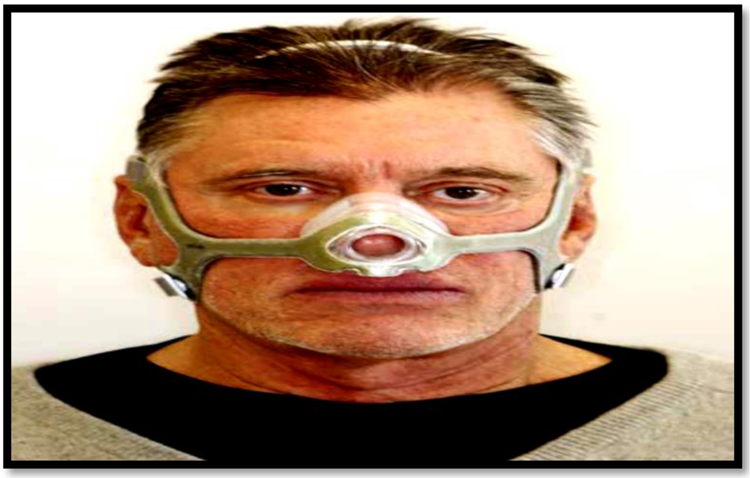


Figure 3: The CPAP device fits over the lip and the labial surface of teeth

(Graber, 2017)

1.8.4 Oral appliance

As a general rule, patients with severe OSA are not treated with oral appliance because of the concern that failed treatment or partial treatment may lead to respiratory failure **(Graber, 2017).**

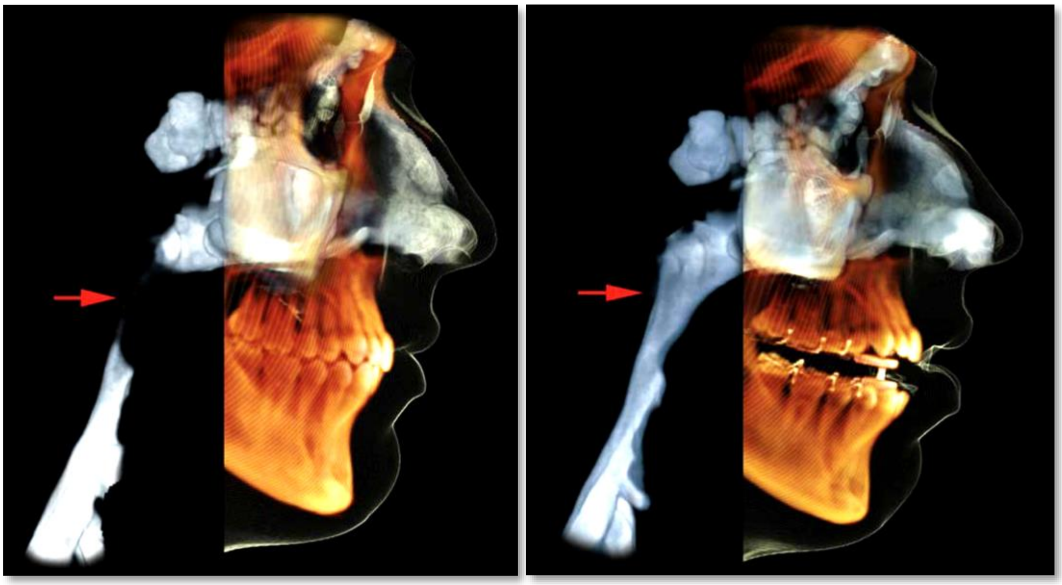


Figure 4:Three-dimensional images show the patient's airway without and with an oral appliance. **(Graber, 2017).**

The three general groups of oral appliances that are available include soft palate lift devices, tongue retention devices, and mandibular advancement splints **(Graber, 2017).** A cross-over clinical trial comparing different OA designs found mandibular advancement splints to be an effective alternative in treating patients with severe obstructive sleep apnea, whereas tongue retention and soft palate lift devices did not achieve satisfactory results **(Annapurna *et al*., 2014)**.

Mandibular advancement splints are the predominant type of oral appliances used in clinical practice and have shown the best results **(Barthlen *et al*., 2000)**.

