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Review Article **Dental Medicine**

Skeletal Class I with Open-Bite Malocclusion Treated with Anterior Vertical Elastics (AVE)

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Abstract

Enhancing aesthetics, occlusion and functions is a primary motivation for individuals with open-bite malocclusion seeking orthodontic treatment. Open-bite malocclusion, characterized by a lack of vertical overlap of the anterior teeth, can be effectively treated using anterior vertical elastics. It's a common, non-surgical orthodontic approach to correct open-bite issues. In this case report, we present the treatment of a male patient with anterior open-bite malocclusion. Initially, the patient underwent a lingual frenectomy followed by an active and passive phase of swallowing rehabilitation by wearing a nocturnal lingual envelope (NLE). Subsequently, a fixed orthodontic appliance was bonded to achieve well-aligned arches, normalize the overjet and overbite with the use of anterior vertical elastics (AVE) and enhance both aesthetics and functions.

Keywords: Open-Bite Malocclusion, Orthodontic Treatment, Swallowing Rehabilitation, Anterior Vertical Elastics.

INTRODUCTION

Dental and dentoalveolar open bite is the result of a mechanical blockage of the vertical development of the incisors and the alveolar component while skeletal relationships are normal, skeletal open bite is determined by a vertical discrepancy. However, in most cases, the distinction is not clear since malocclusion presents both dental and skeletal components [1].

The prevalence of anterior open bite ranges from 1.5% to 11% and varies between ethnic groups according to chronologic and dental ages [2]. Proffit *et al*., recorded a prevalence of approximately 3.5% in patients from 8 to 17 years of age [2]. Etiology involves the interaction of environmental factors such as prolonged sucking habits, mouth breathing, tongue or lip thrusting, adenoid hypertrophy, syndromes, dental ankylosis, postural mandibular imbalance and eruption disturbances with a genetically determined vertical facial grow pattern [1-3].

Orthognathic surgery is the likely treatment option when an open-bite is associated with severe skeletal disharmony. In selected cases, however, in which facial aesthetics is not compromised, the intrusion of the maxillary posterior teeth using skeletal anchorage can provide satisfactory occlusal results, and comparable stability to other open-bite treatment modalities which may involve tooth extractions, intermaxillary elastics, and orthognathic surgery [4].

This case report presents a nonsurgical orthodontic treatment of an adolescent male patient who presented with a complex anterior open-bite malocclusion which was treated using lingual frenectomy, a passive and active phase of swallowing rehabilitation then an orthodontic phase with fixed appliances and vertical intermaxillary elastics.

