

Tooth intrusion using mini-implants

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Abstract

Introduction: Amongst the different types of orthodontically-induced tooth movements, intrusion undoubtedly features as one of the most difficult to achieve. Conventional intrusive mechanics, although viable, involves a rather complex side effect control. This is due, to a large extent, to a difficulty in securing a satisfactory anchorage. Within this context, mini-implants offer an effective skeletal anchorage which has become an invaluable asset to orthodontists since it renders the intrusion of both anterior and posterior teeth an increasingly streamlined procedure from a mechanical standpoint. **Objective:** It is the purpose of this article, therefore, to describe and demonstrate clinically the various ways in which mini-implant can be utilized as an anchorage device to promote intrusion.

Keywords: Mini-implant. Intrusion. Skeletal anchorage.

INTRODUCTION

In numerous orthodontic treatments, adequate anchorage planning is paramount for a successful therapy. Tooth intrusion, be it aimed at correcting an exaggerated overbite or an anterior open bite, be it for correcting extruded teeth due to missing antagonists, poses a considerable mechanical challenge, given the difficulty in controlling undesirable movements of the anchorage units. Obviously, throughout the years, the literature has reported satisfactory results with the use of auxiliary intraoral appliances and extraoral headgear. Nevertheless, it is not always an easy task to enlist a patient's cooperation owing to the physical discomfort and/or esthetic handicap inherent in these appliances.

In this case, mini-implants emerge as an excellent alternative. The development of mini-implants in the few last years has enabled efficient anchorage, requiring no tooth support and with no esthetic compromise whatsoever. Additionally, no patient cooperation is required^{1,2}. These devices have been used in the orthodontic office with increasing frequency in cases where an inadequate number of dental units stand in the way of an effective anchorage, or even only to simplify orthodontic mechanics and make it more predictable¹.

This article is aimed at summarizing and illustrating the various situations where mini-implant use is possible, specifically focusing on tooth intrusion. Some timely recommendations are also offered to ensure that the desired results are achieved.

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INCISOR INTRUSION

Anterior teeth intrusion is indicated in some excessive overbite cases and has been performed traditionally by means of intrusion arch wires, the confection of stair-stepped archwires in the anterior region, or the use of steep curve arch wires on the upper arch, or reverse curve on the lower arch. In many situations, however, the side effects caused by this mechanics are unavoidable, especially extrusion or tipping of the anchorage units. By resorting to skeletal anchorage with the use of mini implants, all other teeth are safe from any undesirable movements.

The ideal position for inserting mini-implants when the purpose is to intrude upper incisors will depend on how much tipping they have. When they are vertically positioned or tipped backwards, as is the case with Angle's Class II, Division 2, one single mini-implant is recommended⁸ to be placed on the median line, as high as possible and

close to the anterior nasal spine. To intrude lower incisors similarly positioned or tipped backwards, one mini-implant should be placed as low as possible between the centrals^{6,8,11}. In this position, the force line will extend across the front of the set's resistance center, thereby generating an intrusion effect combined with the buccal tipping of these units (Fig. 1).

When incisors present with reasonable axial tipping and no changes are therefore required, the force action line should be made to run through as closely as possible to the resistance center of the set of teeth which are targeted to be moved^{6,11}. To this end, the use of two mini-implants is recommended, one on each side, positioned between lateral incisors and cuspids (Fig. 2). A typical example of two mini-implants being used with the aforementioned objective is shown in figure 3. In this case, since the patient had only three lower incisors, the choice was made to remove

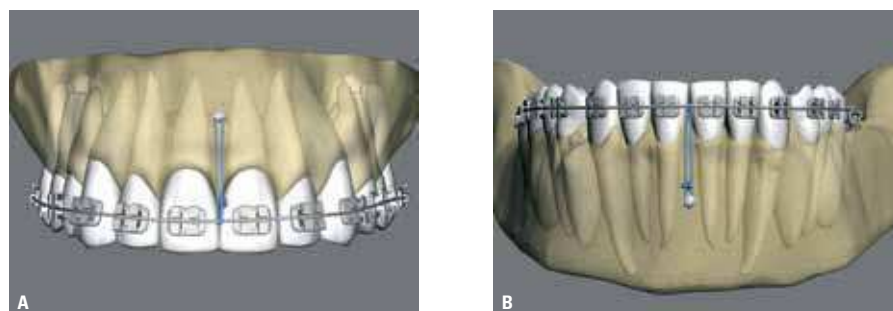


FIGURE 1 - Upper and lower incisor intrusion when it is desirable to have these teeth tip buccally.

