Chapter

Orthodontic Management of Adult Sleep Apnea: Clinical Case Reports

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Abstract

Obstructive sleep apnea (OSA) is a serious public health problem that has important impacts on the quality and life expectancy of affected individuals. It is characterized by repetitive upper airway collapse during sleep. OSA requires a multidisciplinary plan of treatment. There is increasing interest in the role of the orthodontist both in screening for adult obstructive sleep apnea and its management. Dental appliances and orthognathic surgery are two strategies that are currently used in the treatment of sleep apnea. This chapter focuses on the orthodontic management of sleep apnea in adults through three clinical cases with varying degrees of severity of sleep apnea. It provides a background on OSA treatment approaches and discusses the potential risks and benefits of each.

Keywords: adult sleep apnea, orthodontics, management, oral appliances, orthognathic surgery

1. Introduction

Obstructive sleep apnea (OSA) is a common sleep disorder resulting from repetitive narrowing and collapsing of the upper airway [1]. Its prevalence has increased worldwide and affects about one in four men and one in 10 women [2]. OSA is characterized by repeated episodes which lead to sleep fragmentation and oxygen desaturation. Clinically, OSA is defined by the occurrence of daytime sleepiness, loud snoring, witnessed breathing interruptions, or awakenings due to gasping or choking [3, 4]. Polysomnography (PSG) is the gold standard for OSA diagnosis and it allows to assess the apnea/hypopnea index (AHI) that is the expression of OSA severity [5]. The AHI is the mean number of sleep apneas and hypopneas per hour of sleep. The American Academy of Sleep Medicine (AASM) defines mild OSAH as an AHI of 5–15 events per hour; moderate OSAH as 15–30 events per hour; and severe OSAH as an AHI of greater than 30 events per hour [6].

The complexity of OSA is exemplified by its multifactorial etiology such as craniofacial structures and neuromuscular tone [7]. Many risk factors are associated with the occurrence of OSA: obesity (BMI > 35) with increased neck circumference, sleeping in the supine position, smoking, alcohol, type 2 diabetes, nasal obstruction (septal deviation and rhinitis), endocrine abnormalities (hypothyroidism and acromegaly), genetics (family history of OSA), and menopause [8].

Untreated OSA is associated with a range of adverse health outcomes such as cardiovascular diseases, cerebrovascular events, diabetes, and cognitive impairment in addition to impaired quality of life [9, 10].

The treatments of OSA can range from weight loss to maxillomandibular advancement. The treatment of choice is influenced by the etiology of the problem, but also by its severity and the personal yearnings [2].

The orthodontist may play an important role in both screening for OSA and the multidisciplinary management of OSA in adults. The contribution of orthodontists to the study and treatment of respiratory disorders associated with sleep focus on three aspects: the diagnosis of the structural changes often present in these diseases, the treatment of mild to moderate forms using intraoral appliances, and presurgical orthodontic treatment of patients programmed for orthognathic surgery [11]. This chapter aimed to discuss, through three clinical cases, the role of the orthodontist in the management of adult sleep apnea according to the severity of the disorder.

2. Case reports

2.1 Case 1

A 63-year-old female was referred to the Department of Dento-Facial Orthopedics of the Dental Consultation and Treatment Center (CCTD) of the Ibn Rochd University Hospital in Casablanca, Morocco. She was diagnosed with moderate OSA based on polysomnography analysis that showed an apnea-hypopnea index (AHI) of 24. Her body mass index (BMI) was 32 kg/m^2. She exhibited severe snoring and excessive daytime sleepiness. She had no history of temporomandibular disorder.

Facial examination revealed a convex profile with protrusive upper lip, retruded chin, and short throat length (**Figure 1A**). Intraoral examination revealed a full set of teeth with maxillary anterior diastema, Class I molar and canine relationships, shallow overbite, and an important overjet (**Figure 1B**). Lateral cephalometric analysis showed skeletal Class II relationship with mandibular retrusion (SNB = 74°), hyperdivergent vertical pattern (GoGn/Sn = 45°), proclined lower incisors as well as low hyoid bone position, and narrow oropharyngeal airway space, particularly at the retroglossal airway (**Figure 1C**).