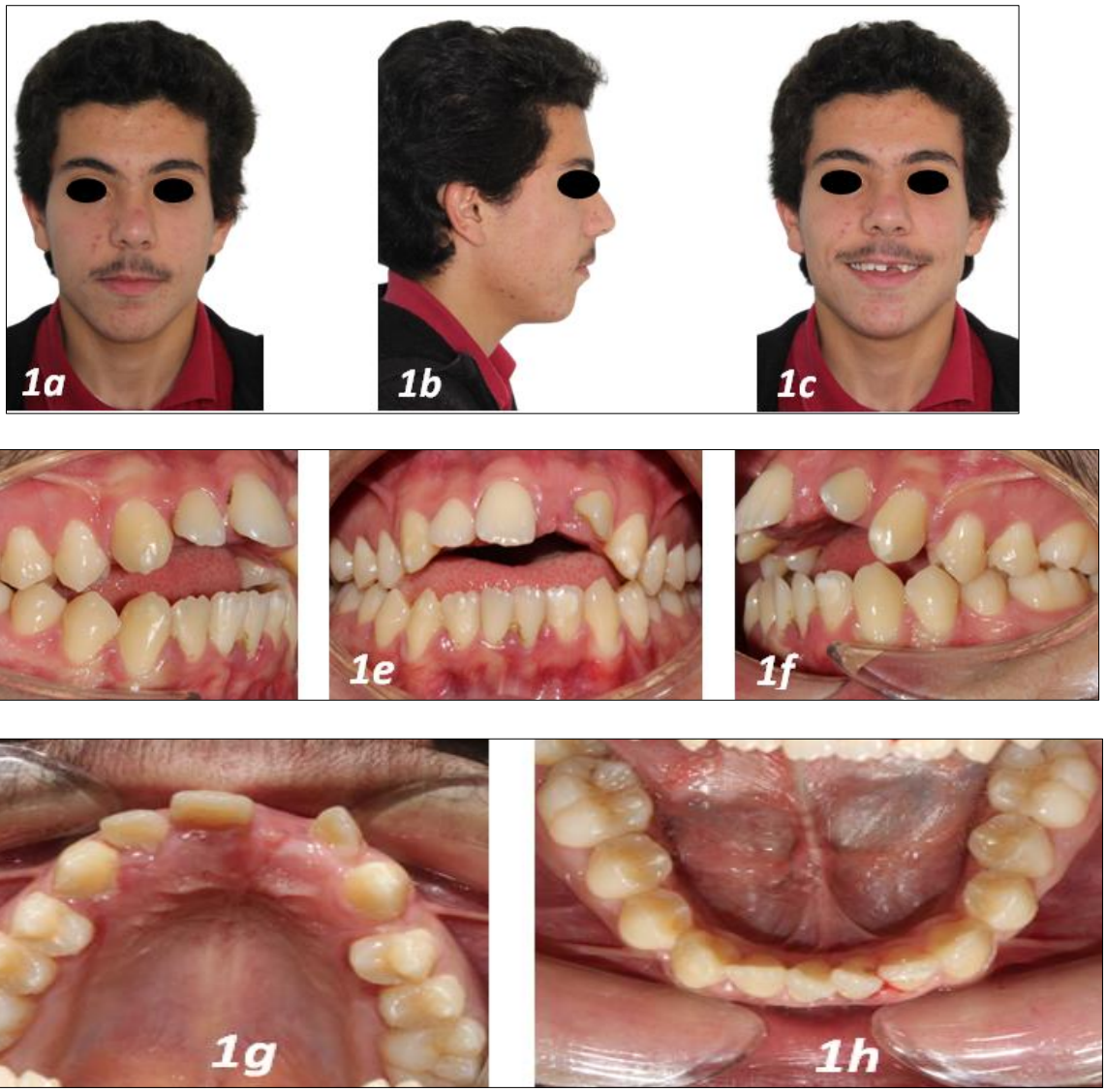

Figure 1 (a-h): Pre-treatment photographs: facial and intra-oral photographs.

