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Case Report

Orthodontic management of severe iatrogenic biprotrusion and resoptions with miniscrews and corticotomies

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Keywords
CBCT
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Summary

Background > This case report describes a patient with severe iatrogenic dental biprotrusion who visited for a second assessment. The patient presented first premolar maxillary extractions, resorbed maxillary incisors and dehiscences in the anterior buccal and palatal cortical bone diagnosed with cone-beam computed tomography (CBCT).
Material and methods > At the beginning of treatment, fixed appliances were bonded on all teeth except on the upper incisors to prevent further root resorption. Mandibular first premolar extractions, miniscrews and corticotomies were scheduled for gaining distalization of the teeth in the four quadrants. When this was achieved, an occlusal splint was placed to extrude the posterior teeth with interarch elastics for increasing the vertical dimension. Next, brackets were placed on the maxillary incisors and a comprehensive orthodontic treatment was performed.
Results > After treatment, changes in incisor positioning were evident, varying the interincisal angle by 57.6 degrees. Nevertheless, slight root resorption of the upper incisors was observed.
Conclusions > Correct diagnosis is necessary to design an adequate treatment plan and make orthodontists aware of possible severe unwanted tooth movements before they occur. In dental biprotrusion without overjet, the first objective should be to distalize mandibular teeth prior to maxillary teeth retraction.

Introduction

Although orthodontic treatment has many recognized benefits, orthodontic appliances can cause complications. Iatrogenic effects resulting from inadequate diagnosis or treatment can lead to reversible or irreversible damage. It is essential to assess the risks of orthodontic treatment since they can sometimes induce periodontal disease, tooth mobility, pulpal reaction, trauma, enamel demineralization, caries, enamel wear, temporomandibular dysfunction or psychological problems [1].

Patients undergoing previous orthodontic treatments with unsatisfactory results can present improper extractions, root resorption, and bone dehiscences, among other complications. Many studies analysed the relationship between root resorption and orthodontic treatments but without reaching an aetiologic consensus [2–4]. One of the main factors directly involved in severe resorption are first premolar extractions, which can cause increased movement of the teeth, and displacement of the apex when closing the extraction space [5–7].

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Glossaire

CBCT Cone beam computed tomography
RAP regional acceleratory phenomenon

In addition, retreatments can be challenging compared to conventional treatments and can be exacerbated in many cases by a patient's lack of motivation to start a new treatment, and by the demand to achieve complex solutions within a short treatment time. Orthodontists should counsel the patient, taking into account their expectations. All these conditions limit the options of the new treatment plan, which should be realistic and comprise the limitations considered [1,8].

The study of treatment complications provides a chance to gain perspective and progress in the quality of treatment that orthodontists can offer to their patients [9].

This case report presents a patient who came to our orthodontic clinic with dental biprotrusion, previous first premolar maxillary extractions and fixed appliances with the complaint that her teeth wiggled, were protruding, and that she was unhappy with her appearance. Cone-beam computed tomography (CBCT) showed resorbed maxillary incisors and dehiscences in the anterior buccal and palatal cortical bone. The treatment was based on fixed appliances with mandibular first premolar extractions, miniscrews in the four quadrants and corticotomies to improve dental movement and reduce orthodontic treatment time.

Case report

Diagnosis and aetiology

A 32-year-old female receiving treatment in another clinic with bonded fixed appliances visited our centre for a second assessment. Her chief concern was the protrusion and the excessive mobility of the maxillary anterior teeth. The patient presented a normal temporomandibular joint examination and no relevant medical history. The pretreatment facial examination revealed a

FIGURE 1
Pretreatment facial and intraoral photographs

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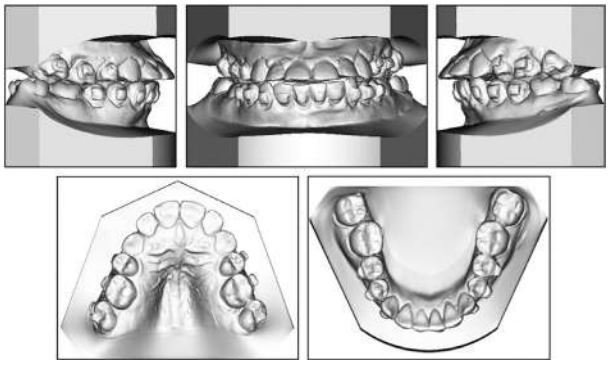