The primary objective was to relieve the symptoms of OSA by using a mandibular advancement device (MAD). The dental appliance chosen was the "KASPERSKY" appliance which corrects the retroposition of the mandible and, consequently, repositions the tongue (**Figure 2**). Initially, the mandibular position of the MAD was preset at 60% of maximal protrusion. Afterward, its position was advanced by 0.5–1 mm every 1–2 weeks until the patient was satisfied with the symptoms. The anterior interocclusal space was kept at 7 mm so that the oropharyngeal airway was opened during sleep, as a result of the anterior displacement of the tongue and hyoid bone, and in turn, the mouth was inhibited from opening wide. The device was worn overnight for 4 months. Regular follow-up visits were conducted to check for any dental problems or side effects (tissue and joint pain), device wear, and to make appropriate adjustments to optimize the desired clinical effect. The patient was seen once every 6 months the first year and once annually afterward. The patient was very positive

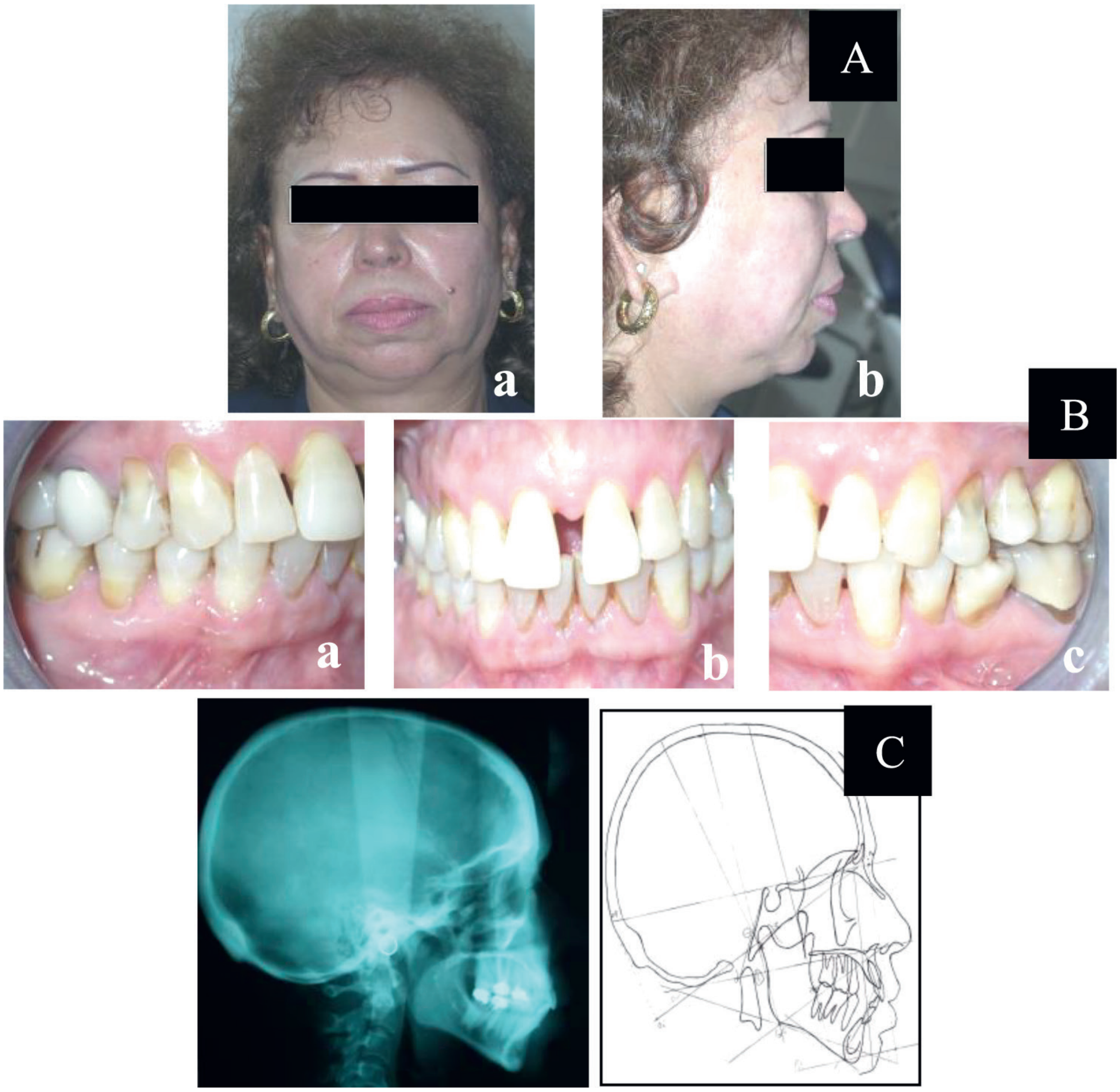

Figure 1.
(A) Pretreatment extraoral photographs: (a) frontal at rest and (b) profile. (B) Pretreatment intraoral photographs: (a) right lateral, (b) frontal, and (c) left lateral. (C) Pretreatment lateral cephalogram.