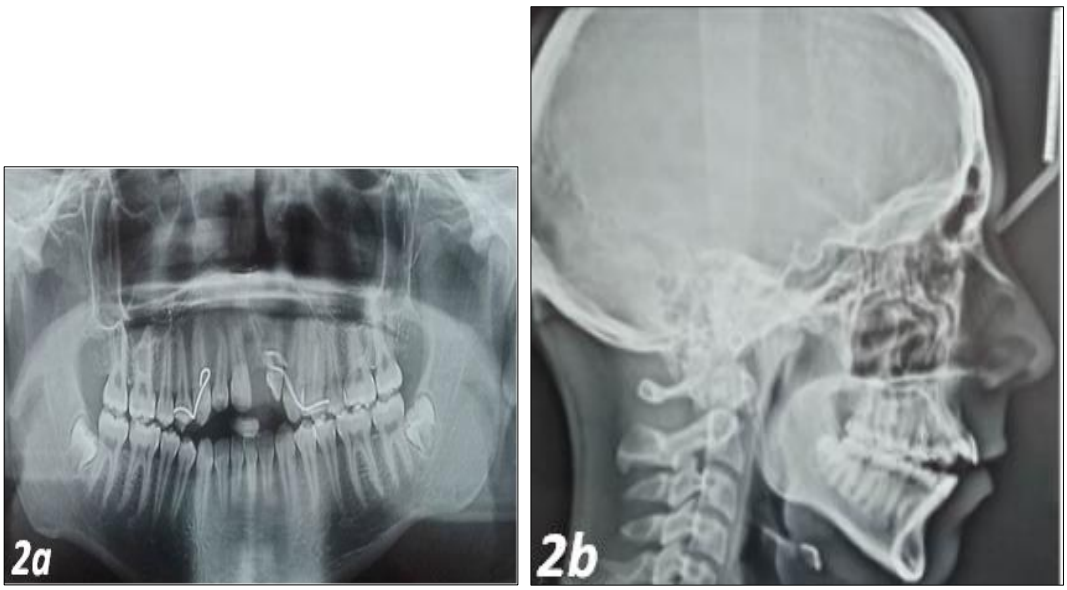

Figure 2 (a-b): Pre-treatment radiographs

PRESENTATION OF THE CASE

Clinical Examination and Diagnosis

A male patient aged 16 years consulted with the Dento-Facial Orthopedics Department at the dental medicine clinic of Monastir, Faculty of Dental Medicine, University of Monastir. His demands were both esthetical and functional. He had a chief complaint of his anterior open-bite with space deficit of the 21 which was absent. No systemic or medical abnormalities were described.

The extraoral examination showed from the frontal view a symmetrical face with a parallelism at the horizontal lines of the face and a straight medial sagittal plane, an increase in the lower third of the face, an underdeveloped cheekbone, and a flat nasolabial fold as a result of a retrusive maxilla. He also presented a passive lip competence with poor volume, an inadequate lip vermilion, especially at the upper lip, presence of a labial occlusion as well as a narrow smile (Figure 1a and 1c).

The profile analysis showed a convex profile, an increased anterior facial height, and posterior facial divergence. He also presented a well-positioned upper lip but a retruded lower lip and a labio-mental fold in allonged S shape. The chin-neck line was narrow due to a retruded mandibule and chin (Figure 1b).

The intraoral examination showed an unsatisfactory oral hygiene, a healthy periodontal status, with no bleeding on probing but with thin periodontal tissues. The upper dental arch was V shaped with the absence of the 21 and a mesio-buccal rotation of the 22. The lower dental arch was U shape, exhibited a mild crowding in the incisal area and presented a short lingual frenulum (Figure 1g and 1h).

Moreover, the occlusal examination revealed an Angle class I molar relationship on both sides associated with an Angle class II canine on both sides. The upper and lower incisors were proclined and the maxillary midline was deviated 4 mm towards the left of the midsagittal plane. The overjet was irregular from 4 to 5 mm and the overbite was from -4 to -5 mm, with an anterior open-bite of 8 mm (Figure 1d, 1e and 1f).

Furthermore, no symptoms or signs of any temporo-mandibular joint (TMJ) disorder were observed, maximal opening and lateral and anterior movements were within normal limits.

The functional examination revealed a mixed ventilation with a mouth breathing predominance, a dysfunctional swallowing and a disturbed phonation.

The analysis of plaster models showed a total dento-maxillary disharmony (DMD) of -31,15 mm according to Tweed's analysis and -14,75 mm according to Steiner's analysis and confirmed the maxillary midline shift 4 mm to the left (Table 1 and 2).

Table 1: Tweed's analysis

Tweed's Analysis		
	+	-
Ant.Crow		3
IR		14,4
Mid.Crow		
C.Spee		1,75
Post.Crow		14
Post.Growth	2	
Total DMD		31,15

Table 2: Steiner's analysis

Steiner's Analysis		
	+	-
Crowding		3
IR		10,75
C.Spee		1
DMD		14,75

The panoramic radiograph showed the absence of the 21 with the agenesy of the maxillary third molars. The mandibular third molars were under development. There were no supernumerary teeth. The crown-root ratios were normal with good alveolar bone levels, no bone pathology and no root resorption. In addition, the mandibular condyles, nasal floor and maxillary sinuses appeared normal (Figure 2a).

