Miniplates allow efficient and effective treatment of anterior open bites

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Abstract

Introduction The treatment of dentofacial deformities and malocclusions with anterior open bites, was one of the first applications of miniplates for orthodontic anchorage. The use of this treatment system reduces the number of patients referred to orthognathic surgery and simplifies many problems. This approach applies intrusive forces to posterior teeth, and the mandible undergoes counterclockwise rotation, which decreases lower facial height and projects hard and soft tissue pogonions. **Objective:** This study describes the principles of orthodontic mechanics in the correction of anterior open bite and illustrates these principles with a series of clinical cases.

Keywords Open bite. Orthodontic anchorage procedures. Miniplates. Orthodontics.

INTRODUCTION

Successful orthodontic therapy depends on judicious anchorage planning. Skeletal anchorage devices have played a significant role in supporting orthodontic treatment[10]. Their chief advantage lies in providing a fixed, stationary anchorage spot inside the oral cavity, which enables orthodontic movements by preventing the unit of resistance from being displaced. Temporary orthodontic implants allow the implementation of skeletal anchorage techniques which boast certain benefits over traditional Orthodontics in many different clinical situations since they do not require patient compliance and allow forces to be applied in different directions without undesirable reciprocal movements[15].

The emergence of skeletal anchorage has allowed professional to develop groundbreaking orthodontic treatment methods. Complex treatments have become simpler and more predictable, treatment length has decreased and orthognathic surgeries could be avoided in patients who did not wish to experience them. These results have been achieved with the aid of several different skeletal anchorage systems. In practice, the natural selection process has restricted anchorage systems to virtually two groups, namely: Mini-implants and miniplates[24]. The use of miniplates for orthodontic anchorage was initially conceived with the purpose of accomplishing lower molar distalization[21]. Eventually, however, these devices gained popularity when they were shown to be applicable in

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treatments involving anterior open bite through molar intrusion[24].

Miniplate benefits are grounded in greater stability and the fact that screw insertion is performed beyond tooth apices, which allows adjacent teeth to be moved in the anteroposterior, vertical[10] and cross-sectional orientations. Miniplates are particularly recommended in conditions requiring the application of stronger orthodontic forces or the joint movement of several teeth[3,22]. Since they do not interfere with dental movements, they also enable teeth in the miniplate area to be moved[6,10,12,21]. Additionally, miniplates do not rely on patient cooperation, except for the usual hygiene and maintenance of the orthodontic appliance[10]. Miniplates are also stable enough to resist orthodontic forces in a variety of tooth movements, besides affording high success rates[7,24].

Miniplates feature certain disadvantages in comparison with mini-implants, such as the need for more invasive insertion and removal surgeries, higher costs and, possibly, increased likelihood of infection[7,15,14].

There are, however, certain clinical conditions where miniplates have proved advantageous. The cases for which miniplates are best indicated involve intrusion, distalization and mesial drift of all maxillary and mandibular teeth, although these devices also provide adequate skeletal anchorage for various other tooth movements[12,18,23].

Miniplates offer a variety of clinical applications. One common indication is for treating anterior open bites. Most adults presenting with anterior open bite tend to have an excess height on the posterior dentoalveolar maxilla. These patients were usually referred for orthognathic surgery to perform the impaction of the maxilla's posterior portion with the resulting counterclockwise rotation of the mandible. Nowadays, less invasive treatment options are available through the insertion of miniplates for molar intrusion. Intrusion alters the occlusal plane, mandibular plane and anterior portion of the face, which ultimately closes the anterior open bite[10,11,19,20].

The intrusion of all posterior teeth to correct an anterior open bite can successfully and predictably be achieved with the aid of miniplates. Therefore, the purpose of the present article is to introduce a methodology aimed at treating anterior open bites by using miniplates for skeletal anchorage.

MINIPLATE INSERTION

Paramount among the factors that play an important part in the successful use of skeletal anchorage devices are the quality and quantity of cortical bone in the insertion site as well as the characteristics of the surrounding mucous membrane. Miniplates whose emergences in the oral cavity are surrounded by keratinized mucosa are statistically more prone to success than those located in the alveolar mucosa, more vulnerable to infection[1,8].