FIGURE 2
Pretreatment dental casts

mesiofacial pattern, esthetic lower facial height and no significant asymmetry.
Intraoral photos showed definitive dentition with the absence of the upper first premolars due to the previous treatment plan and a dental maxillary and mandibular protrusion with no overjet or overbite (*figure 1*). Digital dental cast examinations revealed a Class II molar relationship on the left and right side, with the superior midline shifted to the right side (*figure 2*).

TABLE I
Cephalometric measurements.

Measurement	Norm	Pretreatment	Posttreatment
SNA (°)	82	73.9	74.2
SNB (°)	80	74.0	72.6
ANB (°)	2	-0.1	1.6
Interincisal Angle (°)	130	60.3	117.9
Mx1 to A-Po (mm)	3.5	13.8	7.9
Md1 to A-Po (mm)	1	7.3	1
Mx1 to A-FH (°)	111	160.4	117.5
Md1 to A-Po (°)	22	49.9	31.2
IMPA (°)	90	115.9	99.2
Facial axis (NaBa-PtGn) (°)	90	81.6	79.7
Lower facial height (ANS-Me) (mm)	45	47.4	50.6
LL to E-plane (mm)	−2	1.2	−2.1

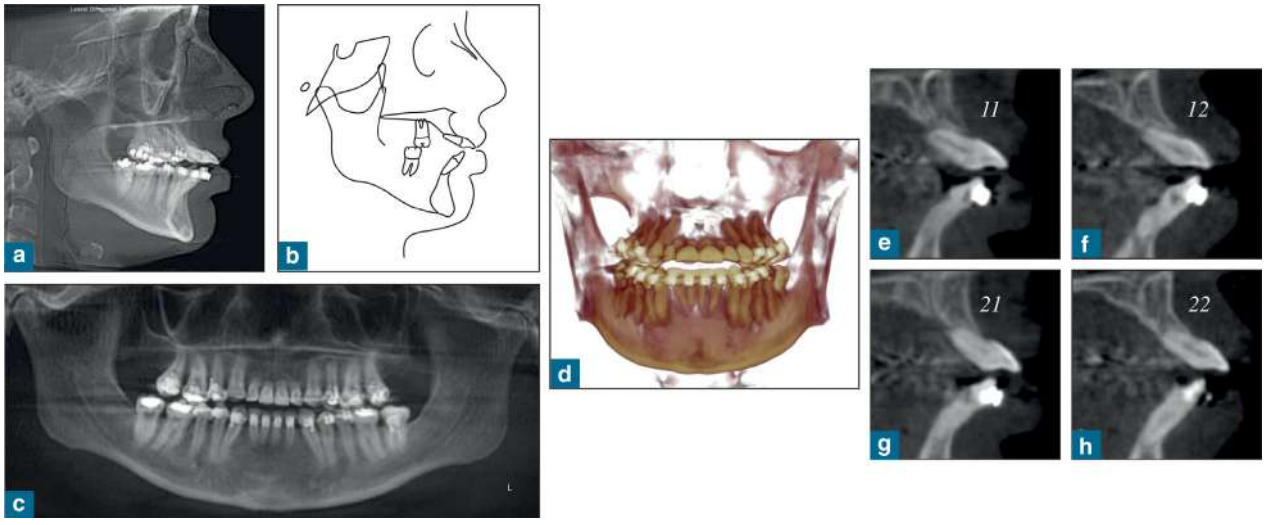

FIGURE 3
Pretreatment views extracted from the CBCT
a: lateral X-rays.
b: cephalometric analysis.
c: panoramic.
d: frontal X-rays.
Sectional views of maxillary incisors; e: right central incisor; f: right lateral incisor.
g: left central incisor.
h: left lateral incisor.