The lateral cephalometric radiograph revealed a class I skeletal malocclusion (ANB = 3°) (AoBo = 4mm) with a maxillary retrusion (SNA= 73°) and a mandibular retrusion (SNB = 70°) in relation to the anterior skull base. Additionally, a hyperdivergent vertical skeletal pattern was noted (GoGn/SN = 40° and FMA = 30°). Furthermore, the maxillary incisors presented increased axial inclination and were protruded in relation to their alveolar base (I/F=122°) same as the mandibular incisors (IMPA=100°) (Figure 2b and Table 3).

Table 3: Patient's cephalometric values

Angles	Patient's initial values	Average values
SNA	73°	82° ± 2°
SNB	70°	80° ± 2°
ANB	3°	0-4°
AoBo	4 mm	[-2 mm – 2 mm]
FMIA	50°	68°
IMPA	100°	87°
FMA	30°	[22° - 28°]
GoGn/SN	40°	32° ± 5°
I/i	110°	135°
I/F	122°	107° ± 5°

Treatment Goals:

The treatment goals for this patient were as follows: (1) To obtain pure nasal breathing and functional swallowing. (2) To close the anterior open-bite. (3) To resolve the dental crowding in maxillary and mandibular arches. (4) To correct the maxillary dental midline deviation. (5) To establish normal Class I canine and molar relationships with normal overjet and overbite. (6) To correct the inclination and position of the maxillary and mandibular anterior teeth. (7) To Improve facial esthetics and smile.

Treatment Alternative

Two treatment plans were proposed: the first option was an orthodontic treatment without premolars extraction using anterior vertical elastics (AVE), the second option was an orthodontic treatment with extraction of 14, 24, 34 and 44. The chosen treatment was the first option.

Treatment Progress

After obtaining the patient's consent, a lingual frenectomy was practiced then a nocturnal lingual envelope (NLE) was used during 6 months. It directs the tongue towards a secondary motor function which adapts itself plastically to the morphological frame thus corrected. For the active phase of swallowing rehabilitation, the patient was told to carry out some tongue exercises, this rehabilitation technique is targeted towards specific muscle groups which have lost their original function for swallowing. The tongue becomes the natural orthopedic appliance of the buccal cavity and the face (Figure 3).

Figure 3: Lingual frenectomy and swallowing rehabilitation.

6 months later, the open-bite had been reduced from 8 mm to 5 mm after the swallowing rehabilitation phase. Bands and preadjusted 0.022" x 0.028"-in brackets were placed to the maxillary teeth. Initially, the 22 was not bonded, it will be tracted later with an overlay. A 0.018"-in nickel-titanium wire was engaged as the initial archwire to start leveling and aligning. For the mandibular arch, the 42 was not bonded at first, it will be included in the archwire after space opening. A 0.014"-in nickel-titanium wire was used to start the leveling phase (Figure 4).

Figure 4: Leveling phase with upper 0.018" NiTi and lower 0.014" NiTi archwires

For the maxillary arch, the following orthodontic archwires: 0.016" x 0.022" NiTi, 0.017" x 0.025" NiTi, 0.018" x .025" NiTi, 0.017" x 0.025"-in SS and 0.018" x 0.025"-in SS was used successively. For the mandibular arch, this archwire sequence was used successively: 0.016" NiTi, 0.018" NiTi, 0.018"-in SS, 0.017" x 0.025"-in SS and 0.018" x 0.025"-in SS.

The first open spring was used between 11 and 22 to open the space for a prosthetic replacement. The second one was used between 41 and 43 to manage the

space to tract the 42. Simultaneously, class II elastics were used on the right side and class III elastics were used on the left side to correct the malocclusion (Figure 5).

