



Orthodontic Treatment of an Adult with a Severe Open Bite and a Class III Malocclusion Using Asymmetrical Mandibular Biomechanics, a Long-Term Follow-Up

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Abstract

Open bite malocclusion is one of the hardest discrepancies to treat orthodontically. The combination of skeletal, dental, and functional factors contributes powerfully to its establishment and aggravation. The key to orthodontic treatment of open bite starts with an accurate diagnosis of the discrepancy. Comprehensive orthodontic treatment might be a good alternative to maxillofacial surgery, which has been considered for a long time the most effective treatment to correcting open bite cases in adults. However, due to its many limitations and the arise of new technologies, such as mini-implants, orthodontic treatment of moderate to severe open bite has nowadays proven itself as a pragmatic alternative to surgery. The following case report describes the treatment of a 21-year-old adult male patient presenting with a skeletal Class III malocclusion, a severe open bite and a bilateral posterior crossbite, complicated by a congenitally missing lower incisor and previously extracted upper first premolars after undergoing 2 previous orthodontic treatments. Patient underwent myofunctional therapy 2 months before orthodontic treatment was initiated in the maxillary arch where a TPA was placed for expansion and correction of the first molar rotations. Differential bonding of the maxillary arch was then initiated with the immediate placement of TADs in the posterior region to support the vertical and sagittal controls. An asymmetrical retraction mechanics was then initiated in the mandible consisting of molar distalization on the left side followed by the reshaping of the lower left canine to replace the lower lateral incisor. On the right side, the extraction of the first bicuspid and retraction using indirect maximal anchorage on the maxillary TADs was implemented. At the end of the treatment, facial enhancement was achieved at rest and during smile, with an increase of the maxillary incisors display at smile, the open bite was corrected, and molar and canine Class 1 were obtained. Finally, we will discuss the comprehensive and synergic treatment factors of dental and skeletal open bite in an adult and will highlight the application of mini-implants in the treatment of anterior open bite and discuss its long-term stability after a 4 year follow-up visit.

Keywords: *Anterior Open Bite; Severe Open Bite; Class III Malocclusion*

Introduction

Anterior open bite is defined as the absence of vertical overlap between the upper and lower incisors anteriorly [1]. The combination of skeletal, dental, and functional factors contributes powerfully to its establishment and aggravation [1]. The skeletal open bite, typically referred to as long face syndrome or condition, is characterized by an excessive vertical dimension of the posterior segments; divergent maxillary and mandibular occlusal planes; a high gonial angle; and an increased total and lower anterior facial heights. The dental open bite was described best by Schudy [2]

who demonstrated that a 1mm of elongation of the posterior segments would open the bite 2 mm anteriorly due to the jaw geometry. The environmental factors include thumb sucking habit, tongue thrust swallowing pattern and a low and anterior tongue posture at rest [3] and it has been demonstrated that myofunctional therapy leads to enhancement in facial, dental, and skeletal features, with a direct impact on treatment stability [4,5].

The key to orthodontic treatment of open bite starts with an accurate diagnosis of the discrepancy. In adults, maxillo-facial surgery

has been considered for a long time the most effective treatment to correcting open bite cases [6]. However, due to its many limitations and the arise of new technologies, such as mini-implants, orthodontic treatment of moderate to severe open bite has nowadays proven itself as a pragmatic alternative to surgery [7], specifically when a partial or total dental contribution is evident [8].

This case report describes the treatment of an adult male patient presenting with a skeletal Class III malocclusion, a severe open bite and a bilateral posterior crossbite, complicated by a congenitally missing lower incisor and previously extracted upper first premolars after undergoing 2 previous orthodontic treatments. The patient was treated without surgery with the use of maxillary mini-implants (TADs), asymmetrical retrusion mechanics in the mandible, and myofunctional therapy. The long-term stability of the orthodontic results, 2 and 4 years after orthodontic treatment, will also be discussed.