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Radiographic assessment by CBCT imaging confirmed the presence of all teeth except for the upper first premolars and wisdom teeth. The upper incisors showed a 1:1 crown-root relationship due to external root resorption and relevant crown proclination, leaving the teeth out of the alveolar bone, especially on the palatal surface (*figure 3*).

Cephalometric analysis showed a Class II skeletal relationship with protrusive maxillary and mandibular incisors (*table I*).

Treatment objectives

The overall objective was to provide the patient with improved aesthetics and with functional occlusion being as conservative as possible. To achieve this result, the specific treatment objectives were:

- to orthodontically relocate the teeth in the dentoalveolar process despite their unfavorable prognosis;
- to give correct inclination to upper and lower incisors;
- to obtain normal overjet and overbite;
- to achieve a stable occlusal relationship, and;
- to improve patient's smiling aesthetics.

Treatment alternatives

In order to retract the maxillary incisors, it was necessary to first gain overjet by reducing the proclination of the mandibular incisors.

For retracting the mandible teeth, we considered three options:

- miniscrews to distalize the lower arch as mandibular wisdom teeth were already absent;
- mandibular first premolar extractions, or;
- a combination of both retraction mechanics, miniscrews and premolar extractions to increase the amount of distalization and achieve enough overjet for the retraction of the upper arch.

Among the options presented, we selected the third option as it offered the advantage of achieving the highest amount of distalization with the best anchorage.

In the maxilla, extraction of the maxillary first premolars would have been the best choice to distalize the upper arch, however, since they were not present and the space was lost due to posterior mesialization, the best option considered was to place two miniscrews in the first and second quadrants for maxillary incisor retraction.

Treatment progress

The main complaint of the patient was dental biprotrusion, even after maxillary first premolar extractions, in addition to excessive mobility of the upper incisors, which could be explained by the resorbed roots, and palatal and buccal dehiscences shown in the CBCT.

Fixed appliances from the former clinic were removed and other brackets (Roth 0.022 × 0.028-inch slot metal brackets) were bonded on all the teeth, except in the four upper incisors. Brackets were not initially placed due to the resorption of these teeth, leaving them free in order to move into a more favourable position only by eliminating inclination of the lower incisors and by lip force.

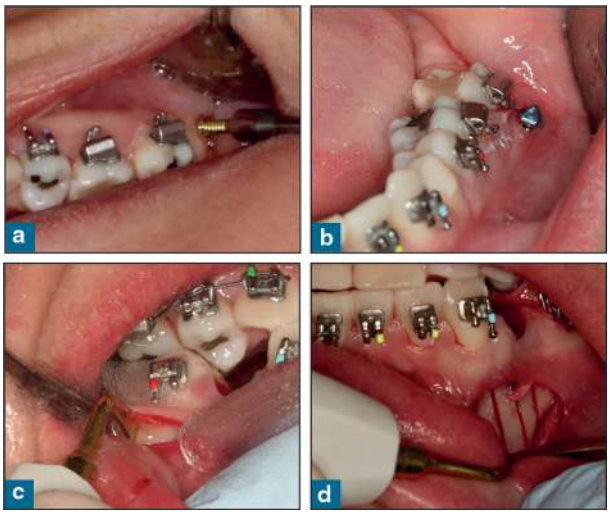

FIGURE 4

Photographs per surgery

a–b: left maxillary and mandibular miniscrews.
c–d: right and left mandibular corticotomies.

For gaining overjet, mandibular first premolar extractions were scheduled, and to reduce dental biprotrusion, four miniscrews (VectorTas™ Temporary Anchorage System; Ormco; Scafati, Italy) were placed to achieve distal movement. Two were placed in the maxillary tuberosity in the upper arch and two bicortical in the extraction space of the mandible. In addition, taking advantage of the anaesthesia used for performing the lower extractions, corticotomies with the piezoelectric handpiece (Piezosurgery® touch dental unit; Mectron; Carasco, Italy) were performed in the third and fourth quadrants to accelerate dental movement and reduce orthodontic treatment time (*figure 4*). This minimally invasive approach is based on an incision to the buccal gingivae without raising a flap to decorticate the alveolar bone.