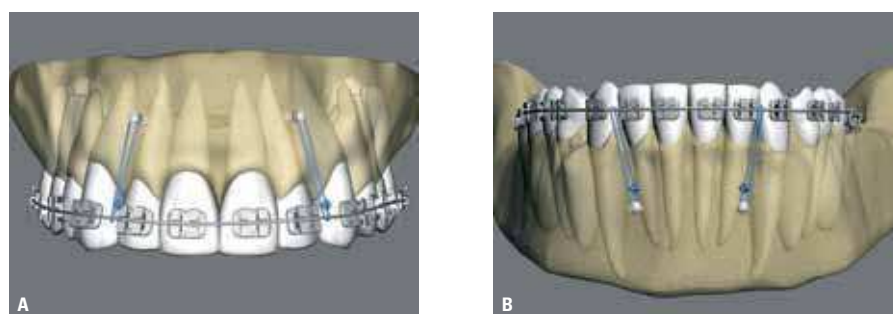


FIGURE 2 - Upper and lower incisor intrusion when it is desirable to maintain teeth's axial tipping.

one, which allowed the cuspids to drift and occupy the position of the lateral incisors. This set of teeth was originally tipped towards the buccal (IMPA=109°). The aim was to induce an intrusion, which would level the Spee curve without aggravating the inclination. As can be observed, the intrusion movement did take place and the lower incisor buccolingual inclination ultimately showed a slight improvement (IMPA=107°).

When performing lower teeth retraction, in Angle's Class II, Division 1 or Angle's biprotru-

sion Class I, treated with bicuspid extraction, an overbite increase may occur, along with incisor axial inclination as teeth move towards the posterior region. In this situation, it is recommended that a mini-implant be inserted at the median line, based on the reasoning described above. Another possibility is the use of vertical loop retraction arch wires, which promotes the incorporation of incisor root lingual torque and allows the orthodontist to make compensatory bends.

As intrusion occurs, it is advisable to check the

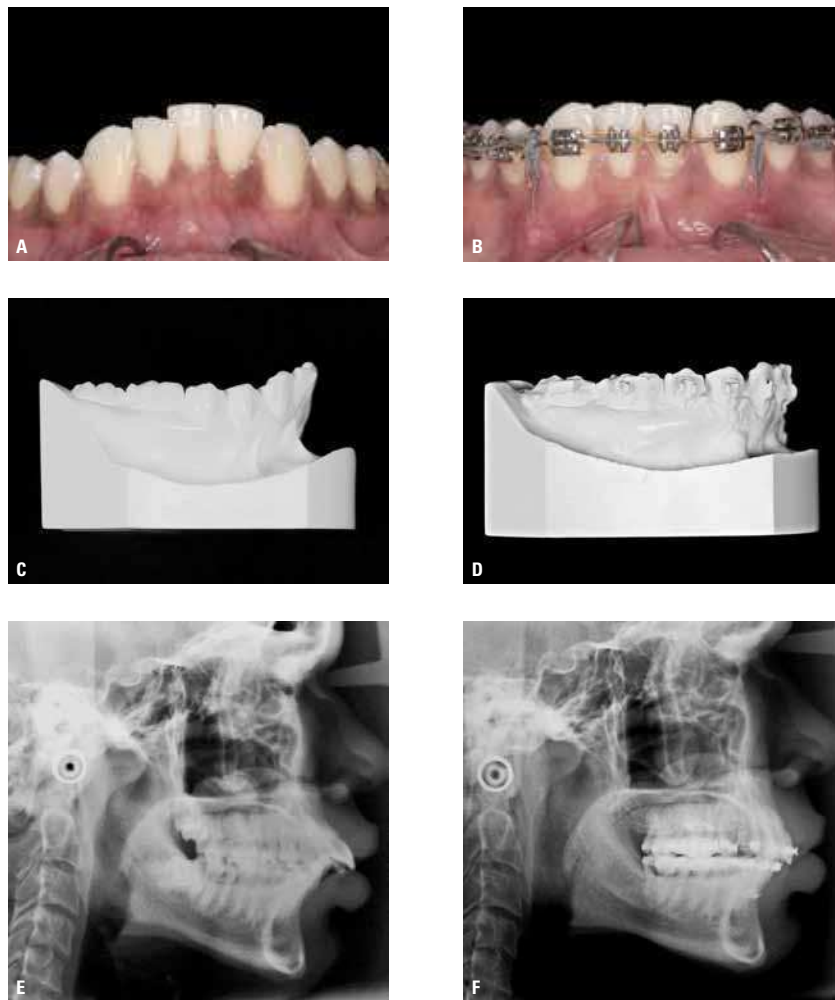


FIGURE 3 - Lower anterior teeth intrusion with embedded mini-implants, inserted in the alveolar mucous membrane (A, B). C and D show Spee curve leveling. In E and F, a slight improvement in the buccolingual inclination of the intruded units can be observed.

arch wire form and the occlusal plane from an anterior view, since changes may occur if intrusion does not take place symmetrically on both the right and left hemi-arches. Another important factor to be monitored is lower anterior torque, which is often lost when intrusion is achieved using light arch wires¹⁴.