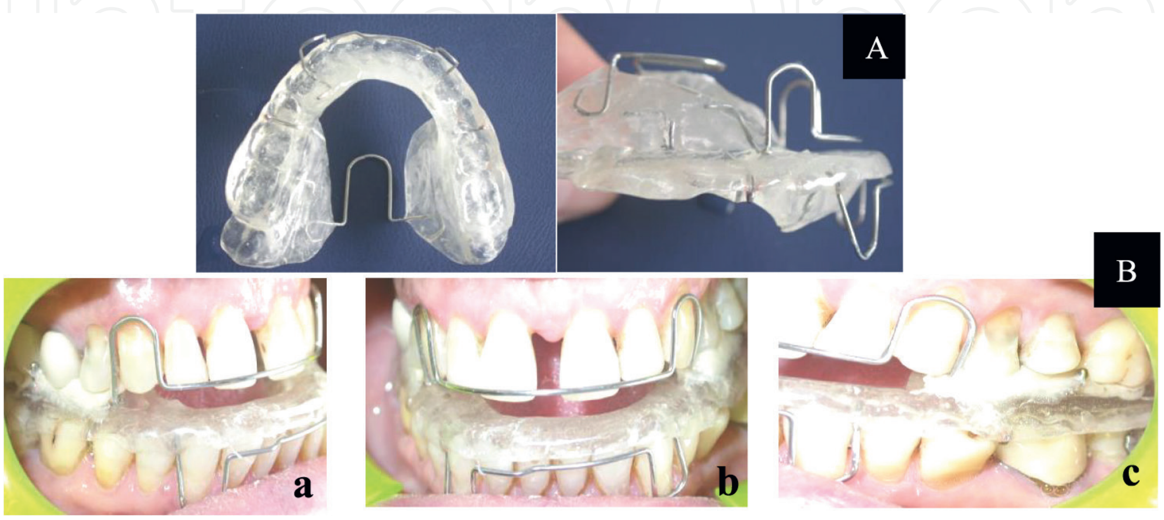

Figure 2.
(A) "KASPERSKY" appliance. (B) Intraoral photographs with the oral appliance: (a) right lateral, (b) frontal, and (c) left lateral.

about the treatment effects. Subjective improvement was noticed with the reported absence of snoring, reduction of daytime sleepiness, and reduction of tiredness. A subsequent sleep test revealed no evidence of OSA with an AHI = 2.5.

2.2 Case 2

A 35-year-old male presented to the Department of Dento-Facial Orthopedics of the Dental Consultation and Treatment Center (CCTD) of the Ibn Rochd University Hospital in Casablanca complaining of chronic loud snoring, restless sleep, and daytime somnolence. His body mass index (BMI) was 27 kg/m^2. The diagnostic polysomnography (**Figure 3D**) revealed a severe OSA with AHI of 30 events/hour. The patient was otherwise healthy and did not smoke nor drink.

Extraoral examination revealed a long symmetrical face, a convex profile with the protrusive lower lip and retruded chin (**Figure 3A**). Intraoral examination showed a full set of teeth except for the first lower left permanent molar, Class II canine relationship in both sides, and right Class I molar relationship. A slight dental crowding in the upper arch was also noted (**Figure 3B**). Lateral cephalometric analysis showed skeletal Class II relationship with mandibular retrognathia (decreased Sella-Nasion-B point (SNB) angle of 70°), hyperdivergent vertical pattern (GoGn/Sn angle of 55°), and proclined lower incisors as well as narrow oropharyngeal airway space (**Figure 3C**).