After 5 months of treatment and having obtained distalization of most of the teeth in the four quadrants, the patient was asked to wear a removable occlusal splint with vertical interarch elastics. The goal of the splint was to prevent the teeth in the upper arch from making contact, minimizing occlusal overload and increasing the vertical dimension by posterior teeth extrusion.

During the eighth month of treatment, after having achieved posterior extrusion, brackets were bonded onto the maxillary incisors and comprehensive orthodontic treatment was performed obtaining aesthetic and functional results (*figure 5*).

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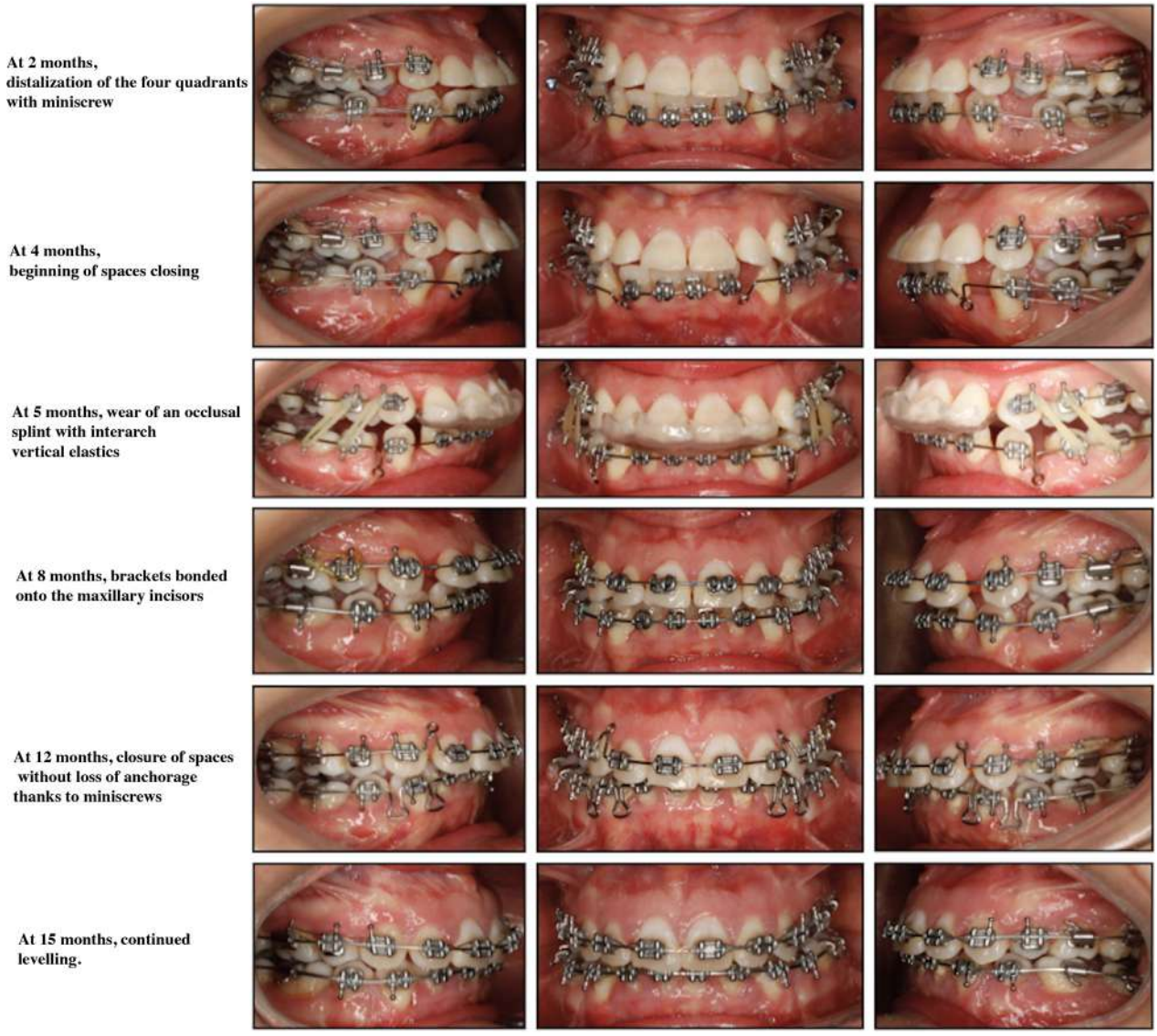