Diagnosis and Etiology

A 21-year-old male patient was seeking orthodontic treatment with a chief concern of anterior open bite, an unpleasant smile and difficulty in biting and chewing food. He reported a long history of orthodontic treatment and relapse from 2 different treatments. The first one was completed at the age of 11 years and involved the extraction of the maxillary first bicuspids, while the second treatment was completed at the age of 19 years and consisted of a maxillary removable appliance. Both treatments did not result in any satisfactory results.

The clinical evaluation showed a typical long face facial pattern with an increased lower facial height, a flat smile arc with inadequate display of maxillary incisors and a straight profile. The intraoral exam indicated an anterior open bite (+5 mm), bilateral crossbite, constricted upper arch with previous extraction of upper first premolars, severe rotation of the first maxillary molars, missing one mandibular incisor and Class III canine and molar relationships with reverse overjet (-3 mm) and a severe curve of Spee. Lower midline was deviated 0.5 mm to the left. Maxillary and lower left wisdom teeth were present on the arch and fully erupted (Figure 1). Patient showed a low and anterior position of the tongue at rest and an atypical swallowing pattern.

The initial cephalometric analysis (Figure 2 and table 1) showed a skeletal Class III malocclusion (ANB, -1.2°); with in-

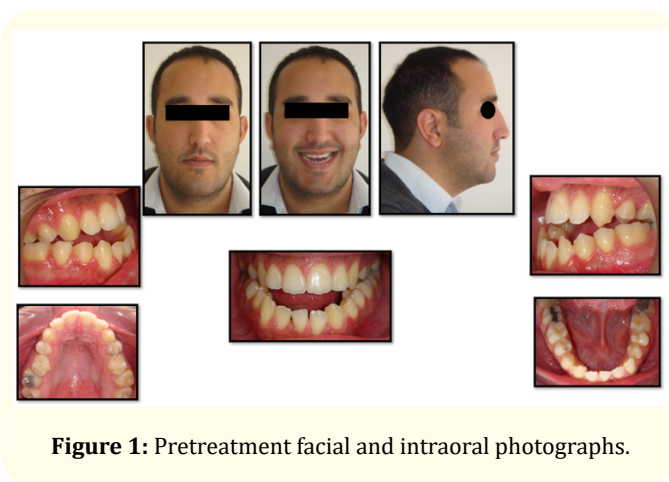


Figure 1: Pretreatment facial and intraoral photographs.

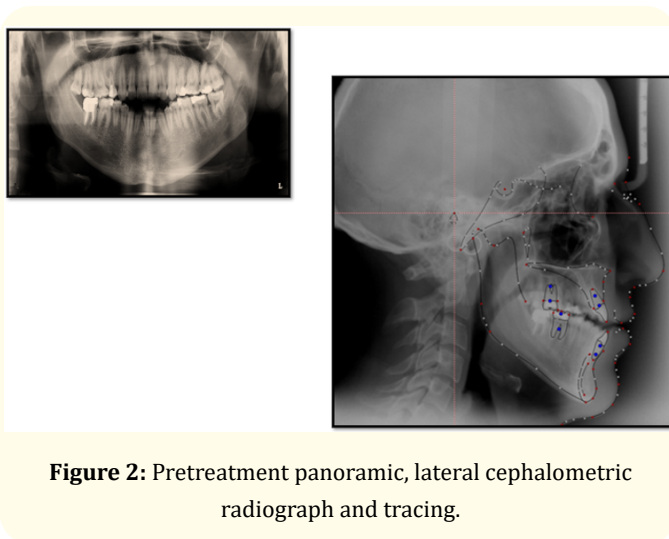


Figure 2: Pretreatment panoramic, lateral cephalometric radiograph and tracing.

creased lower facial height and a severe hyperdivergent pattern (FMA angle, 38.6° ; MP-SN, 41.9°). The occlusal plane showed a severe clockwise rotation (OP, 25°). The maxillary incisors showed a normal inclination (U1-SN, 106.2°), and the lower incisors showed a dental compensation of the Class III with a retroclination (IMPA, 62.0°). The panoramic radiograph showed the agenesis of one mandibular incisor and the absence of the lower right wisdom tooth. The maxillary bicuspid on the right showed an abscess that needed to be addressed by the general practitioner at the clinic (Figure 2).