Figure 5: Progress photographs: use of class II intermaxillary elastics on the right side and class III intermaxillary elastics on the left side + open spring between 11 and 22.

After space opening in the maxillary arch, a prosthetic tooth replacing the 21 was attached on the archwire. Kobayashi hooks were tied up on the maxillary laterals and used to attach intermaxillary vertical elastics (Rainbow) from lower canines to upper laterals (Figure 6).

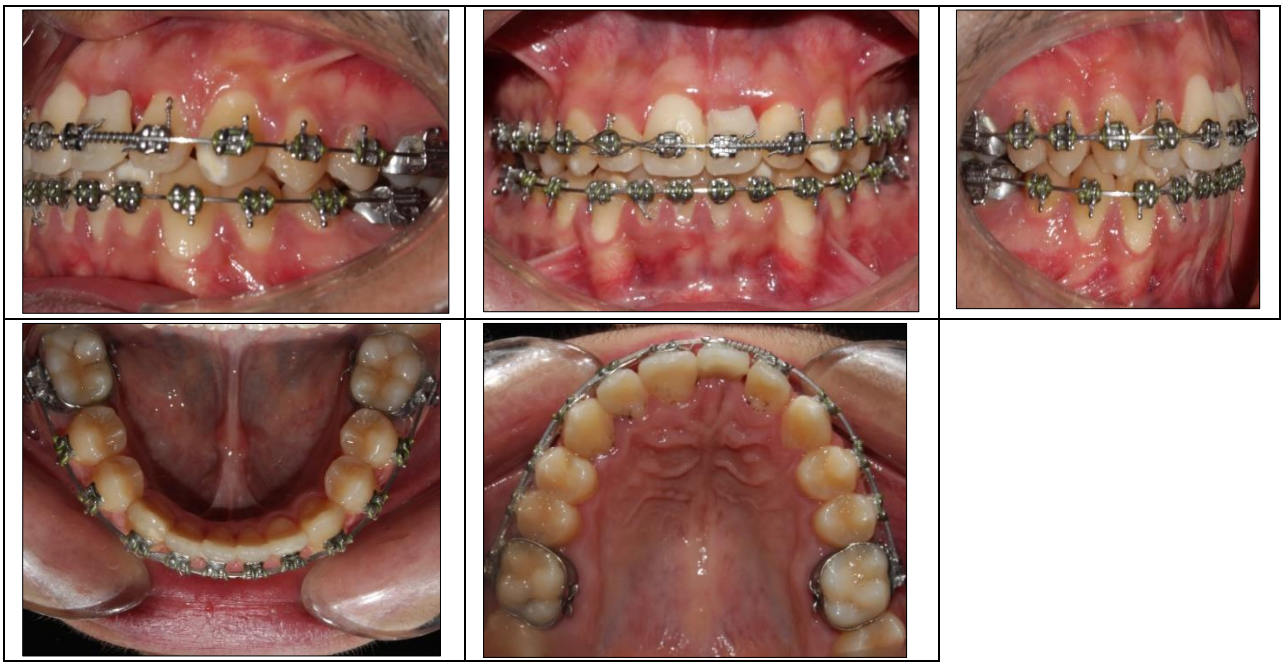

Figure 6: Progress photographs: upper and lower coordinated 0.018" x 0.025" steinless steel archwires.

After 4 months of finishing and detailing, the appliance was debonded. Retention was performed with a bonded stainless-steel lingual canine-to-canine fixed retainer in both maxillary and mandibular arches. An Essix retainer with a prosthetic tooth was also used for the maxillary arch. Finally, post-treatment records were taken.

Treatment Results:

All the predefined objectives were fulfilled, the correction of dental problems allowed the occlusal, functional, and esthetic goals to be achieved: a significant improvement in the soft tissue profile indicated by the position of the chin (Figure 7).