FIGURE 5
Intraoral photographs of treatment stages

Treatment results

Posttreatment records showed that the treatment objectives were achieved after 20 months of active treatment. The final extraoral photographs showed a well-balanced frontal and lateral smiling face with relaxed lip position due to improved inclination of the maxillary incisors (*figure 6*). Intraoral and

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FIGURE 6
Posttreatment facial and intraoral photographs

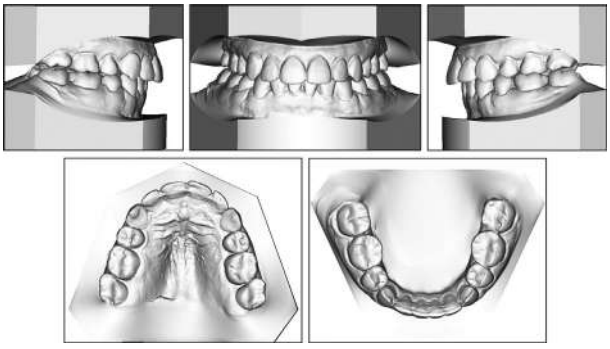

FIGURE 7
Posttreatment dental casts

dental cast examination demonstrated correct inclination of maxillary and mandibular incisors with ideal overjet and overbite (*figures 6 and 7*). Posttreatment CBCT assessment showed successful positioning of the incisors within the dentoalveolar process with slight resorption (*figure 8*). Cephalometric superimposition indicated that the facial profile underwent moderate changes during treatment (*figure 9*). There was no evidence of relapse or complications at 24 months after treatment (*figure 10*). Although the treatment result was encouraging, long-term changes should be considered.

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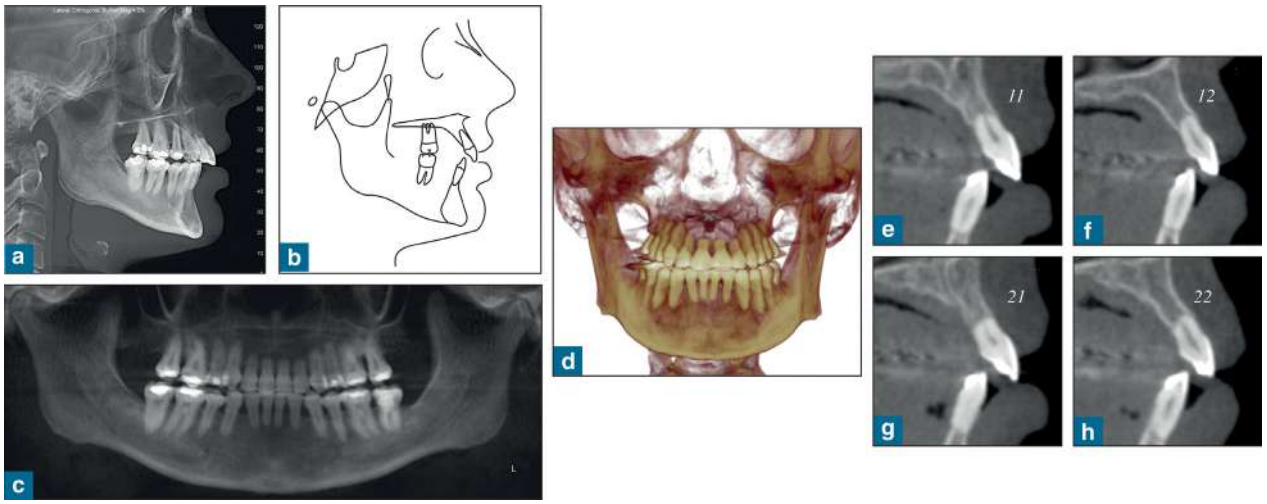