Treatment objectives

The treatment objectives were to (1) close the anterior open bite, (2) establish a functional occlusion with correction of all transverse, vertical and sagittal dimensions, (3) enhance the facial features and the smile line, (4) shorten the lower facial height towards a normal value and (5) maintain a long-term stable occlusion.

Measurement	Normal value	Pretreatment	Posttreatment
Angular (°)			
SNA	82	79.4	79.9
SNB	80	80.6	79.9
ANB	2 ± 2	-1.2	0.1
AOBO	2 ± 5	-5.4	-8.9
FMA	25 ± 3	38.6	35.9
MP-SN	33 ± 4	41.9	41.0
IMPA	88 ± 3	62.0	80.2
FMIA	67 ± 3	79.4	63.9
IFPA	107 ± 3	108	105
Interincisal angle	130 ± 6	149.8	129.5
OP	10	25	12
Nasolabial Angle (Col-Sn-UL)	102.0	103.6	105.2
Linear (mm)			
Overjet	2 ± 2	-4.0	2.0
U1-NA	4.3 ± 2.7	4.8	5.2
L1-NB	4 ± 1.8	0.0	6.4
U6-PP (UPDH)	27 ± 3	30	30.2
L6-MP (LPDH)	39 ± 3	37.7	37.6
Upper Lip to E-Plane	-8.0	-8.3	-6.7
Lower Lip to E-Plane	-2.0	-6.1	-4.1

Table 1: Cephalometric measurements at pretreatment and posttreatment.

Treatment alternatives

1. Orthognathic surgery in conjunction with orthodontic treatment. Surgery would include the advancement of the maxilla with a clockwise rotation, in combination with a mandibular set back. Presurgical orthodontic treatment would involve reopening of the space of the missing lower incisor, and the increase of the negative overjet. The extraction of the lower left wisdom tooth would be required. Surgery would correct the facial features and enhance the smile line. This option was refused by the patient.

2. Orthodontic camouflage treatment. Two options were considered but both incorporated the same strategy in the maxillary arch that required the placement of a transpalatal arch (TPA) combined with two maxillary posterior mini screws in order to control the vertical dimension. The TPA would assist in the correction of the first molars rotation and the correction and stabilization of the transverse dimension. The posterior TADs would be used for maxillary posterior alveolar impaction, creating a clockwise rotation of the maxillary occlusal plane which would help in the enhancement of the smile line of the patient and the correction of the open bite. These biomechanics would induce a counterclockwise rotation of the mandible [9], which could worsen the reverse overjet, but help in the correction of the open bite [10], therefore it should be controlled through the wear of Class III elastics from the lower canines to the maxillary mini screws.

Two options were possible in the mandible:

1. The first option was a conventional orthodontic camouflage treatment of a Class III malocclusion and included the bilateral extraction of the first lower bicuspid with maximal incisor retraction on posterior TADs.
2. However, the patient had a congenitally missing lower incisor, and the lower left canine was a good candidate for canine substitution due to its shape and size. The correction of the Class III malocclusion would then involve asymmetrical mechanics. Molar distalization on the left side using a posterior mini screw with the extraction of the lower left wisdom tooth would be performed to correct the molar relationship, followed by the reshaping of the lower left canine to replace the lower lateral incisor. On the right side, the extraction of the first bicuspid and retraction using maximal anchorage on TADs would still be implemented.

