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Case Report Article

Orthodontic treatment with clear aligner of a pre-rehabilitation trauma patient: case report

Alexandre Fausto da Veiga Jardim[1]
Taina Itana Coelho Lima[2]
Lucas Rodrigues Araújo Estrela[2]
Carlos Estrela[2]

Corresponding author:
Alexandre Fausto da Veiga Jardim
Alameda Coronel Eugênio Jardim, n. 129, setor Marista
CEP 74175-100 – Goiânia – GO – Brasil
E-mail: Alexandre.fvj@gmail.com

[1] Department of Orthodontics, South American University – Goiânia – GO – Brazil.
[2] Department of Stomatological Sciences, Goiás Federal University – Goiânia – GO – Brazil.

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Abstract

Objective: To report a multidisciplinary case involving rehabilitation and orthodontics in a patient with a history of a car accident. **Case report:** A 22-year-old female patient, AQ, presented with a complaint of orthodontic correction and prosthetic rehabilitation of teeth lost in a car accident. The patient exhibited a Class III malocclusion with a right subdivision, mesialized lower segment, and crowding on this side. Teeth 11, 12, and 13 were missing and replaced by a removable prosthesis. Additionally, dental bimaxillary protrusion was observed. The proposed treatment included distalization of the lower right segment to correct crowding and distalization of the upper segments to improve dental inclination. The patient requested the use of clear aligners for orthodontic treatment. Distalization was performed using support from an extra-alveolar mini-implant in the right buccal shelf region. Proper sequencing of movements was crucial in the treatment planning. In the upper arch, dental implants with provisional crowns were placed in an ideal position to serve as a reference for final positioning and as anchorage for dental movement. At the end of the treatment, correction of dental crowding and improvement in dental inclination were achieved, enabling the patient's rehabilitation. **Conclusion:** Proper planning integrating different specialties is essential to achieve an ideal clinical outcome. Dental implants provide absolute anchorage for orthodontic movement and, when combined with virtual planning, can be a valuable tool for case resolution without compromising patient esthetics.

Introduction

Orthodontics involves the application of mechanical forces on a biological system to break homeostasis, thereby triggering biochemical reactions that stimulate bone remodeling and, consequently, dental movement. To achieve this, these forces must be carefully calculated to ensure that the dental movement occurs as planned by the orthodontist [6, 12].

As every force generates an equal and opposite reaction force, one of the major challenges in orthodontics is the correct balance of these forces, which determines which teeth will move and which will remain stable. This concept is known as anchorage: the selection of which teeth will perform the movement, and which will resist it. This is of such importance that various methods and mechanics to achieve better anchorage control have been extensively described in the literature since the advent of orthodontics as a specialty [6, 9, 12].

In the early 20th century, tip-back bends were used to enhance anchorage. Such bends were exceedingly difficult to perform and significantly interfered with orthodontic mechanics. Other techniques, such as the use of a Nance button, transpalatal bar, lingual arch, cortical anchorage, intermaxillary elastics, ligatures, and extraoral appliances, have been extensively employed in the pursuit of greater control over force application in orthodontic treatment [2, 9, 12].

The movement of molar distalization has always posed a challenge for clinicians. This is because molars have high anchorage values, and when distalized, they exert a reactive force on anterior teeth, which have low anchorage values. This often requires elaborate and labor-intensive mechanics that still do not guarantee orthodontic success. Treating patients with tooth loss becomes even more challenging, as it complicates the correct distribution of force systems. Additionally, these patients frequently present with other associated conditions, such as bone loss [2].

Previous studies [1, 3, 5, 8] have shown that molar distalization with clear aligners presented considerable loss of efficacy. It has been pointed out that due to reciprocal forces, about half of the space obtained might be due to undesired movement of anterior teeth. This can be avoided with the help of resources such as intermaxillary elastics, skeletal anchorage, correct staging and attachments [6-8, 10, 13].

This article presents a case report of a patient with tooth loss from previous trauma who underwent orthodontic treatment with aligners. The tooth loss reduced the number of teeth in the anchorage unit, requiring distalization of the lower molars without proclination of the lower incisors. Additionally, the treatment involved retracting anterior teeth to address previous proclination prior to rehabilitation.

Case report

A 32-year-old female patient presented to a private practice with the chief complaint of tooth loss resulting from a motor vehicle accident, along with crowding in the lower arch. She was referred by her prosthodontist to correct dental misalignment and retract protruding upper anterior teeth in preparation for dental implant placement.

The dental trauma that led to tooth loss was due to a vehicular collision a few months prior and had a great impact on aesthetics and self-esteem of the patient. She was using a removable provisional prothesis at the time but wasn't satisfied with the visual aspect of it.

Upon clinical examination, the patient presented a slight Class II profile, with mandibular retrusion and slightly vertical growth pattern. When smiling, it was noted the absence of teeth 1.1, 1.2 and 1.3 (figure 1). Intraoral inspection revealed a molar Class I bilateral relationship, severe crowding in the lower arch and accentuated proclination of incisors and both arches had some degree of atresia and although the patient presented with a bilateral Class I molar relationship, the lower posterior teeth in the right side presented with a severe crowding resulting in mesial angulation of tooth 4.3, lingual inclination of tooth 4.5 and a mesial drift of teeth 4.6 and 4.7 of 4mm. The patient also had considerable restorative work in posterior teeth (figure 2). The radiographic exams showed that teeth 1.4, 1.5, 2.1, 3.7 and 4.7 had previous endodontic treatment and the patient reported that in the upper arch this had been caused by the traumatic injury in the accident (figure 3a). The lateral cephalogram confirmed the vertical growth pattern, a mandibular retrusion and shortened mandibular ramus and anterior teeth with excessive proclination (figure 3b).