FIGURE 8

Posttreatment views extracted from the CBCT

a: lateral X-rays.
b: cephalometric analysis.
c: panoramic.
d: frontal X-rays.
Sectional views of maxillary incisors; e: right central incisor.
f: right lateral incisor.
g: left central incisor.
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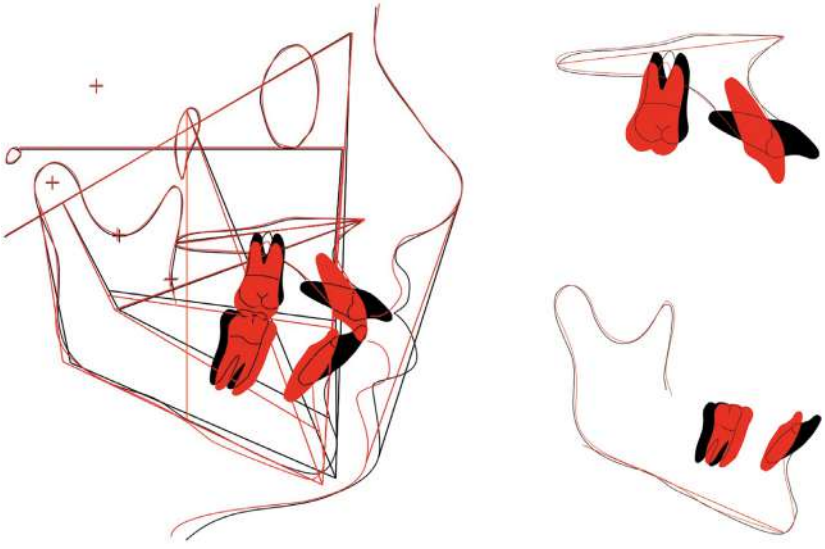

FIGURE 9

Superimposition of tracings before (black line) and after treatment (red line)

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FIGURE 10

Facial and intraoral photographs at two years posttreatment

Discussion

Before treating a patient and especially prior to retreatment, orthodontists must evaluate the risk-benefits of new treatment plans developed together with the patient in order to reach agreement according to patient expectations [8].

The present case report describes the retreatment of a 32-year-old female with a severe biprotrusion with external root resorptions and dehiscences who had previously undergone treatment in another clinic with maxillary first premolar extractions. The extraction spaces were closed by loss of anchorage and mesialization of the posterior teeth, increasing upper incisor proclination instead of anterior teeth retrusion. The treatment included levelling and aligning with fixed appliances, lower premolar extractions, corticotomies and miniscrews in the four quadrants for accelerating distalization and minimizing treatment time due to the amount of root resorption. In addition, during treatment an anterior occlusal splint was placed to increase vertical dimension and to reduce anterior tooth contact. Another treatment alternatives were discussed before the start of treatment to reduce the inclination of mandibular incisors. However, distalizing only with miniscrews in the lower arch would not have given the enough overjet to achieve a notable change in the initial position of the upper incisors. On the other hand, the alternative of lower first premolar extractions without the use of miniscrews, could have result in a lost of anchorage and indeed less space for the retrusion of the upper incisors. Because of all these reasons, the combination of both techniques was finally chosen as the safest option.

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The duration of treatment with fixed orthodontic appliances has been found to contribute to the degree of root resorption. Patients undergoing lengthy orthodontic treatment or experiencing a large amount of tooth movement, present a significantly greater grade of root resorption [10,11]. Levander and Malmgren [12] reported that after 6 to 9 months of orthodontic treatment, root resorption was detected in 34% of the teeth, while the results of other studies have shown that root resorption may begin in early stages of orthodontic treatment, being especially characteristic in teeth with long, narrow and deviated roots [13]. A significant correlation between tooth mobility and total root length has also been reported, concluding that there is a higher risk of tooth mobility in a maxillary incisor if it undergoes severe root resorption (root length $\leq$9 mm) during orthodontic treatment [14]. The initial records of the patient showed severe apical root resorption of the maxillary incisors and degree 2 of mobility [15], and therefore, one of our main objectives was to achieve the best result within a reasonable treatment time without overloading the upper anterior teeth. Despite having used the most conservative orthodontic mechanics, slight root resorption of the incisors was observed after treatment. In addition, a slight Class II remained in the right side, perhaps due to the fact that the lower arch was distalized as far as possible to avoid strong contacts in the incisors area, because of the root resorption that the patient initially presented.