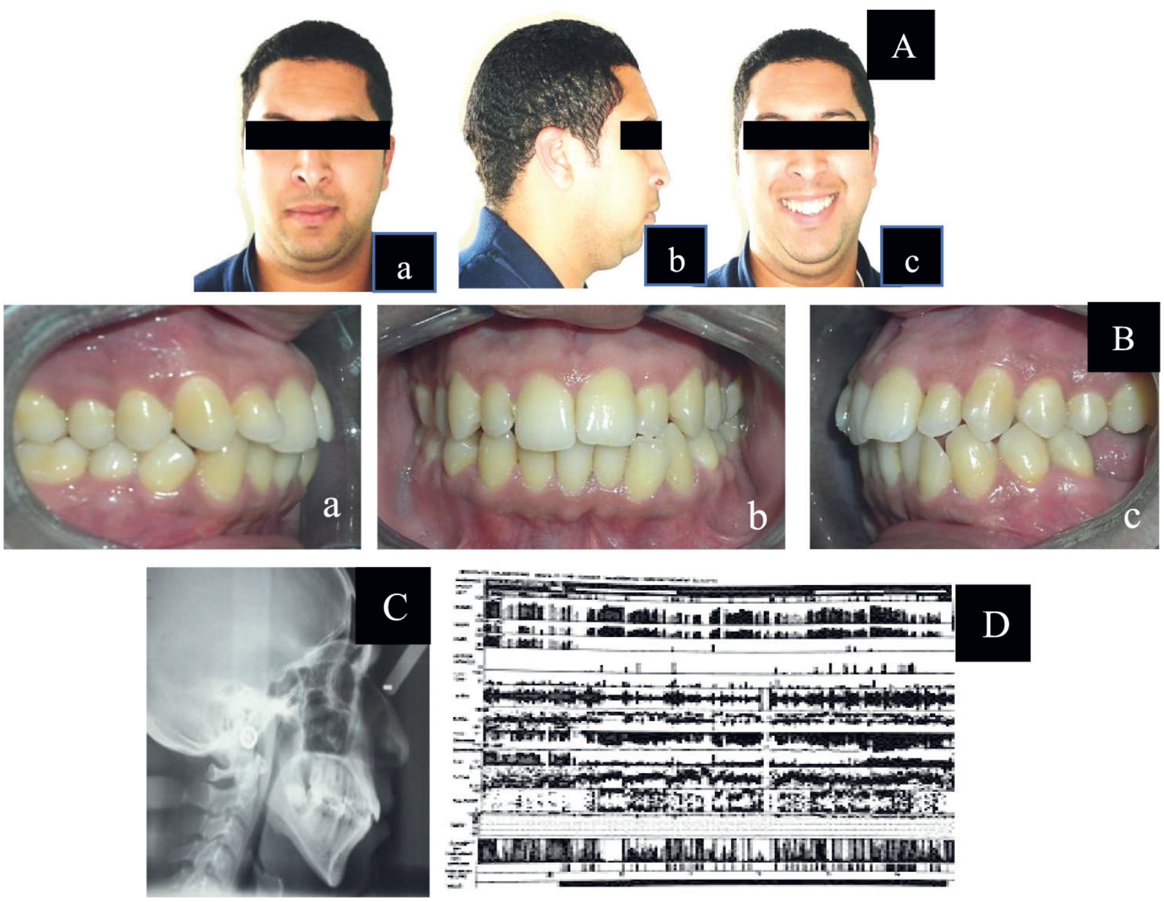

Figure 3.
(A) Pretreatment extraoral photographs: (a) frontal at rest, (b) profile, and (c) frontal smiling. (B) Pretreatment intraoral photographs: (a) right lateral, (b) frontal, and (c) left lateral. (C) Pretreatment lateral cephalogram. (D) Pretreatment polysomnography.

The primary objective was to relieve the symptoms of the severe OSA by mandibular and genioglossus advancement surgery. The presurgical orthodontic aimed to decompensate the teeth within arches and to correlate both arches. A treatment plan with the extraction of four premolars was set. After orthodontic preparation, a 9 mm mandibular advancement was performed by a bilateral sagittal split ramus osteotomy using rigid bone plate fixation associated with advancing genioplasty.

The main outcome measures were assessed by the functional, occlusal, radiographic, and esthetic changes achieved and also by a reduction in the AHI. A normal over-jet and over-bite were established, the inferior pharyngeal airway space was increased, and there was a profound esthetic profile enhancement (**Figure 4**). The patient snoring and overall AHI significantly improved; he was more rested with easy breathing.

2.3 Case 3

A 29-year-old male presented to the Department of Dento-Facial Orthopedics of the Dental Consultation and Treatment Center (CCTD) of the Ibn Rochd University Hospital in Casablanca for repetitive nocturnal apneas, gummy smile as well as unesthetic profile. His body mass index (BMI) was 22.3 kg/m^2. The diagnostic polysomnography (**Figure 5D**) revealed a severe OSA with AHI of 54.4 events/hour. The patient was otherwise healthy and neither smoke nor drink.