CUSPID INTRUSION

In conventional mechanics, cuspids are traditionally intruded by means of arch wires with second order bends or bypass bends associated with elastics and using the neighboring teeth for anchorage. In these cases, the extrusive component of the anchorage units cannot be avoided. Another alternative is the use of segmented arch wires relying on posterior teeth for anchorage. When a patient presents with dental losses in this area or with periodontal impairment in the existing teeth, this type of mechanics should be ruled out.

With the use of mini-implants, these undesirable effects and/or limitations are no longer an issue. When one wishes to intrude a cuspid tooth while keeping its axial inclination, the buccal insertion of two mini-implants is recommended, one on the mesial and one on the distal region of the tooth targeted to be intruded. This approach is important since the use of only one mini-implant is bound to generate, in addition to the intrusive force, a distal or mesial force component - de-

pending on mini-implant position - which is likely to tip the tooth. In this example, buccal activation alone will produce a root palatal torque component as cuspid intrusion occurs. To control this undesirable effect a straight .019" x .025" stainless steel archwire could be fashioned and placed alongside the cuspid's buccal surface immediately below the bracket. It should be underscored that a contact between the archwire and the teeth surface would be essential for controlling this effect. Such contact should, therefore, be monitored and adjusted at each new appointment¹ (Fig. 4).

Another available alternative would be the insertion of a mini-implant in the buccal area, in the cuspid's mesial region, and another one in the palatal area, in the distal region, or vice versa, and then activating the whole set by placing an elastic connecting the two mini-implants across the center of the cuspid crown. It is often necessary to place a strategic composite resin bridge on the cuspid crown to stabilize the elastic in its position.

POSTERIOR TEETH INTRUSION

The need to intrude posterior teeth is mostly due either to a loss of antagonist units, or when there is vertical excess on the posterior region causing an anterior open bite³. Compared with anterior tooth intrusion, posterior intrusion is harder to achieve owing to molars and bicuspid typically having more voluminous roots, which causes the

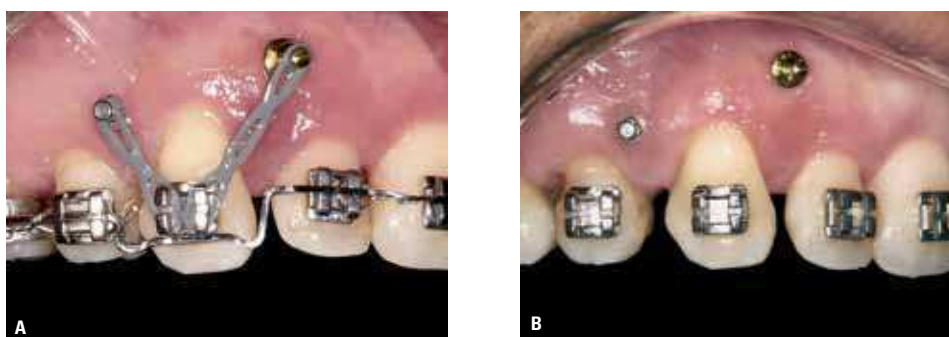


FIGURE 4 - Upper cuspid intrusion using a .019"x .026" archwire alongside the unit to avoid buccal tipping.

alveolar bone to respond more significantly, extending treatment length. The three-dimensional control of tooth position is instrumental in posterior intrusion success. As well as the vertical position, the arch form, inclination of the teeth, occlusal plane inclination and posterior torque should be planned according to the each individual treatment objectives¹⁴. Most cases require tooth body movement so that certain difficulties should be considered, such as the resistance center location, which is influenced, to a certain extent, by individual differences; the root shape and the amount of bone tissue, in addition to anatomical conditions, which often prevent the insertion of mini-implants in ideal sites^{7,14,21}.

Single unit intrusion

A loss of dental units in the posterior region often brings about an extrusion in teeth on the antagonist arch. This extrusion not only compromises the space required for prosthetic rehabilitation but can also cause inconvenient results, such as periodontal defects and occlusal interferences during functional movements²⁵. It is, thus, important to correct this problem by intruding the tooth in question.