The second orthodontic option in conjunction with myofunctional therapy was chosen. The plan would result in an ideal Class I canine and molar with the correction of the open bite and the anterior and lateral crossbites. We have decided to use only two maxillary TADs instead of four (two maxillary and two mandibular) for pecuniary reasons. The maxillary TADs would be used for vertical control at the start of the treatment and for posterior alveolar im-

paction during treatment. The TADs will also be used for indirect maximal anchorage through the wear of Class III elastics from the lower canines to the maxillary TADs.

Treatment progress

The patient was first referred to a myofunctional therapist. After evaluation of the tongue posture, an 8-months program was proposed to correct the anterior and low posture of the tongue at rest and the tongue thrust swallowing pattern. It was initiated 2 months before the start of the orthodontic treatment, in a way to test patient compliance and benefit from myofunctional therapy.

The bonding of the lower arch was deferred until mechanics were set up in the upper arch to support the vertical and sagittal controls. The treatment was initiated with an impression for a TPA and referral for extraction of the lower left wisdom tooth. The TPA was then placed and activated to correct the mesio-palatal rotation of the first molars, and in expansion to correct the crossbite on the molars with a negative root torque to prevent the formation of hanging cusps. Bonding of the maxillary arch was then initiated using 0.022-in slot MBT-prescription brackets (Ormco® Mini Diamond® Twin) with the immediate placement of upper maxillary TADs (AbsoAnchor® SH1413-06) between the upper second bicuspid and the first molars to control the vertical dimension from the start of the treatment using a 0.012 mm ligature wire tied in a triangular shape form the TADs to the bracket of the second bicuspid and the molar tube on both sides. A clear step in the initial maxillary arch wire between the anterior and lateral segments could be noted clinically after bonding which reinforced the choice to control the vertical dimension from T0 (Figure 3 and 4). At 2 months, bonding of the lower arch was performed in conjunction with the full time use of light Class 3 elastics (Ormco® 2 Oz ¼ Owl) from the lower canines to the maxillary TADs to control the inclination of the lower incisors during initial alignment phase. The patient was referred for the extraction of lower right first bicuspid when 0.019-in x 0.025-in SS wire was reached. An asymmetrical retraction mechanics was then initiated in the mandible. On the right side, a 12 mm Ni-Ti closed coil spring with medium force was used from the first molar tube to a crimpable hook placed between the lower right canine and the lower right lateral incisor to create an en-masse retraction. On the left side, compressed springs were placed between lower left canine, lower left first bicuspid, lower

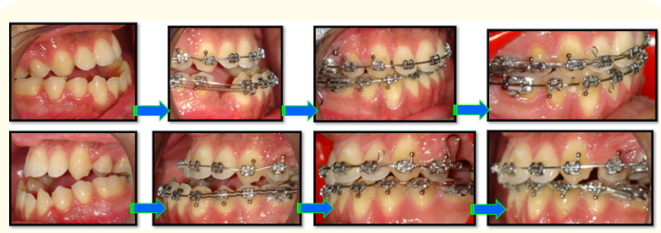


Figure 3: Progress intraoral lateral photographs and chart showing the synergistic effect of myotherapy, TPA placement, TADs and extractions on the treatment of the anterior open bite.

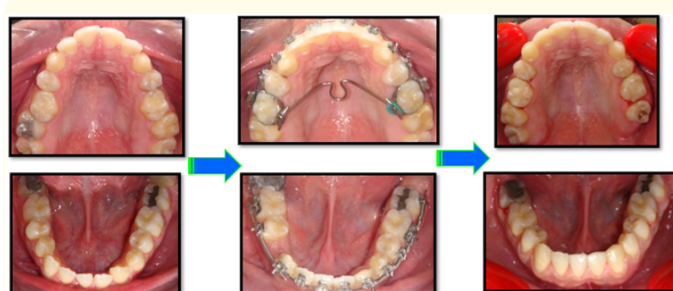


Figure 4: Progress intraoral occlusal photographs and chart showing the synergistic effect of myotherapy, TPA placement, TADs and extractions on the treatment of the anterior open bite.

left second bicuspid, lower first molar and second molar along with tip back bends [11], toe-in bends and negative torque on the molars, in conjunction with the full time use of heavy Class III elastics (6 oz 1/4) on the maxillary TADs on both sides for indirect maximal anchorage.