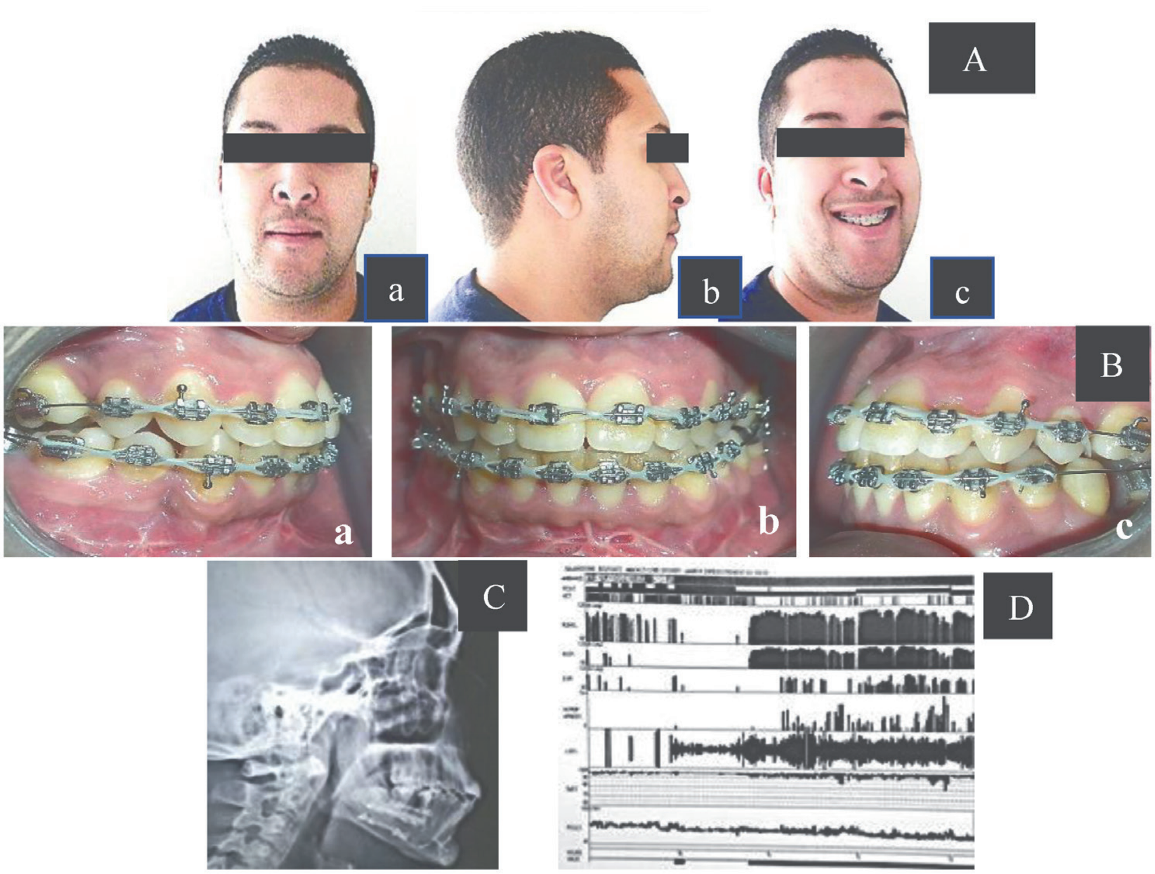

Figure 4.
(A) Posttreatment extraoral photographs: (a) frontal at rest, (b) profile, and (c) frontal smiling. (B) Posttreatment intraoral photographs: (a) right lateral, (b) frontal, and (c) left lateral. (C) Posttreatment lateral cephalogram. (D) Posttreatment polysomnography (Surgery performed by Professor Kadiri).