The influence of anatomical location on anchorage devices is also regarded as relevant. However, researchers' views on this issue are divergent. Whereas Kuroda et al.[15] assert that implants positioned in the posterior mandibular region are more failure-prone than those placed in the maxilla's posterior region, Chen et al.[1] claim that, in general, implants inserted in the maxilla exhibit less stability than those inserted in the mandible. Nevertheless, although maxillary bone is more porous, with a thinner cortex, which might predispose the maxilla to a lower success rate than the mandible[17], the experience we have amassed after inserting more than 400 miniplates has convinced us that, in actuality, there is no such difference in stability. The latter data will be published soon. The reasons and facts submitted by Kuroda et al.[15] remain obscure, although it has been speculated that other factors might have influenced their results, such as the amount of keratinized gingiva, greater hygiene difficulties and major surgical obstacles due to the mandible's anatomical morphology.

Miniplate planning should only be conducted after a detailed analysis of the patient's orthodontic documentation, definition of a treatment plan and the choice of a biomechanical method. Following the surgery, the site selected for implant insertion should be carefully assessed by taking into account bone quality and an analysis of the panoramic radiograph or tomographic image.

Moreover, a surgical guide should be fashioned to ensure an ideal positioning of miniplates. This is a very useful resource in anatomical structure injury prevention[10,21]. The choice of miniplate size and shape should be based on the length of the adjacent teeth's roots and the contour and density of the underlying bone. "L"-shaped miniplates are recommended for the mandible since their shorter legs are projected over the anterior region, making for easy and free access. In the maxilla, however, "Y"-shaped or "T"-shaped miniplates are often preferred since these are more easily contoured around the maxillary bone in the cortical bone regions, which prevents miniplates from getting loose or encroaching upon the maxillary sinus[19].

The miniplate insertion site is selected according to bone availability, mechanics of choice and integrity of the adjacent soft tissue[3]. Miniplates are usually inserted in the zygomatic process of the maxilla or in the mandibular body. The zygomatic process of the maxilla constitutes a suitable site in the maxilla owing to its solid bone structure and its safe distance from the upper molar roots[8].

Miniplate insertion surgeries are performed using local anesthetic. Formerly, the surgical technique involved a horizontal incision. Currently this technique has been replaced, in certain cases, by a vertical incision to streamline surgical operation, reduce scar size and facilitate healing[9]. After tissue dissection and bone exposure, the miniplate is fitted around the bone contour and attached with two or three screws.

The tissue is then closed and sutured, allowing the exposure of the miniplate to the inside of the oral cavity. The post-operative period of miniplate insertion is characterized by minor edema and pain[8]. Special hygienic care should be taken following miniplate insertion. Recommendations comprise the use of a post-surgical brush dipped in 0.12% clorexidine gluconate for 15 days and triclosan-based antiseptic throughout the treatment.

Although the application of orthodontic forces immediately after insertion is not ruled out, it is highly advisable to stand by and wait at least for another 2 weeks to elapse[23,24] with the purpose of allowing the patient's soft tissues sufficient time to heal.

MINIPLATE USE COMPLICATIONS

The use of miniplates for orthodontic anchorage can give rise to certain complications.

One of the most common consists in inflammation and/or infection around the miniplate due to an accumulation of bacterial plaque resulting from the patient's inadequate hygiene[9,21]. Once an infection is cured with the aid of irrigation, topic hygiene and anti-bacterial therapy, frequently, the miniplate can be used again. Inflammations are usually easily controlled with the use of oral antiseptics and adequate brushing[1]. The biofilm which gathers on the mini-implant surface – once treated with clorexidine or a fluoride solution – significantly reduces the presence of viable microorganisms. Adverse bacterial activity, however, is also influenced by the substrate surface and responds to rugosity and superficial chemical composition[4].

Another miniplate-related complication, albeit uncommon, is associated with the jugal mucosa being irritated by the skeletal anchorage device. This feature causes the patient to feel some discomfort but does not usually impact miniplate success rate[9].

One factor worthy of note, which can lead to orthodontic anchorage failure, is the nearness of mini-implants to the tooth roots since such proximity renders bone remodeling around the mini-implant extremely difficult while allowing the transmission of occlusal forces from the teeth to the mini-implants[16]. However, miniplates are usually positioned away from tooth roots and the screws used to attach the miniplate hardly ever touch the lamina dura surrounding the tooth roots.