After 8 months a 2 mm positive anterior overbite was achieved, and both TADs were removed (Figure 4). The lower wire was changed to a continuous 0.019-in x 0.025-in SS with a full power chain to close the residual spaces. The lateral crossbite was fully corrected and the TPA was also removed. At this stage, anterior box elastics (5 oz 3/16) were given to the patient to overcorrect the overbite by inducing the extrusion of the upper incisors and increase their display during smile, using differential size wires: 0.017-in x 0.025-in SS in the maxillary arch and a heavier 0.019-in x 0.025-in SS in the lower arch.

However, the upper left first molar needed to be extracted due to endodontic lesion which created a complication to the treatment, and a mesialization mechanics with a closing loop was used to mesialize the upper right second and third molars. At 20 months, coronoplasty of the lower left canine was performed and the residual spaces were closed. The cross bite was corrected on the upper right wisdom tooth with the use of cross elastics (4 Oz 1/8).

After 25 months, the appliances were removed (Figure 5). A fixed lower lingual retainer was bonded on the lower arch and an upper Hawley appliance was delivered to the patient for full-time usage for the first 6 months and for nighttime wear for the next 12 months.

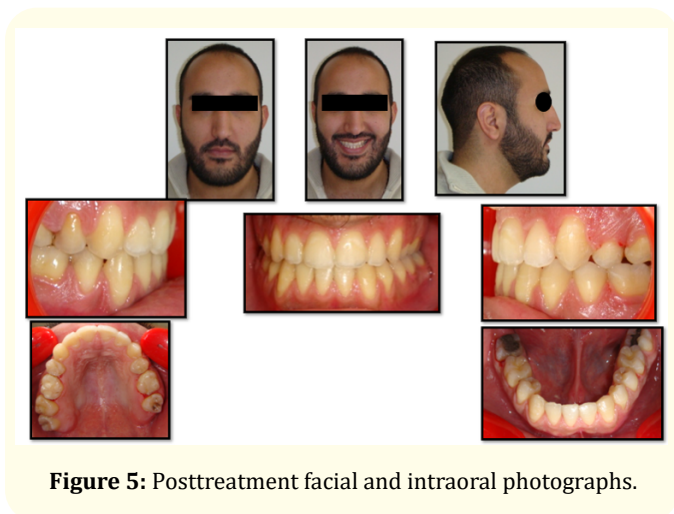


Figure 5: Posttreatment facial and intraoral photographs.

Treatment results

Facial enhancement was achieved at rest and during smile, with an increase of the maxillary incisors display at smile. The patient's 5 mm anterior open bite was closed by posterior molar intrusion and 2 mm of positive overbite was achieved. The dental CI III malocclusion was corrected, and ideal Class I canine and molar relationship were achieved with lower left canine substituting for lower left lateral incisor and upper right second molar replacing the first molar (Figure 5). The lateral cross bite was corrected and the curve of Spee was flattened.

The Cephalometric analysis showed an enhancement of the patient's profile with a normalization of Z angle from 70° to 75°. The

vertical dimension was controlled and FMA was reduced from 38.6° to 35.9°, and the Occlusal Plane Angle (OP) was corrected from 25° to 12° which indicated an anti-clockwise rotation of the mandible and a clockwise rotation of the maxillary occlusal plane (Table 1). The maxillary incisors were proclined, and the lower incisors were retruded and the interincisal angle (U1-L1) was normalized from 149.8° to 129.5°. End of treatment Panoramic and Cephalometry are shown in figure 6. The myofunctional therapy report stated that the posture of the tongue at rest and during swallowing were fully corrected. The extraoral and intraoral results were stable after four-year follow-up visit with harmonious facial features and good occlusal stability (Figure 8).