Mandibular advancement splints effects include:

1. Enlargement of velopharyngeal airway caliber in the lateral dimensions **(Chan *et al*., 2010 A; Chan *et al*., 2010 B).**
2. Increasing UA neuromuscular tone.
3. Stimulation of UA dilator muscles **(Tsuiki *et al*., 2007).**

Mandibular advancement splints can be one piece (monobloc) or two pieces (bibloc) in design, custom-made or prefabricated, and titratable or nontitratable **(Graber, 2017).**

A B

Figure 5: a) Sagittal view of EMA.(b) Lingual view of EMA
(Ronald and Dennis, 2010)

Rapid maxillary expansion:

Is a therapeutic procedure that the authors successfully performed for many years to obtain a skeletal expansion of the upper jaw. The anatomic criteria of this technique consist in the application of orthopedic forces, through particular procedures, on the midpalatal suture. This suture is mainly made up of compact bone laterally and fibrous tissue with fibroblasts, collagen fibers, and vessels centrally **(Pirelli *et al.*, 1993; Pirelli *et al.*, 1996)**. Because of the biology of the bone, bone distraction is feasible and can be performed by exerting heavy stresses through an orthodontic device anchored to the teeth. The maxilla widens as a result of bone distraction at the suture level, increasing its cross section as well as the anatomic space of the nasal cavity.At the cross-sectional level, there is a significant increase, with a significant improvement in nasal airflow. The nasal cavities are definitely affected by increasing the cross section of the upper jaw, and it is a real anatomic alteration that results in improved upper airway patency. This increase is also the basis for the positive effects induced by the RME maneuver on the respiratory function.CT images before and after RME therapy confirm that the expansion occurs not only in the maxillary arch but also in the nasal cavity (figure 6), the widening of the nasal fossa and the septal release restore normal airflow. This anatomic change brings about an increased patency of the upper airway. This patency is the basis for the positive effects induced by the maneuver, and it acts on air exchange, with a net improvement of breathing disorders during sleep **(Christian, 2010)**.

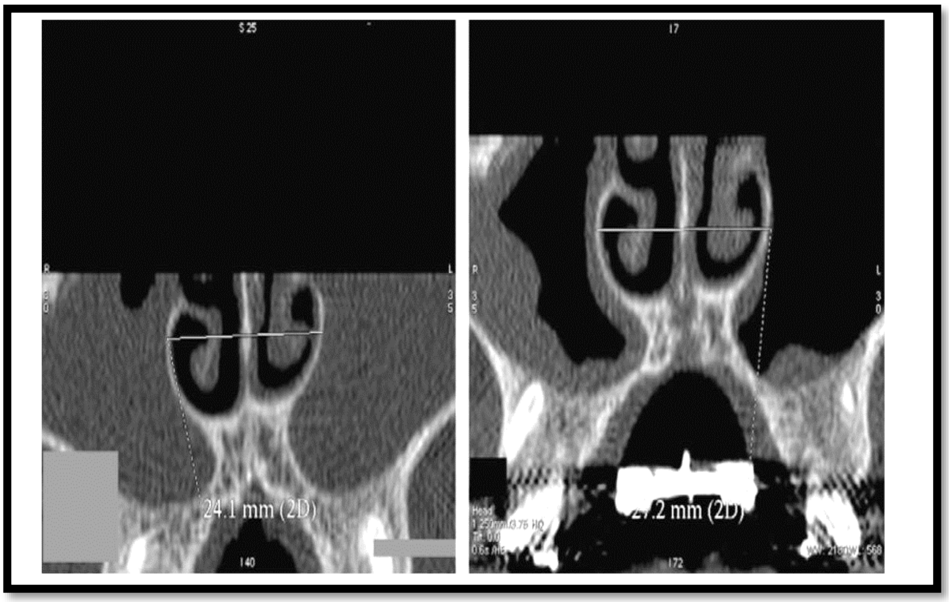


Figure 6: CT Dentascan of nasal cavity increase before and after RMA **(Christian, 2010)**

1.8.5 Orthognathic surgery

Surgical procedures may be considered as a secondary option when the patient is intolerant of CPAP or OAs or when CPAP therapy is unable to eliminate OSA **(Graber, 2017)**. Surgery may also be considered as a secondary therapy in patients with mild to moderate OSA, when the patient is also intolerant of OAs, or when OA therapy provides unacceptable improvement of the clinical outcomes **(José *et al*., 2012).**

Surgical treatment alternatives for OSA treatment include:

- **UA bypass procedure or tracheostomy:** This procedure creates an opening in the trachea to bypass the UA where obstruction is causing OSA. A tube or stoma is placed for ventilation **(Graber, 2017)**
    - **Nasal procedures**: The objective of procedures such as septoplasty, functional rhinoplasty, inferior turbinate reduction, and nasal polypectomy is to eliminate the obstruction that is preventing nasal breathing **(Sugiura *et al*., 2007; Friedman *et al*., 2011).**