Another factor that could be associated with the risk of losing skeletal anchorage systems is a high traction force, although a clear definition of this phenomenon can be elusive. A number of unsuccessful attempts have been made to associate miniplate failure with different types of forces, such as those produced by chain elastics, nickel-titanium springs or chain elastics combined with springs.

BIOMECHANICS TO CORRECT ANTERIOR OPEN BITE USING MINIPLATES

Intrusive vertical force is produced by means of a chain elastic or nickel-titanium spring attached to the miniplate's exposed link and to the molar tube (Fig. 1). Segmented as well as straight arch wires can be used (Fig. 2A). Although the possibility has been raised that the use of straight arch wires might cause incisor overeruption due to occlusal plane rotation[19], the authors' experience has shown that such effect does never occur (Fig. 2B), as already published elsewhere[11].

To avoid molar buccal rotation while applying intrusive force, the use of a contracted rectangular arch wire is indicated or, preferably, a transpalatal bar or lingual arch (Fig. 3)[9,10,19,20]. Should any undesirable alteration occur in the cross-sectional plane, this can be solved by bonding a tube directly onto the miniplate while concurrently activating a power arm in the same orientation as the corrective force (Fig. 4).

Molar intrusion in only one of the maxillas can be accomplished by correcting open bites of up to 3mm[10]. Open bites of more significant sizes should be corrected with the aid of miniplates in both arches. The simultaneous intrusion of upper and lower molars allows a greater counterclockwise mandible rotation and more significant skeletal changes[14].

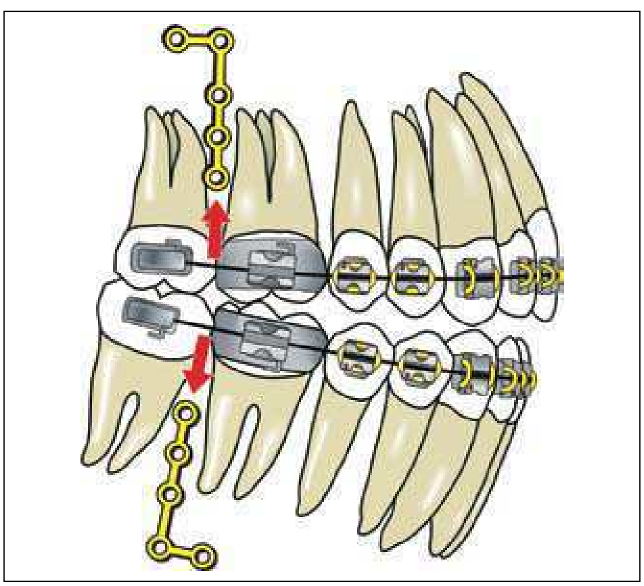

FIGURE 1 - A diagram depicting the application of an intrusive force from the occlusal-most miniplate link to the appliance.

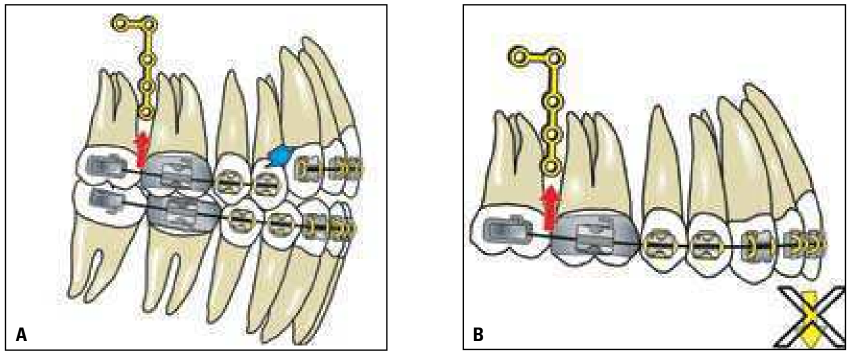

FIGURE 2 - Intrusion-related mechanical issues. **A)** Both continuous arch wires and segmented arch wires can be utilized. Segmented arch wires (blue arrow) are best suited for open bites restricted to the anterior region. **B)** When continuous arch wires are used, incisor extrusion does not occur (X on the yellow arrow), as previously suggested[18], but not demonstrated in the literature.