On the upper arch, in the event that one single posterior tooth requires intrusion, two mini-implants should be inserted, one buccally and one palatally, the former on the mesial and the latter on the distal region. The mini-implants, if

placed accordingly, will provide a controlled vertical movement without undesirable inclinations²⁵. Force can be applied either by extending elastics between the mini-implants and the orthodontic accessories installed on the buccal and palatal surfaces of the tooth in question (Fig. 5A), or by extending elastics directly on the tooth's occlusal surface and connecting one mini-implant to the other (Fig. 5B). In this case, caution should be exercised not to allow the force action line to cause the elastic to drift towards the mesial or distal region, which might lead the dental unit which is undergoing intrusion to tip^{1,2,16}.

Intrusion of groups of teeth

Prior to the advent of mini-implants, the major alternatives for rehabilitating a patient who presented with a group of extruded teeth in the posterior region were often accomplished either by stripping the occlusal surfaces of these teeth or through a surgical procedure combined with impaction (embedding)^{5,17,23}.

Nowadays, with the help of skeletal anchorage, a controlled orthodontic intrusion of these units can be achieved. In the event of a group of teeth requiring intrusion, the whole group should be handled all together in a group^{1,2,4}. Brackets can be bonded to the buccal and palatal surfaces of the teeth involved and connected with segmented archwires; an orthodontic archwire segment can be bonded directly to the buccal and/or palatal

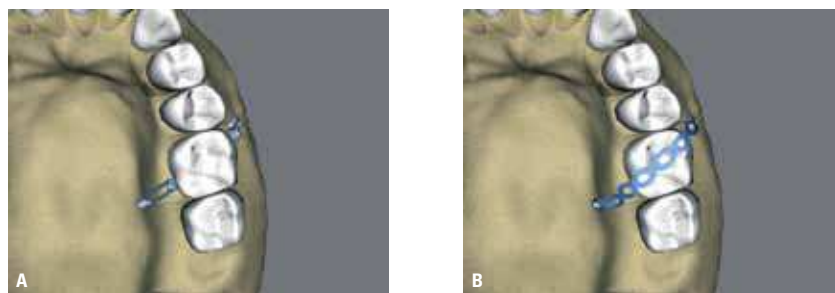


FIGURE 5 - Buccally and palatally placed mini-implants for intruding the upper first molar, activated with elastic on an archwire, via the buccal and palatal regions (A) and with an elastik chain, via the occlusal surface (B).

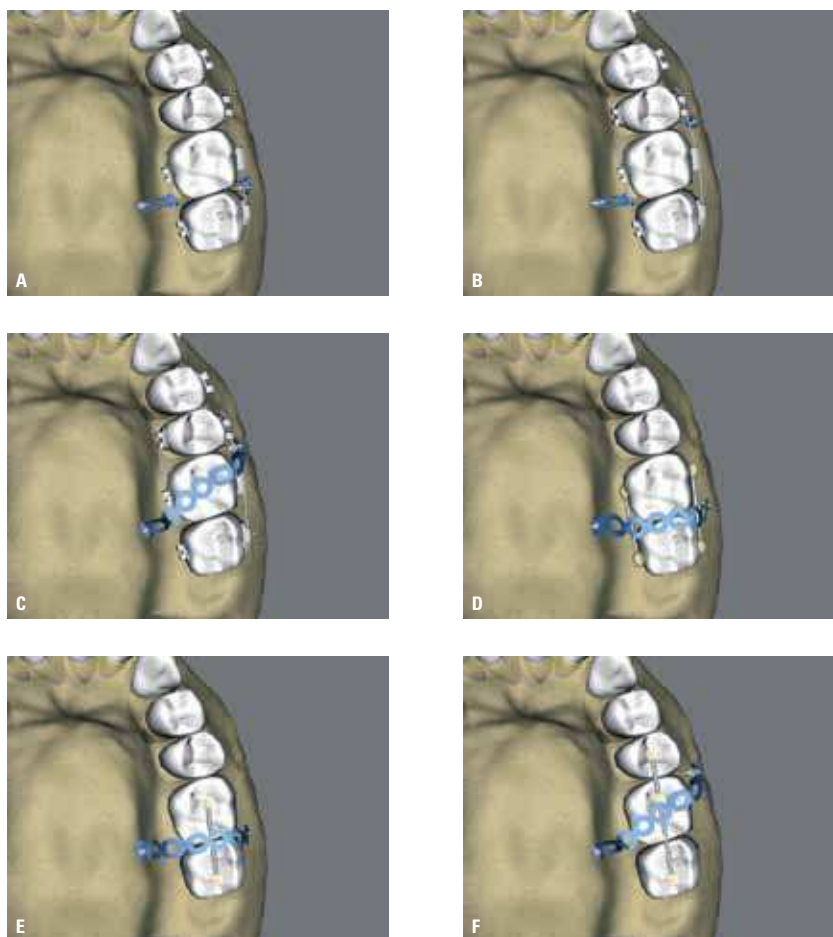


FIGURE 6 - Different forms of intrusion of a group of posterior teeth with some of the segments attached to brackets on the buccal and palatal regions (**A, B and C**); bonded directly to these surfaces (**D**) or attached to the occlusal surface (**E, F**). As can be seen, activation can be achieved using elastic on the archwire attached to the arch segments (**A, B**) or with an elastik chain running alongside the occlusal surface (**C a F**).