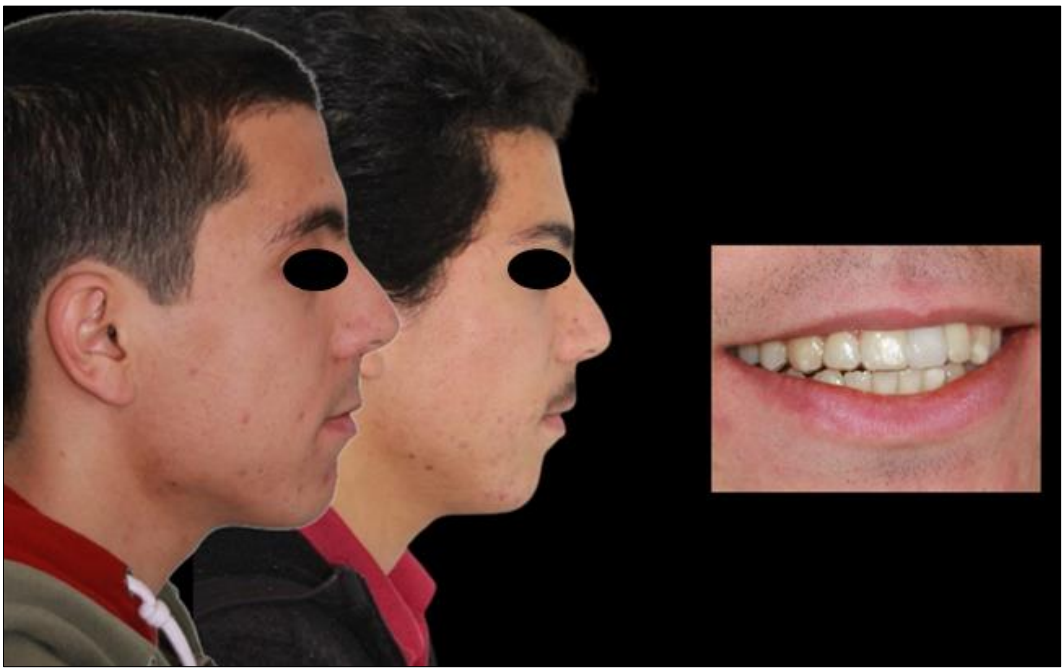

Figure 7: Profile comparison and smile photographs

His smile esthetics were improved (Figure 7 and 8c). Intraorally, an Angle class I bilateral canine and molar relationship was achieved with good interdigitated occlusion, crowding was corrected, open-bite was closed and an adequate overjet and overbite were achieved. The upper and lower dental midline coincidence was obtained (Figure 8d to 8h). Additionally, functional dynamic occlusion was procured with lateral movement guided by the canines and protrusive movement by the incisors.

Figure 8 (a-h): Post-treatment photographs: facial and intra-oral photographs.

The post treatment cephalometric evaluation and superimposition confirmed a positive change in the profile. There was also a significant change in skeletal measurements in both sagittal and vertical dimensions. Moreover, final cephalometric analysis showed a class I relationship with no change in value of the ANB angle (3°). The facial divergence has decreased with a change in values of the FMA angle from 30° to 27°. The maxillary incisors were retruded and lingually tipped, and the mandibular incisors were also retruded and had their axial inclination decreased (Table 4 and Figure 8). Total and partial superimposition of initial and final cephalometric tracings revealed the changes occurred with the treatment (Figure 9).