The labial and lingual cortical plates at the level of the incisor apex may represent the anatomical limits of tooth movement [16]. When a tooth is moved through the cortical plate and then back into the alveolar bone, the bony dehiscence does not always respond in the same way. Zachrisson [17] reported that although partial buccal bone regeneration may be observed in some patients, this finding may not be applicable in every patient. Sariyaka et al. [16] concluded that bone loss is inevitable in the cervical region, especially on the lingual side during retraction of the maxillary and mandibular anterior segments. Moreover, histologic studies have found a lower level of vertical bone apposition with further slight thickening of the cortical plate after orthodontic movement [18]. In this case report, at the start of treatment, the type of movement we sought was biological repositioning of the maxillary anterior teeth into the cortical plates of the dentoalveolar process, which were considered orthodontic walls. Despite achieving a relevant reduction of upper incisor inclination, analysis of the final CBCT showed remodelling at the alveolar bone level [19].

In 1966, Tweed highlighted a better harmony of facial lines, stability of dentition, healthy oral tissues and masticatory efficiency when the incisors of their patients were well positioned over the basal bone at the end of treatment [20]. Generally, first premolar instead of second premolar extractions allow for a more relevant incisal retraction with less reduction of the intermolar arch width [21]. In this patient, the lower first premolars were extracted and two miniscrews were placed to achieve skeletal anchorage and increase the amount of distalization in the lower arch. However, to decrease the upper incisors, initial protrusion treatment options were limited, as the space of premolar extractions had already been lost. Segmental retraction of the upper arch was made using miniscrews for direct anchorage. Brackets of the upper incisors were bonded only when enough space for their retraction had previously been made. Miniscrews were placed bicortically in the mandible, providing a high level of stability and reducing cortical bone stress [22]. In other studies, the amount of incisor retraction was between 1.49–2.7 mm with a distal tipping of 4.3 degrees [23,24]. In the present case, the maxillary incisors were moved distally 5.9 mm with palatal tipping of 42.9 degrees and mandible incisors 6.3 mm and 18.7 degrees (*table I*). These differences could be due to the exaggerated bimaxillary protrusion at the beginning of treatment.

The patient presented such a traumatic occlusion that the main aim of the orthodontists was to achieve stability as soon as possible. This objective led to the use of corticotomies in the mandibular arch at the start of treatment to retract the lower incisors and gain overjet. Corticotomies induce a regional acceleratory phenomenon (RAP), which provides the biological basis for accelerated tooth movement during a period of a few months, decreasing the total treatment time [25]. Different techniques have been described to generate rapid tooth movement [26–29]. Nevertheless, the piezocision-assisted orthodontic approach is a minimally invasive surgical technique which reduces trauma and possible osteonecrotic damage in comparison to a high-speed surgical bur [30].

Although there are several orthodontic treatment appliances (miniscrews, piezosurgery, CBCT, among others), the main key in reducing complications is to achieve a correct tridimensional diagnosis and personalized treatment, making orthodontists aware of the possible severe unwanted tooth movements before they occur.

Conclusions

An adult patient under orthodontic treatment with previous upper first premolar extractions, bone dehiscences, root resoptions and severe bimaxillary protrusion visited our clinic. The patient was treated with lower premolar extractions, temporary anchorage devices in the four quadrants and corticotomies as well as an anterior occlusal splint. Notable tooth retraction was achieved, improving facial and dental aesthetics and function. In dental biprotrusion without overjet, the first objective of a clinician is to distalize the mandibular teeth in order to gain enough overjet, to posteriorly be able to retract the maxillary teeth. Therefore, a precise tridimensional diagnosis and an adequate treatment plan is essential to preclude the loss of anchorage, in order to avoid moving teeth out of bone and reducing the risk of root resorption.

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Consent for publication: a written consent signed by the patient, was recorded.

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