surfaces; alternatively, a single orthodontic archwire segment can be attached to the occlusal surfaces, provided it does not cause any interference (Fig. 6).

Even for a wider number of teeth, two mini-implants are usually sufficient to bear the load^{2,3}. As can be seen in figure 7A, a loss of teeth in the right posterior segment of the lower arch determined the extrusion of the second bicuspid and the first and second molars. Since the first molar was more extruded than the other teeth, two mini-implants were initially inserted to achieve intrusion (Fig. 7B) until the teeth in the right

hemi-arch were leveled. An archwire was then attached to the occlusal surface of the bicuspid and the molars and the system was once again activated using elastic, and ultimately intruded all together in a group (Fig. 7C and 7D). Figure 7e shows the result achieved. Another example of the use of mini-implants with the same purpose can be viewed in figure 8.

Anterior open bite correction

Anterior open bite, especially in adult patients, is a condition which requires great effort to correct and retain^{8,9,10}. From a dentistry point of view,



FIGURE 7 - A clinical case showing upper posterior teeth extrusion due to missing antagonist elements (A). In B, activation to achieve intrusion of a slightly extruded first molar, using two mini-implants. As can be observed, some resin was added to the mesiopalatal cuspid with the purpose of providing orientation for placement of an elastik chain, thereby preventing a drift to the mesial region, which might cause the cuspid to tip. An archwire was then attached to the occlusal surface C of the bicuspid and molars and the system was once again activated using elastic for group intrusion (D). In E, the resulting movement can be observed.

its etiology may be connected to a deficient alveolar growth in the anterior region, an excessive alveolar growth in the posterior region, or both. In general, during dentition development, these issues can be easily addressed. However, as the growth phase ends, solutions become increasingly hard to work out through conventional methods.

When planning involves posterior teeth intrusion, mini-implants once again emerge as an excellent anchorage option. In the example shown in figure 9, an intrusion was necessary for both cases. Thus, a mini-implant was used on the buccal and one on the palatal region, on both the right and left sides. Since the teeth in the posterior region featured perfect alignment, the intrusion force was applied with straight wires. Under certain conditions, attaching an arch segment to the teeth's palatal surfaces is recommended in order

to prevent elastics or springs - which are used to achieve the intrusion - from touching the palatal mucous membrane.

Another alternative would be to insert mini-implants via the buccal region only. In this case, to control torque on the teeth undergoing intrusion it is suggested that a transpalatal bar be used on the maxilla, away from the palate by a distance identical with the number of millimeters planned for the intrusion; and on the mandible, a lingual bar, kept away from the incisors^{12,19,24} (Fig. 10). Should there be a transverse-related issue, the appliance used for the upper arch expansion can be maintained, as shown in figure 11. In this case, the use of a Hyrax screw was preferred. It was placed away from the palate on a par with the desired intrusion.