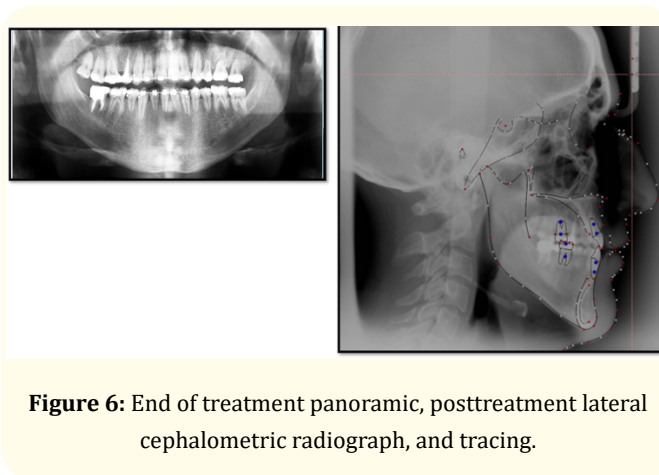


Figure 6: End of treatment panoramic, posttreatment lateral cephalometric radiograph, and tracing.

Discussion

The patient presented in this case report had a skeletal CI III malocclusion, with a severe open bite, complicated by dental and functional factors. Dental factors included the congenital absence of the lower lateral left incisor and the previous extractions of the upper first premolars during the first orthodontic treatment that the patient had received outside our office. The extraction of the upper left first molar due to endodontic lesion during our orthodontic treatment made an additional complication to the case. Therefore, proper anchorage management using TADs became a pillar for the success of the non-surgical orthodontic treatment of the case to ensure both vertical and sagittal controls.

The particularity of this case relies in the management of the spaces in the mandibular arch and the complications that have

risen in the maxillary arch, particularly the extraction of the upper left first molar due to an endodontic-periodontal infection and the subsequent need to mesialize the second and third molars while controlling the inclination of the upper incisors. Concerning the mandibular arch, the treatment approach was challenged by the agenesis of the lower lateral incisor and the requirement for strategic extractions. The dental compensation of the CI III malocclusion is typically treated with the symmetrical extractions of the lower first bicuspid on the right and left side. However, the agenesis of 1 lower incisor has created a difficulty that needed to be approached by asymmetrical mechanics, where extraction of only the lower first bicuspid on the right side was planned and an en-masse distalization was done on the left side using coil springs and indirect anchorage using TADs in the maxillary posterior interradicular space. Challenges from asymmetrical mechanics may include midline shift during orthodontic movement and occlusal cant from the different centers of resistance used [12], but were contained through the bilateral use of CI III elastics from the lower canines to the maxillary TADs. Adequate biomechanical preparation was, therefore, an important factor for a successful treatment in this case.

Concerning the correction of the vertical dimension, temporary skeletal anchorage devices are being used routinely to correct anterior open bite. 2 to 4 mm molar intrusion using TADs have been reported in the literature with a mean of 2.3 mm [8], while a molar intrusion on maxillary skeletal mini plates of 1.45 - 3.32 mm with a mean intrusion of 1.99 mm have also been reported [10]. We have used 2 TADs in the maxillary arch on the day of the bonding to ensure maximal vertical control and reduce any risk of supereruption of the posterior teeth during the initial leveling phase and throughout the treatment. Vertical control combined with a normalization of the position of the tongue has resulted in the closure of the open bite with a reduction of FMA of 2.7°, and a correction of the anterior dental open bite through a normalization of the occlusal plane angle with a correction of 13°. Cephalometric superimposition was done using Dolphin Imaging system (Dolphin Imaging 11.95 Premium®). It showed a maxillary and mandibular molar stabilization. Posterior build-ups that were placed on the upper molars using Ultra Band-Lok adhesive (Reliance Orthodontics®), showing comparable results with previous studies [13]. The control of the Class III malocclusion using CI III elastics on TADs for

indirect anchorage alleviated the risk of aggravation of the malocclusion due to the counterclockwise rotation of the mandible, while the retractive mechanics used in the lower arch, managed to correct the canine and molar dental malocclusion. A significant change in the occlusal plane angle has occurred during treatment which can be associated with both a posterior control and an anterior extrusion that has happened spontaneously after the correction of the position of the tongue through myofunctional therapy.