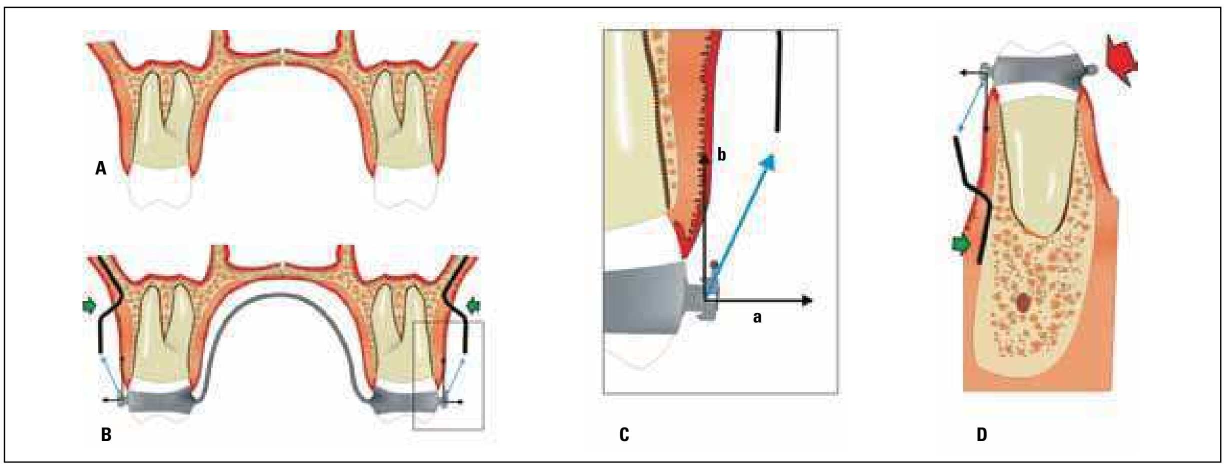

FIGURE 3 - Diagrams representing cross-sections of the maxilla in the first upper molar region. **A)** Prior to placing the appliance. **B)** Miniplate insertion (green arrow) and application of intrusion forces (blue arrows). **C)** Intrusive forces decomposed into an expansive component **(a)** and an intrusive component **(b)**. Expansive components cancel out one another in the presence of a palatal bar or **(D)** lingual arch (red arrow).

FIGURE 4 - In order to correct any cross-sectional alterations in the upper and lower dental arches, a bracket or tube can be bonded directly onto the miniplate and be used as anchorage for arch wires, springs and other devices. To this end, two small grooves should be made in the miniplate link to retain the bonding resin.

CLINICAL CASES

Case 1 – miniplates in maxilla and mandible, placed unilaterally

Male patient, 21 years and 9 months old, exhibited a Class I malocclusion with severe open bite, which caused only the right second molars to occlude. There was vertical asymmetry featuring inclined maxilla, lower on the right hand side. TMJ radiographs and scintigraphic images were requested to check for possible left condyle morphological alterations and hypercaptation. An analysis of these exams ruled condyle hyperplasia or neoplasia (Fig. 6).

Treatment goals

The treatment goal was to close the open bite and achieve adequate overbite and overjet.

Treatment alternatives

The patient was offered the following treatment alternatives:

1. Orthodontic treatment combined with orthognathic surgery in the maxilla and mandible.
2. Orthodontic treatment with the insertion of two titanium miniplates in the right hand side, one in the maxilla and one in the mandible.

Treatment progress

After aligning and leveling lower and upper teeth, surgical guides were fashioned to provide orientation for the surgeon as to the desired miniplate position. Prior to surgery, a palatal bar and lingual arch wire were inserted with the purpose of preventing posterior teeth buccal rotation during the intrusion process. These appliances had their arch wires untempered on the left hand side to attain greater flexibility and allow for adequate movement.

Two weeks after miniplate insertion on the right hand side of the mandible and maxilla chain elastics were placed between the miniplates and the first molars with the aim of intrud-

FIGURE 5 - Initial photographs showing an asymmetric open bite. **A, B , C)** Extraoral image and **D, E, F)** intraoral images.