Another detail requiring utmost attention is

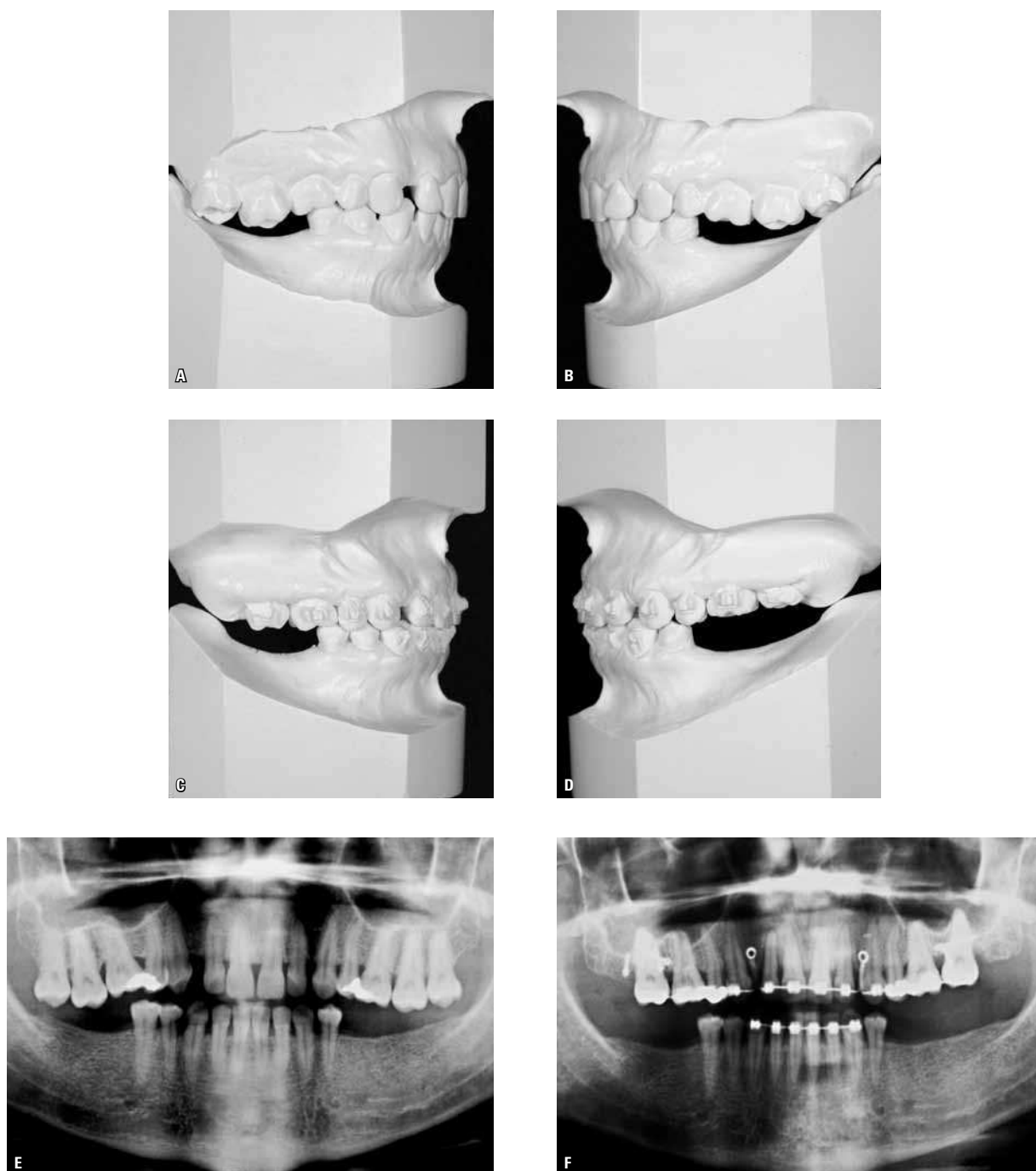


FIGURE 8 - Intrusion of upper arch posterior units to allow rehabilitation using screws in the lower arch. A comparison between the models with the initial radiographs and the period after molar intrusion shows a clear improvement.