Table 4: Patient's cephalometric values comparison

Angles	Patient's initial values	Patient's final values
SNA	73°	74°
SNB	70°	71°
ANB	3°	3°
AoBo	4 mm	1,5 mm
FMIA	50°	57°
IMPA	100°	96°
FMA	30°	27°
GoGn/SN	40°	37°
I/i	110°	119°
I/F	122°	114°

Figure 8: Post-treatment cephalometric radiograph

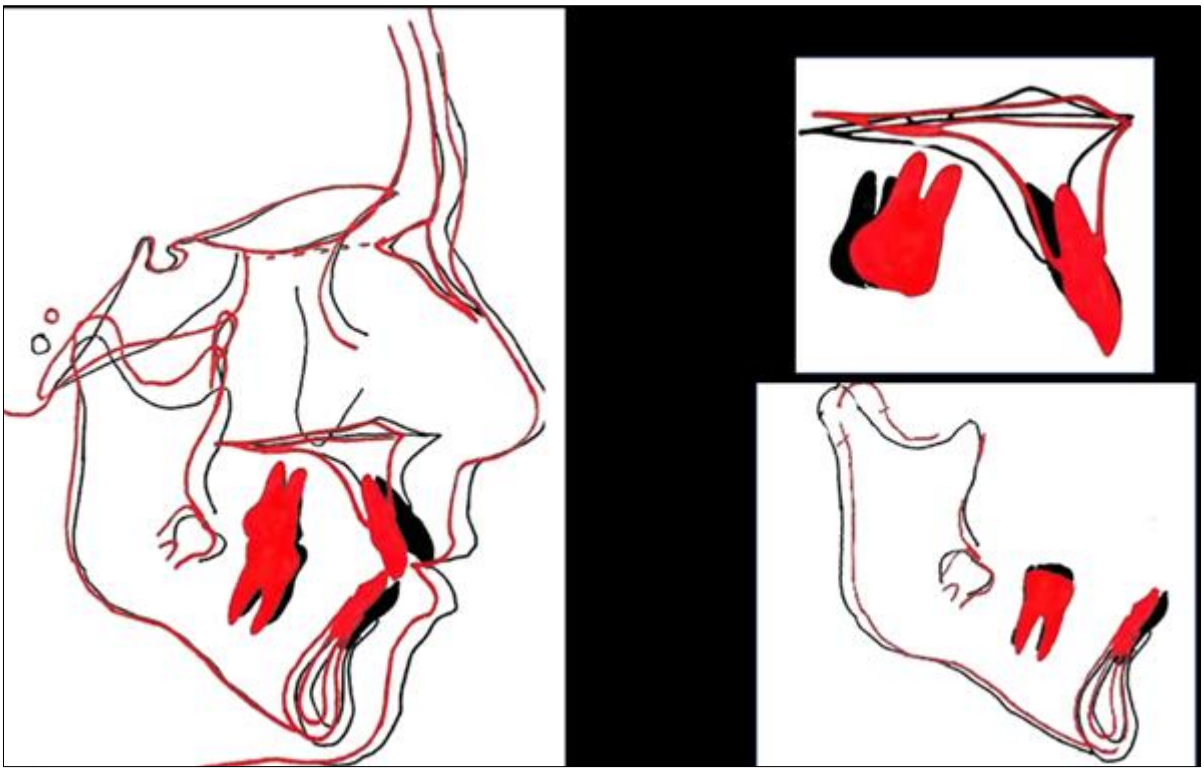

Figure 9: Total and partial cephalometric superimpositions

Lastly, the panoramic radiograph shows satisfying root parallelism and good bone healing (Figure 10).

Figure 10: Post-treatment panoramic radiograph

DISCUSSION

When a young person shows up for an initial consultation in the orthodontic office, and the clinician sees an open bite, most of the time a few red flags go up as this bite problem is challenging for most orthodontists. The open bite malocclusion is often difficult to treat successfully, and the long-term stability is frequently questionable [5].

Several alternatives have been proposed for the orthodontic non-surgical treatment of open bite, including intrusion or vertical control of posterior teeth [6-8], or extrusion of the anterior teeth [9]. However, in unfavorable skeletal patterns, an orthognathic surgery is suggested as the most appropriate approach [10, 11].