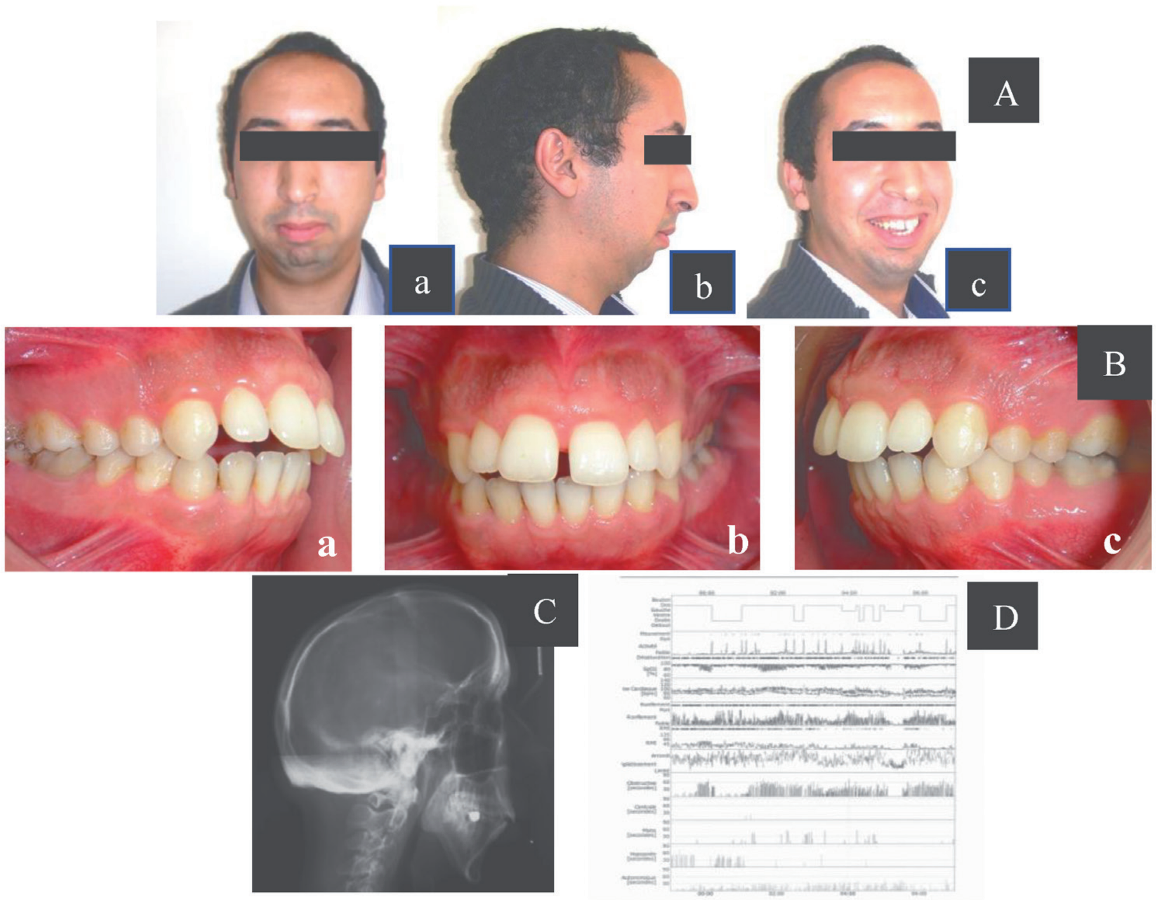

Figure 5.
(A) Pretreatment extraoral photographs: (a) frontal at rest, (b) profile, and (c) lateral smiling. (B) Pretreatment intraoral photographs: (a) right lateral, (b) frontal, and (c) left lateral. (C) Pretreatment lateral cephalogram. (D) Pretreatment polysomnography.

The patient reported a previous orthodontic treatment that relapsed. The clinical examination showed a long symmetrical face, a convex profile with lip incompetence, retruded chin, and a very poor chin-neck contour (**Figure 5A**). Intraoral examination revealed Class II canine and molar relationships in both sides, anterior open bite, important overjet, and maxillary interincisal diastema (**Figure 5B**).

Lateral cephalometric analysis showed skeletal Class II relationship with mandibular retrognathia (decreased Sella-Nasion-B point (SNB) angle of 68°), hyperdivergent vertical pattern (GoGn/Sn angle of 62°), proclined upper and lower incisors, as well as narrow oropharyngeal airway space (**Figure 5C**).

The patient received combined orthodontic and surgical treatment of his skeletal malocclusion to advance the mandible, manage the retroglossal obstruction and ensure an esthetically pleasing appearance. Presurgical orthodontic aimed to decompensate the teeth within arches and to correlate both arches, then maxillomandibular rotational advancement and advancing genioplasty were planned. The treatment led to good esthetics and well-settled occlusion (**Figure 6A** and **B**). The maxillomandibular advancement surgery (MMA) was very effective in nearly eliminating the obstructive events and in improving nocturnal breathing as evidenced by the postoperative polysomnography (**Figure 6D**). On lateral cephalometry, the posterior airway space was increased postoperatively (**Figure 6C**). The patient reported easier breathing, undisturbed sleep, and complete resolution of excessive daytime sleepiness.