Regarding the long-term stability, long term success in treatment of open bite malocclusions resides in a proper myofunctional orofacial therapy to correct the position and the activity of the tongue during rest and function. Smithpeter and Covell [14] have proven the importance of myofunctional therapy during orthodontic treatment and have demonstrated that it is highly effective in maintaining closure of anterior open bites compared with orthodontic treatment alone. In this case report, the patient was compliant and followed a myofunctional therapy that lasted 8 months and was initiated 2 months pre-treatment, which can be associated with long term stability after 4 years follow-up. Another factor to consider when discussing long term stability is the choice of treatment between a surgical approach and an orthodontic compensation treatment. Surgical treatment of the open bite with a downward movement of the maxilla showed relapse in 20% of patients beyond 1-year post-surgery [15] while molar intrusion through posterior impaction on TADs showed most relapse during the first year of retention when a 0.5 to 1.5 mm of re-eruption was most likely to occur [16] but did not exhibit significant recurrence between the 1-year and 3-year follow-ups [17]. In this case, an intrusion accompanied with a slight mesial movement of the maxillary molars has occurred during treatment as seen on the superimposition (Figure 7), which might have reduced relapse [18]. Occlusion and facial profile were maintained 4 years after retention (Figure 8).

Conclusion

The orthodontic treatment of an adult with a skeletal Class III malocclusion with severe open bite using asymmetrical mandibular biomechanics, was discussed in this article. The key for long-term success lies in the synergic effect of different treatment factors that are: myofunctional therapy, the use of a TPA, adequate biomechanical preparation through TADs, and strategic extractions. An illus-

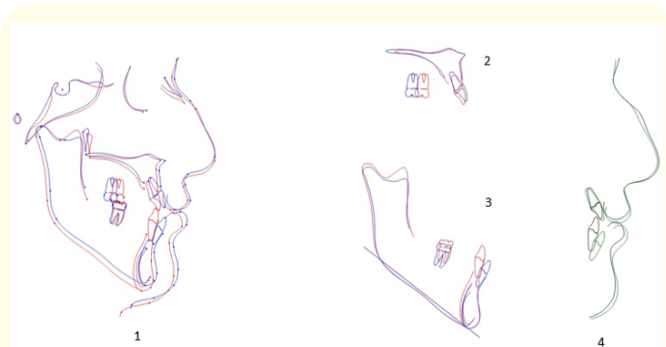


Figure 7: Cephalometric superimposition. Pretreatment (BLUE) and posttreatment (RED). (1) Tracing, (2) Maxilla, (3) Mandible, (4) Full profile.



Figure 8: 4-year follow-up facial and intraoral photographs.

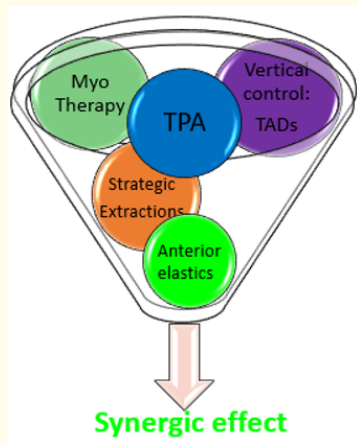


Figure 9: Diagram showing the synergic effect of different factors to correct open bite malocclusion.

tration of this synergy can be found in figure 9 through a diagram that summarizes the factors used in this case report. The results were stable after 4 years and no relapse had occurred in the occlusion and the facial esthetics were maintained.

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