In the case presented in this report, the patient chief complaint was not only the anterior open-bite induced by sucking habits, but also the absence of the 21 caused by a traumatism, resulting in a significant psychosocial impact. This patient was 16 years old at the beginning of treatment. He came looking for a solution for his unaesthetic smile appearance. He presented a

class I skeletal malocclusion (ANB = 3°) with an anterior open-bite, extended from right first premolars to left canines with a hyperdivergent vertical skeletal pattern (GoGn/SN = 40° and FMA = 30°).

In this case, the surgical approach wasn't required. In fact, the treatment options were: intrusion of posterior teeth, extrusion of anterior teeth or combination of the two options. The decision is based on the vertical positioning of the maxillary incisors relative to the lip line and whether there is a skeletal background (face height). Posterior teeth intrusion is indicated in cases with normal to excessive incisor exposure upon smiling and increased face height. Anterior teeth extrusion is indicated in cases where there is insufficient incisor exposure at rest and upon smiling and decreased face height. In this case, the patient presents an insufficient incisor exposure while smiling but not too much increased face height, so we chose to extrude the anterior teeth.

The cause of malocclusion must be treated first of all, by a lingual frenectomy, then the use of nocturnal lingual envelope (NLE) and exercises for swallowing rehabilitation at the same time. Secondarily, fixed orthodontic appliance was used to level the arches and close the open-bite using anterior vertical elastics (AVE). Some authors recommend to bond anterior teeth more cervically to aid in closing open-bite.

If the patient is not cooperative, instead of using a removable appliance such as nocturnal lingual envelope (NLE) we can use a tongue crib or spur isolated or associated with anterior vertical elastics (AVE), to correct tongue posture and consequently close the bite. Two types of spurs can be used: banded or bonded. Bonded spurs seem to be better tolerated by patients [12].

The elastics used in this case were 8 mm/4,5 Oz. The objectives of using the elastics, besides extruding incisors, are also to correct the occlusal plane inclination and to align the maxillary incisors in relation to lip line. Vertical elastics can be used when there are still some anteroposterior discrepancies that are concurrently being corrected, for example the correction of Angle class II and III in this case with intermaxillary elastics.

The elastics are recommended to be used as much as possible except during meals, which corresponds to approximately 18 – 20 hours per day. If the patient complies with these guidelines, closure occurs at a rate of 1 mm per month. If no change in overbite is observed after 3 months, it is most likely that the patient is not correctly complying in using the elastics. The elastics are used until overcorrection is obtained, whenever possible. Ideally, once the bite is closed, the elastics still have to be used as recommended, for 4 months, which is the necessary time for bone to form in the alveolus (alveolar bone remodeling) after the extrusion of the anterior teeth [13].

Finally, the treatment outcomes were very favorable, all objectives were fulfilled. In fact, the achievement of treatment objectives was clinically and radiologically confirmed: there was a significant improvement in upper and lower incisors protrusion: I/F angle varied from 122° to 114° and IMPA angle varied from 100° to 96°. The patient became normodivergent (FMA = 27° instead of 30°).

However, the major challenge for anterior open-bite malocclusion treated orthodontically was the long-term stability. To ensure this objective, the obtention of functional and stable occlusion and the use of an adequate retention is required. Therefore, it is mandatory for all orthodontists to diagnose the case correctly, and plan the treatment and retention initially.

CONCLUSION

Anterior open-bite malocclusion is a great challenge for orthodontists: a detailed diagnosis with a rigorous analysis of the occlusal, skeletal and soft tissue components has to be performed. Also, a correct planning as well as an adequate execution of the treatment plan are determinant factors for a successful result and long-term stability. In the case described, achieving planned treatment goals was challenging. The management of anterior open-bite malocclusion was shown successfully. To fulfill the treatment objectives, combined swallowing re-education and orthodontic treatment were suggested. Indeed, good facial esthetics, functional and occlusal results were achieved. However, the maintenance of stable results is thus influenced by muscle adaptation, functional swallowing, the establishment of a good interincisal angle, and a good interdigitation of the occlusion [14].

Declaration of Patient Consent: The authors certify that they have obtained all appropriate patient consent.

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