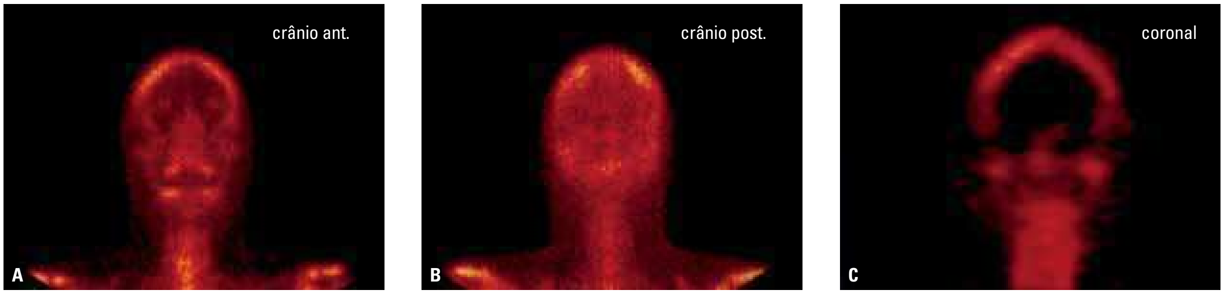

FIGURE 6 - Scintigraphic images: **A)** anterior section, **B)** posterior section and **C)** coronal section.

FIGURE 7 - Treatment progress with the implementation of chain elastics between the miniplates and the right first molars in order to intrude the posterior teeth.

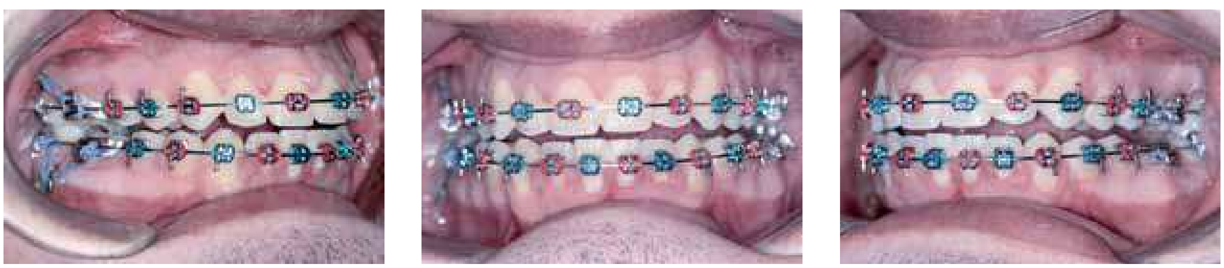

FIGURE 8 - Molar intrusion progress and the resulting open bite closure where the chain elastics were further extended to the second molars.

ing the posterior teeth (Fig. 7). Subsequently, intrusion elastics were also extended the second molars (Fig. 8). As soon as an adequate overbite was achieved, a speech therapy treatment was launched which lasted throughout the entire orthodontic treatment.

Results

The upper and lower molars were intruded and the mandible underwent a counterclockwise rotation (Fig. 9). Table 1 displays the initial and final cephalometric measurements with a decreased lower facial height. At the end of the orthodontic treatment, proper dental relationships were established (Fig. 10). A 3 x 3 lower retainer was put

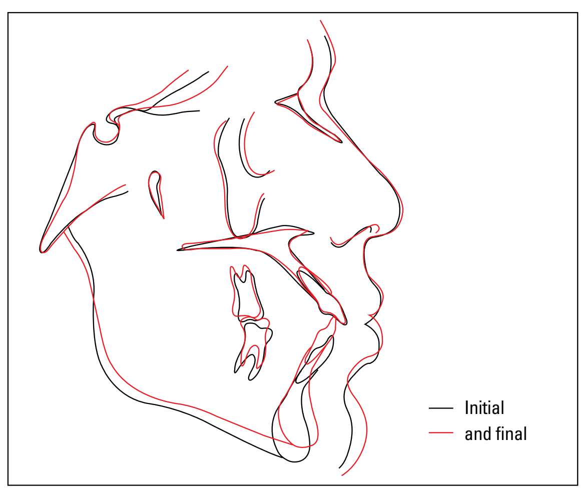

FIGURE 9 - Superimposed Initial and final cephalometric tracings showing upper and lower right molars' intrusion and the resulting counterclockwise mandible rotation.

FIGURE 10 - Final photographs with proper dental relationships in place. **A, B , C)** Extraoral image and **D, E, F)** intraoral images.