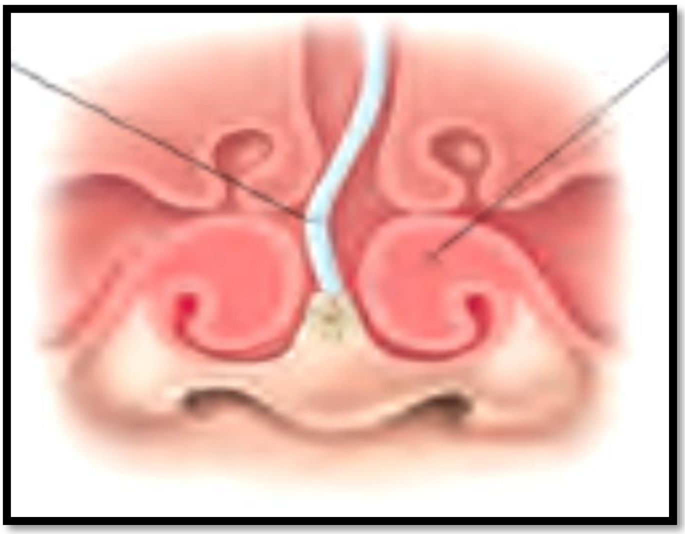


Figure 7: Frontal view of the upper airway demonstrating a deviated septum and swollen turbinates **(Ronald and Dennis, 2010).**

•**Tonsillectomy and/or adenoidectomy:** When OSA is properly diagnosed such procedures can provide significant improvements in the treatment of OSA in children and young adults **(Graber, 2017).**

1.8.6 Upper airway electrical neurostimulation

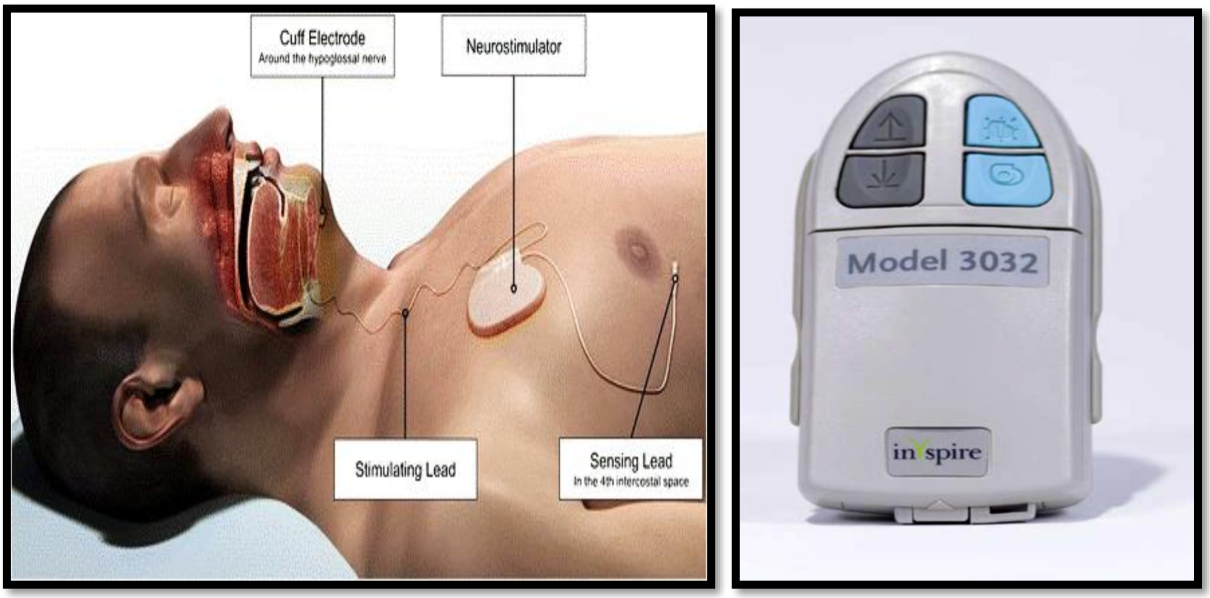
Upper airway stimulation therapy is effective for a subset of obstructive sleep apnea patients with continuous positive airway pressure intolerance **(Ryan, 2022)**. It based concept is stimulation using a unilateral implantable neurostimulator for the hypoglossal nerve **(Graber, 2017)**.