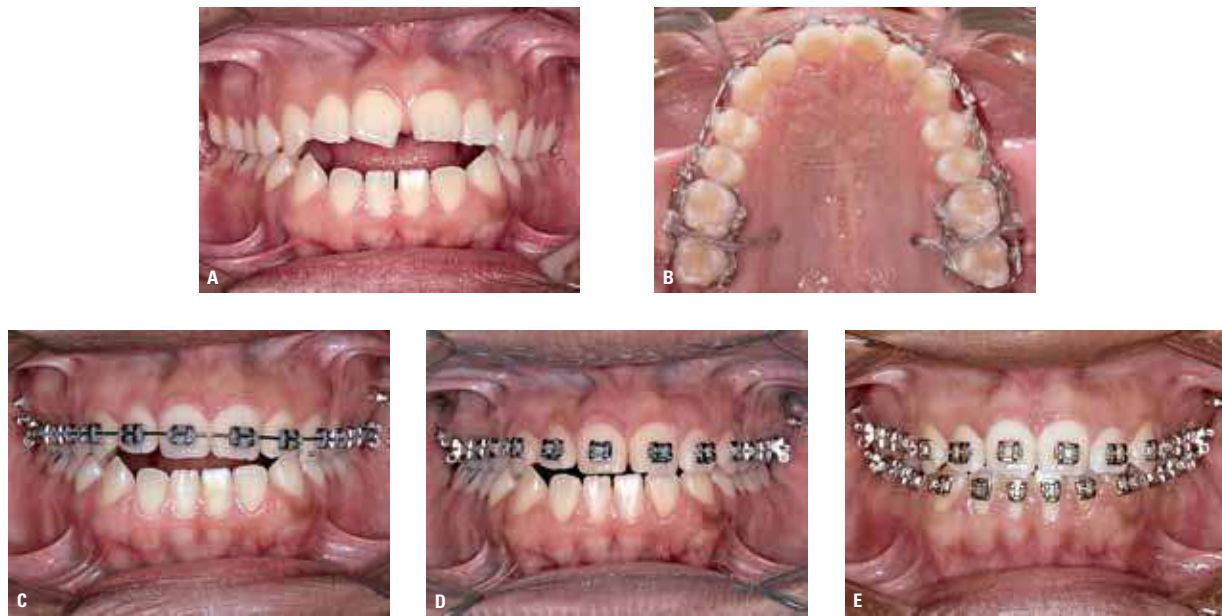


FIGURE 9 - Correction of anterior open bite using posterior segment intrusion of the upper arch. This movement was accomplished by means of mini-implantimplanted in the buccal and palatal surfaces between the first and second molars. Illustration E shows the current condition.

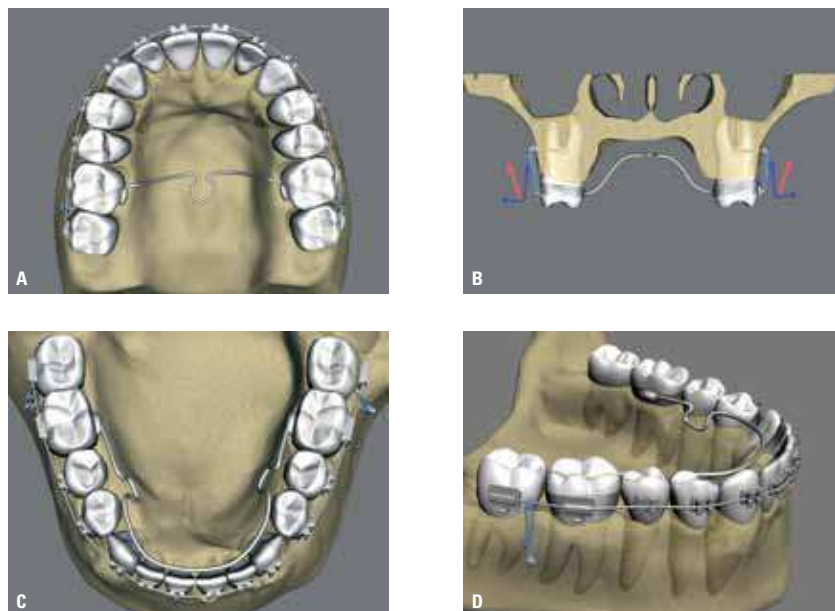


FIGURE 10 - Intrusion of posterior teeth using mini-implants via the buccal region only. To avert tipping toward the force line orientation, a palatal bar should be installed on the upper arch, but kept at a distance from the palate; and on the lower arch, a lingual bar, at a distance from the incisors.

the anteroposterior incisor relationship. If the initial overjet is negligible, incisor trauma may ensue when closing the bite owing to the mandible's counterclockwise rotation. Thus, to stave off this problem, the lower teeth should be retracted first, thereby creating the necessary overjet¹⁹.

With the purpose of avoiding a relapse, a high headgear traction force can be recommended for night use. It is also important for the patient to be monitored by a speech therapist to ensure proper tongue positioning, thus avoiding future problems related to changes in incisor position^{19,20}.

OCCLUSAL PLANE CORRECTION

In cases of occlusal plane inclination from a frontal view, both in the anterior and posterior regions, the insertion of mini-implants at strategic sites allows the use of a discrete force magnitude on either side, thereby facilitating the correction of such defect. The same applies to both the upper and lower arches²⁴. One example of such pro-

cedure in the anterior region can be seen in figure 12. The patient's frontal view featured a significant difference between the right and left sides, with the right side looking clearly lower than the other side. A mini-implant was then installed between the cuspid and the bicuspid and the straight wire which was inserted in the orthodontic appliance was activated directly.

More severe occlusal inclinations can be found in patients who have lost dental units, patients featuring facial asymmetries, severe muscle dysfunctions and certain localized pathologies. This issue is hard to address by means of conventional orthodontic resources alone. The use of mini-implants, in such cases, goes a long way towards streamlining the procedure for intruding an un-leveled arch segment⁶.

GENERAL CONSIDERATIONS

As mentioned above, when mini-implants are inserted for intrusion anchorage, these screws



FIGURE 11 - Intrusion of posterior teeth using mini-implants via the buccal region only. A Hyrax appliance was used to correct the transverse condition and provide control over buccolingual tipping during movement.