Table 1 - Initial and final cephalometric measurements (Case 1).

measurements	norm	initial	final
SNA	82°	74°	76°
SNB	80°	79°	81°
ANB	2°	- 4°	-5°
1/. NA	22°	47°	38°
1/-NA	4mm	23mm	22mm
/1.NB	25°	39°	33°
/1-NB	4mm	12mm	10,5mm
/1.1/	131°	98°	114°
NB-Pog		3mm	3mm
SN.Poi		19°	11°
SN.Pos		15°	14°
SN.GoGn	32°	31°	29°
AFAI		95mm	91mm
g-sn		68mm	70mm
sn-stms		34mm	34mm
stmi-me		68mm	68mm
stms-stmi		0mm	0mm

* g = glabella; sn = subnasal; stms = upper stomium, stmi = lower stomium; me = mentum in soft tissue

in place. Additionally, for the upper arch, wrap-around style removable retainers were produced. One conventional, for day time use, and one with a palatal grid in the right hand side region, for night time use. After six months of orthodontic treatment had elapsed, only the night time retainer was maintained.

Case 2 – miniplates in mandible, placed bilaterally

Female patient, age 30, presented with an adequate anteroposterior relationship, but a discomforting anterior open bite (Fig. 11). There was no significant crowding in the upper and lower arches. The patient had an osseointegrated implant in the region of tooth 25, which had a significant impact on skeletal anchorage planning.

Treatment goals

The treatment goal was to correct overbite and overjet as well as open bite.

FIGURE 11 - Initial extraoral **(A, B, C)** and intraoral photographs **(D, E, F)** showing anterior open bite.

FIGURE 12 - Intraoral images with surgical guide positioned in the lower arch.

FIGURE 13 - Treatment progress after activation of the orthodontic appliance using chain elastics propped on the miniplate to achieve lower molar intrusion.

Treatment alternatives

The patient was offered the following treatment alternatives along with a thorough explanation of the advantages and disadvantages of each alternative.

1. Orthodontic treatment using anterior vertical elastics for incisor and canine extrusion.

2. Orthodontic treatment with the insertion of two titanium miniplates in the mandible for molar intrusion. Miniplates were not indicated for the maxillary region owing to the presence of an osseointegrated implant in the region of tooth 25.

Treatment progress

Treatment consisted in bonding an orthodontic appliance on the lower arch and included the insertion of a lingual arch wire to avoid lower teeth buccal rotation during intrusion. Three months after starting lower teeth alignment and leveling a surgical guide was fabricated which indicated to the surgeon the desired position of the miniplate's occlusal-most link (Fig. 12).

Two weeks after miniplate insertion surgery, intrusion mechanics was started. The wait time was only meant to allow all adjacent soft tissue to heal adequately, thereby ensuring for the patient a more comfortable manipulation of the affected region. This mechanics was implemented by means of chain elastics to intrude molars (Fig. 13). However, the method can also be well implemented using springs. Intrusion mechanics was conducted using 0.017" x 0.025" stainless steel arch wires. After open bite closure the patient began a speech therapy treatment which lasted throughout the entire orthodontic treatment.

FIGURE 14 - Final photographs showing that proper occlusion was accomplished. **A, B , C)** Extraoral images and **D, E, F)** intraoral images.

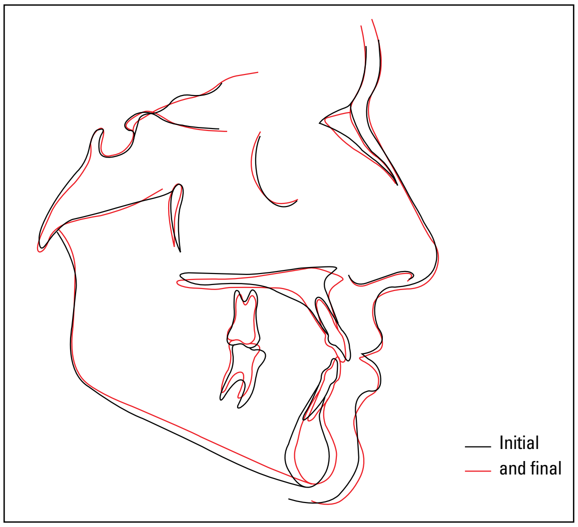

FIGURE 15 - Initial and final cephalometric tracings are superimposed, showing right upper and lower molars' intrusion and the resulting counterclockwise mandible rotation.