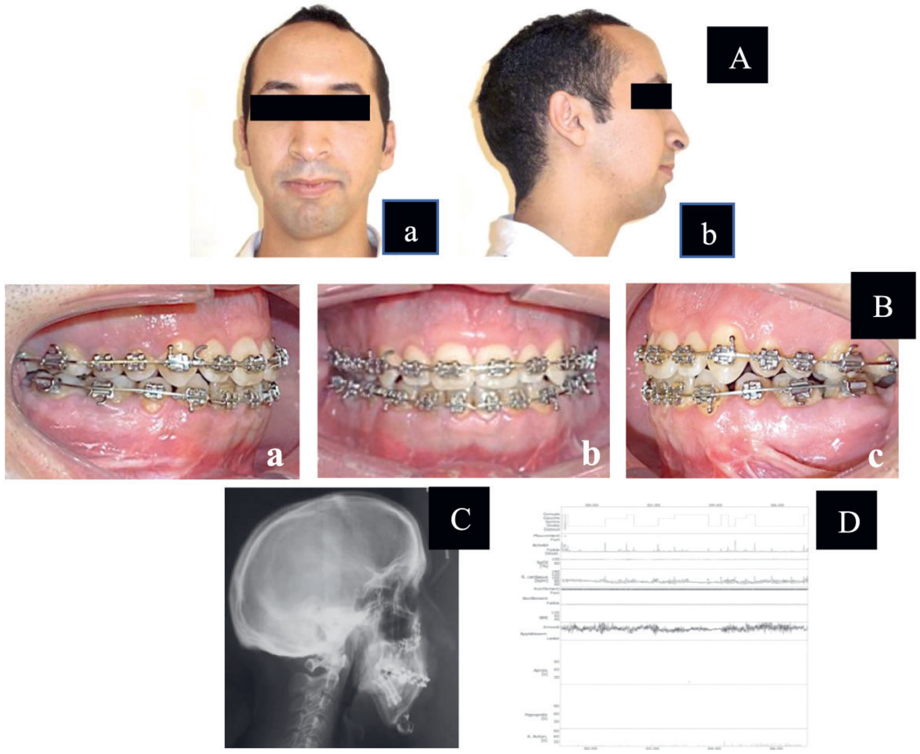

Figure 6.
(A) Posttreatment extraoral photographs: (a) frontal at rest and (b) profile. (B) Posttreatment intraoral photographs: (a) right lateral, (b) frontal, and (c) left lateral. (C) Posttreatment lateral cephalogram. (D) Posttreatment polysomnography (Surgery performed by Professor Kadiri).

3. Discussion

Obstructive sleep apnea (OSA) is a sleep disorder characterized by repeated interruption of breathing during sleep due to episodic collapse of the pharyngeal airway. The diagnostic strategy includes a sleep-oriented history, physical examination, and objective testing of the patient [12]. The gold standard for diagnosis of OSA is overnight polysomnography. The AHI, which is the mean number of sleep apneas and hypopneas per hour of sleep, is an objective and specific measure of the severity of OSA. The American Academy of Sleep Medicine (AASM) defines mild OSA as an AHI of 5–15 events per hour; moderate OSA as 15–30 events per hour; and severe OSA as an AHI of greater than 30 events per hour [6].

The orthodontist is well-positioned to perform an OSA screening assessment and refer at-risk patients for diagnostic evaluation [7]. Besides the clinical examination, some important anatomic features observed radiographically in patients with OSA include, narrow mandible arch; maxillary and mandibular retrognathism; increased lower facial height; the lower and more anterior position of the hyoid bone; reduced pharyngeal area; increased cranio-cervical angle; decreased distance between the base of the tongue and the posterior pharyngeal wall; hypertrophied tonsils and adenoids; over-erupted maxillary and mandibular dentition and enlarged tongue [4].

Besides lifestyle modification (weight loss, smoking cessation, reduction of alcohol intake, position management, and sleep hygiene), there are three major interventions for obstructive sleep apnea: positive airway pressure (CPAP) therapy, oral appliance therapy (OAT), or surgery [6, 13]. The treatment of choice is influenced by the etiology of the problem, its severity, and the patient's individual needs.

Although CPAP is widely used as a first-line treatment for OSA, OAT mainly mandibular advancement devices (MAD) are an alternative to CPAP in the treatment of mild to moderate OSA. Their lower cost, relative comfort, and ease of use lead to greater patient compliance [8]. Worn intraorally during sleep, the MAD can prevent upper airway collapse by holding the mandible and tongue forward [6].

The devices may vary in construction, material, coverage of the teeth, and the possibility of vertical and lateral movements of the mandible [14]. There are two main types of oral appliances namely: the monobloc and the bibloc appliance. A retrospective comparative study by Isacsson et al. [15] found that both the monobloc and bibloc appliances were equally effective and significantly reduced the AHI by a mean of about 12–14 events per hour.