The Inspire upper airway stimulation system **(Figure 10**), which was developed by Inspire Medical Systems, was recently approved to treat moderate-to-severe OSA **(Food and Drug Administration, 2020; Inspire Medical Systems, 2020).** This device is indicated for use in OSA patients aged 22 years and older who demonstrate failure of or intolerance to PAP treatment. An AHI score of 15 to 65 with PAP use is considered treatment failure. If the patient does not use a PAP machine for more than 4 hours per night or for more than 5 nights per week, he or she is considered to be intolerant to PAP treatment. Patients aged 18 to 21 years with an AHI score of 15 to 65 may use UAS if they meet the following criteria: They are intolerant to or have failed PAP therapy; do not have complete soft-palate collapse; do not qualify for or have failed adenotonsillectomy therapy; or have exhausted all other therapeutic options **(FDA, 2020).**

Inspire UAS system device is surgically implanted in the patient's chest. After a recovery period of 1 month, the device may be activated. **(FDA, 2020 A; FDA, 2020 B)**. The device has a small generator, a breathing sensor lead, and a stimulation lead **(figure 11)**. The patient can turn on the therapy before bedtime and turn it off in the morning through a remote control **(Graber, 2017).** The patient can use it by a remote to turn the therapy on at bedtime and off upon waking **(FDA, 2020).**

Figure8: Inspire Upper airway electrical stimulation system**,** Implantable device(left), remote(right).

(Inspire **Medical Systems, 2020)**



A B

Figure 9 : Upper airway electrical stimulation. A.*(From left to right)* Stimulation lead, generator, breathing sensor lead., neurostimulator, cuff electrode B. Remote control **(Graber, 2017).**

CHAPTER 2: Discussion

The purpose of this study was to review the role of orthodontist/sleep dentist in managing of sleep apnea. A declaration is warranted. OSA, in most cases, is a chronic condition.

The sleep is an activity that takes one third of our lives, being fundamental to the maintenance of the mental, physical and emotional health of our organism, so by these frequent episodes of intermittent sleep deprivation the general condition of person affected.

The most effective treatment plans are comprehensive and multidisciplinary because OSA is a complex multifactorial condition. The sleep team, including the orthodontist/sleep dentist, mustn't be intimidated by the trial and failure nature of OSA management. If we try our best to follow evidence-based practices, we do eventually help many patients.

There are certain behavioral and systemic factors that can contribute to sleep apnea. These include: obesity, acromegaly, pleomorphic adenoma, COVID-19.

Most patients with sleep apnea are objectively sleepy, although daytime sleepiness is underreported because it generally manifests itself over a prolonged period and patients change their lifestyles gradually to compensate for it. Loud snoring, fatigue, or both are frequently the patient's only symptoms. A focused history taking and physical examination of patients who report such symptoms may aid in identifying persons at risk for sleep apnea. Other patient characteristics associated with sleep apnea include male sex; age of more than 40 years; habitual snoring; nocturnal gasping, choking, or resuscitative snorting; observed apnea; and a history of systemic hypertension. Symptoms of daytime somnolence, unrefreshing sleep, morning headaches, cognitive impairment, depression, nocturnal esophageal reflux, and nocturia are commonly reported, but do not distinguish sleep apnea from other, nonpulmonary, sleep disorders.

The Inspire Upper Airway Stimulation (UAS) device (also called Hypoglossal nerve stimulation or HNS device). It is FDA approved and it is the newest option for obstructive sleep apnea treatment. The device is implanted in the chest and works to stimulate the tongue to keep the upper airway open during sleep.

CHAPTER 3: Conclusions

- Sleep disorders, most commonly OSA, affect a great portion of the adult population.
- The airway is an integral part of the craniofacial complex, often ignored during clinical examination and when determining the diagnosis and treatment options.
- Many patients go undiagnosed. In children, airway problems reportedly have detrimental effects on craniofacial growth and development.
- The orthodontist is strategically positioned to screen children and adults. The simple incorporation of a few questions and radiographic examination are probably sufficient to identify risks and to refer for proper diagnosis. Even if the orthodontist decides not to treat an airway problem, understanding the condition for the purpose of screening and referral is still an important responsibility of the orthodontist.

Suggestions for future studying

- Looking for more treatment modalities that treat root cause of sleep apnea
- Find out methods eliminate loud snoring in patients with sleep apnea
- Studying effects of treating sleep apnea on lowering blood pressure in hypertensive patients

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