Table 2 - Initial and final cephalometric measurements (Case 2).

medidas	norma	inicial	final
SNA	82°	73°	75°
SNB	80°	75°	76°
ANB	2°	- 2°	-1°
1/. NA	22°	32°	30°
1/-NA	4mm	10,5mm	7,5mm
/1.NB	25°	22°	23°
/1-NB	4mm	3,5mm	4,5mm
/1.1/	131°	129°	127°
NB-Pog		4mm	4,5mm
SN.Poi		17°	14°
SN.Pos		17°	18°
SN.GoGn	32°	32°	32°
AFAI		69mm	67mm
g-sn		63mm	65mm
sn-stms		22mm	22mm
stmi-me		48mm	48mm
stms-stmi		0mm	0mm

* g = glabela; sn = subnasal; stms = estômio superior; stmi = estômio inferior; me = mento em tecido mole.

Results

The orthodontic treatment was finished with an adequate overbite (Fig. 14), with lower molar intrusion and mandibular counterclockwise rotation (Fig. 15). Table 2 displays the initial and final cephalometric measurements. The retainers used in this case were similar to those used in the previous case. A lower 3 x 3 fixed bar and two wraparound style removable retainers – one conventional, for day time use during 6 months and one with a anterior palatal grid, for night time use during an indefinite period of time.

The patient was instructed about the importance of maintaining speech therapist control after the orthodontic treatment had been completed.

Case 3 – miniplates in maxilla, placed bilaterally

Female patient, 22 years and 8 months old, whose clinical exam disclosed Class I malocclusion with anterior open bite.

Treatment goals

The treatment goal was to correct anterior open bite while providing adequate overbite and overjet.

Treatment alternatives

The patient was offered the following treatment alternatives:

1. Orthodontic treatment using anterior vertical elastics.

2. Orthodontic treatment using skeletal anchorage – insertion of two titanium miniplates on the right and left hand sides of the maxilla.

Treatment progress

Initially, lower and upper teeth were aligned and leveled. The surgical guide was then inserted (Fig. 16) along with a palatal bar in order to prevent undesired buccal rotation of the posterior teeth.

Two weeks after insertion of the miniplates in the maxilla, 0.017" x 0.025" stainless steel arch wires and chain elastics were placed between the

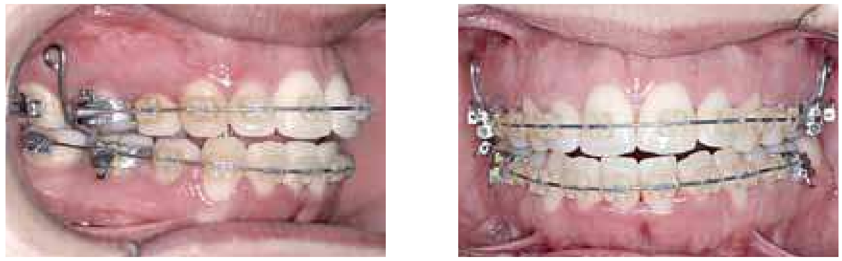

FIGURE 16 - Fixed orthodontic appliance was bonded to the upper and lower arches with a surgical guide positioned in the upper arch to provide orientation to the surgeon regarding the desire miniplate position.

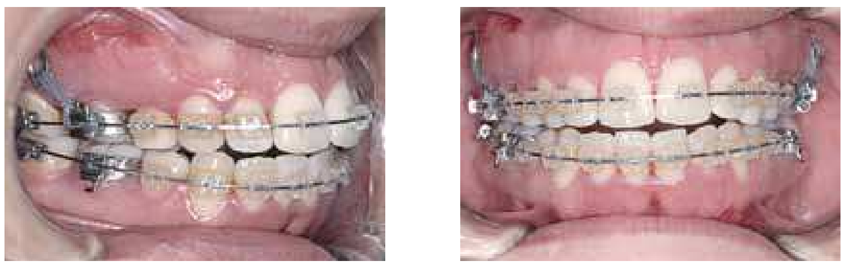

FIGURE 17 - Beginning of upper molar intrusion movement by means of chain elastics attached to the miniplates.