Candidates for a MAD require adequate healthy teeth, no important TMJ disorder, adequate jaw range of motion, and adequate manual dexterity and motivation to insert and remove the OA [12]. A meta-analysis by Sharples et al. [6] found that the most important patient feature is the ability to protrude the mandible 6 mm or more. Oral appliances initially are delivered with the mandible advanced to a position approximating two-thirds of the maximum protrusion [7]. The amount of protrusion can be titrated or increased until optimum symptom relief is obtained as in the first clinical case.

Short-term side effects of MAD are common but most resolve within 2 months. They include dental and gingival tenderness, hypersalivation, dry mouth, TMJ discomfort or sounds, and myofascial pain, [16]. Skeletal changes occur soon after the onset of treatment (6 months). Small but statistically significant increases in face height are accompanied by a significant downward position of the mandible secondary to dental changes [17]. Occlusal changes start happening later on, and they will be significant at the 30-month follow-ups [4]. They include a decrease in overjet, proclination of mandibular incisors, retroclination of the maxillary incisors, decreased occlusal contacts, and mesial shift of the molar and cuspid occlusion [16]. Some effects can lead to beneficial orthodontic changes in Class II division one patients, as in the first clinical case, especially decreasing in overjet and the tendency toward a mesiocclusion [17]. The dental situation needs to be carefully checked during regular visits. In cases of unacceptable, progressive occlusal alterations, the indication for therapy with an OA has to be re-evaluated and might be changed to CPAP or even surgery [18].

If MADs are preferentially indicated for mild or moderate OSA, orthognathic surgery may be an effective and safe treatment in patients with severe sleep apnea as in cases 2 and 3 or in patients who do not desire or cannot tolerate long-term CPAP therapy. The principle of surgical treatment is to get a physical airway by a permanent skeletal change that leads to soft tissue adaptation [3]. Of the surgical procedures, mandibular advancement, maxillomandibular advancement (MMA), and genioplasty are the most frequently performed. In OSA patients with micrognathia or retrognathia the surgical mandibular advancement may be considered. In case two, mandibular and genioglossus advancement surgery illustrated objective improvement in the symptoms associated with severe OSA. With this type of surgical intervention, the entire body of the mandible is brought forward [19]. Presurgical orthodontics is mandatory, otherwise, the width of the maxilla is typically too narrow to accommodate the advanced mandible [20]. However, little evidence is present for isolated mandibular advancement. Currently, osteotomy of maxillo-mandibular advancement (MMA) is the first-choice treatment for severe OSA. Chang et al. [9] reported success rate of MMA ranges from 75 to 100%. Moving the jaw stretches the palatine tissue, which in turn exerts traction upon the palatoglossal muscle and increases lingual support, favoring pharyngeal patency [11]. MMA predictably leads to significant improvements in daytime sleepiness, QOL, sleep-disordered breathing, and neurocognitive performance, as well as a reduction in cardiovascular risk (blood pressure) [21]. The AHI score is improved over the long term and the results remain stable over time.

According to Calero et al. [11], two characteristics must be fulfilled to indicate MMA. First, there must be multiple sites of obstruction, or blockage must be diffuse and inaccessible. Second, the patient must present skeletal class II malocclusion, and MMA surgery must offer multiple benefits for the patient. Presurgical orthodontic therapy aims to obtain complementary maxillary and mandibular dental arches. Patients with a Class II malocclusion, as in the third clinical case, undergo surgical mandibular advancement to achieve a Class I dental and skeletal relationship. Advancement of the maxillomandibular complex by 8–12 mm is generally required to obtain the intended result [22]. According to Lee et al. [23], a non-extraction approach is preferred in patients with OSA to retain expanded pharyngeal volume after surgery. An additional procedure for completing MMA is genioglossal muscle advancement (GA). This technique expands the magnitude of genioglossal, geniohyoid, and digastric muscle replacement [11].

4. Conclusion

Adult sleep apnea is a complex sleep-related breathing disorder that decreases quality of life and increases morbidity and mortality in patients. It is a highly prevalent disease and requires long-term and multidisciplinary management.

Orthodontists should recognize the signs and symptoms of this disorder to identify patients at risk of developing the complications of sleep apnea and guide the selection of appropriate treatment. Various oral appliances can be applied with good results in mild to moderate cases. In severe OSA, a surgical orthodontic approach is indicated. Maxillomandibular advancement surgery is a safe, very effective, and highly skeletally stable procedure.

Long-term management of OSA and regular follow-up are required to monitor compliance to therapy, treatment efficacy, side effects, and development of medical complications related to OSA.

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