FIGURE 12 - Mini-implant insertion on the right hand side of the upper arch only, with the purpose of intruding this segment and correcting the occlusal plane.

should be placed as far apically as possible, both on the upper and lower arches, observing the overall limits of the keratinized mucous membrane. Such distance facilitates system activation in addition to decreasing the risk of damage to any adjacent dental units during intrusion, which was likely to occur given their proximity to a wider root surface area²¹. The alveolar region, however, should be avoided since this region is at a greater risk of local inflammation, which can impair mini-implant stability while increasing the likelihood of the miniscrews being covered with soft tissue. Within this context, some authors^{15,19} report that in the posterior region, the more apically placed a mini-implant, the more perpendicular to the cortical bone it should be positioned, to avoid perforating the maxillary sinus²¹.

In some cases, however, when a patient has a very narrow keratinized mucous membrane, the mini-implant should be implanted in the alveolar mucous membrane. It is thus advisable, at first, to install an embedded mini-implant, under the gum, with a ligature tying it to the outer environment to allow activation with springs or elastics (Fig. 3). An incision is required to make way for a tapered bur or a spiral bur, depending on bone density. At the time of insertion, the alveolar mucous membrane should be expanded and care should be taken to keep the incision borders out of the way, thereby preventing soft tissue from getting entangled in the mini-implant spires. After insertion and ligature placement, the incision should be sutured with one or two stitches.

As observed previously, the number of mini-implant and their insertion site depend directly on the number of teeth to be intruded and their location. In general, at least two mini-implants are necessary, one on the buccal and one on the palatal regions, strategically placed in the region where the orthodontist wishes to work. In this way, the appropriate teeth or segments are intruded with utter buccopalatal tipping control. It should be emphasized that on the lower arch

the insertion of a mini-implant on the lingual side, although desirable for torque control, is a source of major discomfort for the patient. In this case, one alternative is to control the side effects by placing a rather stiff stainless steel arch wire – such a .021" x .025", for example – to increase the buccal root torque of the teeth targeted for intrusion. In the event that there is only one tooth for intrusion, its buccal surface can be placed in contact with an orthodontic archwire, immediately above the bracket in like manner as the example shown for the upper cuspid (Fig. 4).

When the intrusion of a larger number of teeth is desired, more mini-implants can be used (Fig. 13). It should be born in mind¹³, however, that each mini-implant can sustain at most a load of 450cN, and that an optimum orthodontic force should be sufficient to stimulate cellular activity without completely occluding any blood vessels. By way of exemplification, the ideal^{20,22} force for an upper molar intrusion is approximately 150cN. Thus, in most cases, just a few mini-implants prove adequate in promoting an intrusion movement, although it is extremely relevant to consider the system being employed, the condition of the supporting alveolar bone and the patient's individual response. It should be underscored that because the intrusive movement requires a greater bone resorption area, it tends to occur more slowly, on average, than other orthodontic movements. In some cases, there is a period of up to three months of inaction before any change in tooth position is noted. Movement should be allowed to start before increasing the amount of force, since once the state of inertia is broken, the intrusion is bound to begin and continue with some consistency, at a rate of approximately 0.3 mm / month.

An important aspect which deserves consideration prior to intruding any given tooth is an analysis - using periapical and/or proximal radiographs - of the amount of bone present between such tooth and its adjacent elements. According to



FIGURE 13 - Intrusion of four posterior teeth using two mini-implants via the buccal region. Since there were no antagonist teeth, buccolingual tipping control was achieved by means of an arch wire segment bonded to the occlusal surface of these units and tied to a mini-implant inserted in the palate.

Mathews and Kokich¹⁸, if the alveolar bone happens to follow along the same irregular path as the marginal crests of the teeth in question, by leveling the crests through intrusion the bone will also be leveled. However, if the bone level between the adjacent teeth is flat, the orthodontic intervention, by way of an intrusion, is likely to produce a vertical bone defect and, consequently, a periodontal pocket on the tooth's proximal surface. In this case, according to the authors, the best approach would be to level out the occlusal plane by stripping down the crown length.

Special care and continuous follow-up are required to ensure treatment success. Stringent control of oral hygiene, including professional attention before and after the orthodontic move-

ment, is essential since supragingival plaque can contribute to the formation of subgingival plaque during intrusion. Periodic periapical radiographs are also recommended to be taken at four to six month intervals, to monitor the risk of radicular resorption when predisposing factors are identified, such as pipette-shaped roots or a record of previous traumas.

Finally, after intrusion has been achieved with the aid of mini-implants, it should be underscored that the same routine procedures should be taken as when utilizing conventional mechanics. A three-month maintenance period should ensue to connect the tooth or set of teeth which were moved with ligature wire, thereby preventing a relapse.

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