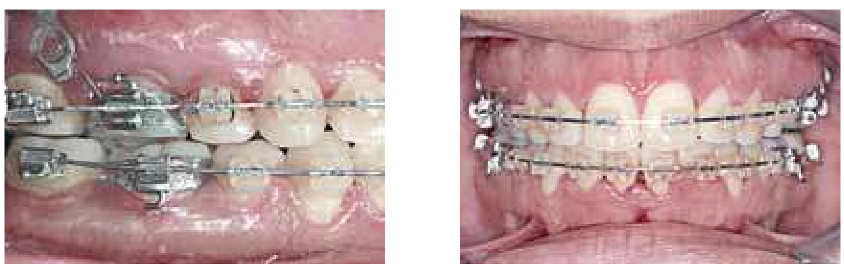

FIGURE 18 - Retention of the intrusion movement by tying stainless steel arch wires.

miniplates and the upper first molars aimed at intruding the latter (Fig. 17). As soon as an adequate overbite was achieved, intrusion was retained using stainless steel arch wires between the miniplates and the molars (Fig. 18). From that moment onwards the patient had to undergo speech therapy treatment and was made aware of how important it was to maintain it.

Results

The orthodontic treatment was finished having achieved adequate tooth relationships while the open bite had been corrected (Fig. 19). Table 3 displays the initial and final cephalometric measurements for this case.

There occurred upper molar intrusion, which led to a counterclockwise rotation of the mandible and a decrease in lower facial height (Fig. 20). The same retainers used in the previous cases were also employed in this case. A lower fixed 3 x 3 bar with two wraparound style removable retainers: One conventional, for daytime use and one with a palatal grid, for night use.

Six months after orthodontic treatment completion, only the night time retainer remained in use.

CONCLUSIONS

Anterior open bites can be treated with efficacy and efficiency by means of miniplates, which pro-

FIGURE 19 - Final intraoral photographs with proper dental relations established.

Table 3 - Initial and final cephalometric measurements (Case 3).

measurements	norm	initial	final
SNA	82°	73°	75°
SNB	80°	75°	76°
ANB	2°	- 2°	-1°
1/. NA	22°	32°	30°
1/-NA	4mm	10,5mm	7,5mm
/1.NB	25°	22°	23°
/1-NB	4mm	3,5mm	4,5mm
/1.1/	131°	129°	127°
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SN.Poi		17°	14°
SN.Pos		17°	18°
SN.GoGn	32°	32°	32°
AFAI		69mm	67mm
g-sn		63mm	65mm
sn-stms		22mm	22mm
stmi-me		48mm	48mm
stms-stmi		0mm	0mm

* g = glabella; sn = subnasal; stms = upper stomium/ stmi = lower stomium; me = mentum in soft tissue

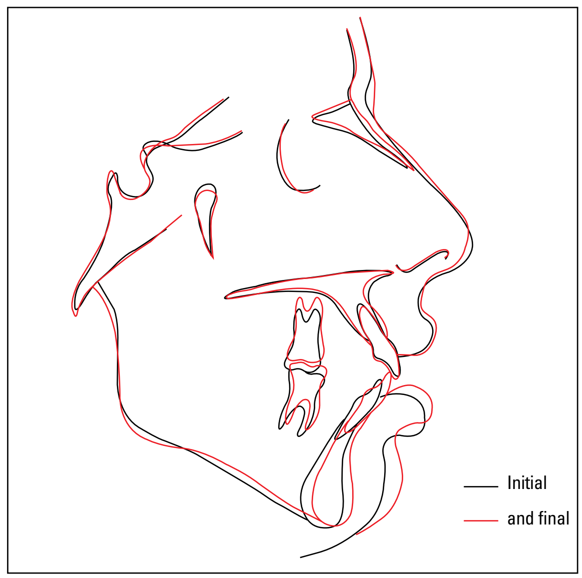

FIGURE 20 - Superimposed initial and final cephalometric tracings showing upper molar intrusion and the resulting counterclockwise mandible rotation.

vide anchorage for posterior teeth intrusion. Such intrusion results in a counterclockwise rotation of the mandible, which causes a decrease in lower facial height and an anterior displacement of hard and soft tissue pogonions. A wide range of such problems are amenable to treatment using this technique, which prevents orthognathic surgeries or, at least, can simplify treatment of certain conditions.

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