Figure 1 – Initial presentation of a patient with tooth loss of 1.1, 1.2, and 1.3 due to automotive trauma

Figure 2 – Intraoral images showing severe crowding in the lower arch and a bilateral Class I relationship

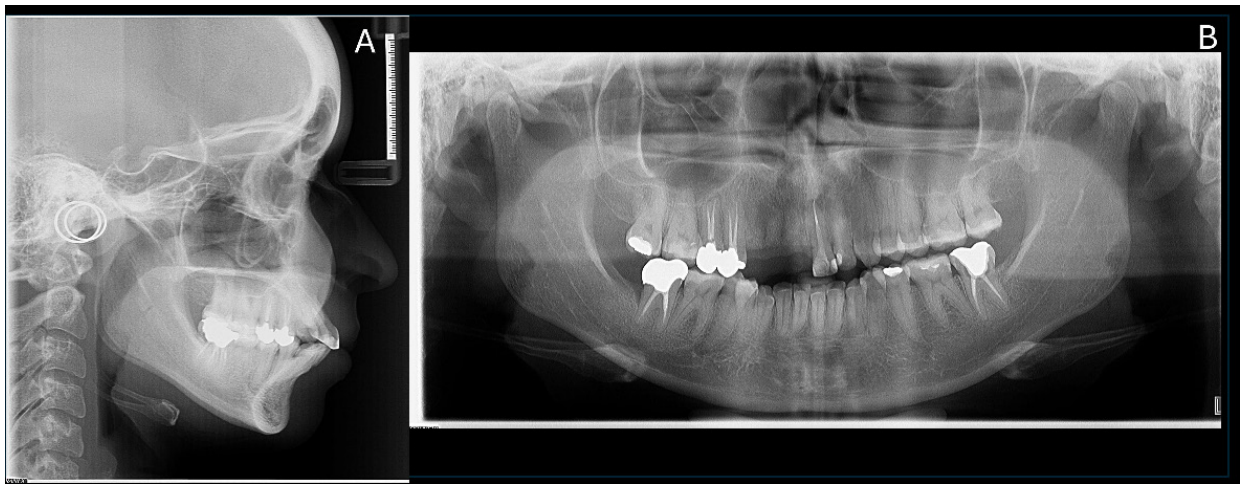

Figure 3 – Radiographic exams indicating a facial pattern 2 and dental biprotrusion. Endodontic treatment of teeth 1.5, 1.4, and 2.1 due to the automotive trauma. Teeth 3.6 and 4.6 had prior endodontic treatment due to toolh decay

Treatment objectives aimed to improve incisor inclination and reduce crowding. This would be done with expansion of both arches and the distalization of the lower and upper right quadrant allowing for correction of the posterior crowding and reducing the incisor proclination. To improve molar relationship, upper left quadrant would also be distalized.

The treatment plan was presented to the patient and after agreeing with the proposed objectives, she opted for treatment with clear aligners. She signed a consent form regarding treatment and authorization for the use of her image. A digital plan was elaborated using and the first setup showed a that teeth 4.6 and 4.7 would need to be distalized 2.5 mm and considerable interproximal enamel reduction (IPR) would have to be performed to achieve the treatment objectives. To avoid posterior IPR it was opted to increase the amount of distalization to 3.5 mm and the use of skeletal anchorage was recommended to the patient to improve movement predictability. This also allowed for less IPR in anterior teeth.

The upper arch would also be retracted to reduce incisor proclination and it was recommended that the patient installed the upper dental implants and had provisional crowns made for better aesthetic and to allow for better anchorage during retraction. This would also avoid the need for using pontics in the aligners, as would take a tool on treatment efficiency and biomechanical control. The virtual plan was sent to the prosthodontist as a stereolithography file (.stl) so that the dental implants were installed considering the upper incisors final planned position.

Treatment progress

Orthodontic treatment began after the installation of the dental implants and provisional crowns (figure 4). A new dental scan was obtained, and an updated version of the aligner planning was made available. The first treatment plan resulted in 37 stages in the upper and lower arch.

Figure 4 – Installation of implants with provisional crowns to allow for tooth movement

In the first clinical session resin attachments were bonded and IPR was performed. The patient returned on the following month to install an extra alveolar titanium implant (Peclab, Belo Horizonte, Brazil) on the lower right buccal shelf region of the mandible and a 3/16 medium elastic (Morelli, Sorocaba, Brazil) was immediately applied on a button bonded to the vestibular face of the lower right canine (figure 5). The patient proceeded with treatment with 6 weeks appointments to evaluate treatment progress.

Figure 5 – Distalization mechanics supported by extra-alveolar mini-implant

When patient was on aligner 22, loss of lower aligner adaptation was observed, signaling that there was loss of tracking during treatment. A new dental scan was made and upon inspection and comparison with the original plan, it was constated that the lower right second premolar was colliding with the lower right first premolar (figure 6a), impeding its buccal inclination and distalization. A second plan was made, this time it was requested that at least 0,5 mm of space should be created mesial and distal to tooth 3.5 before moving it labially (figure 6b).

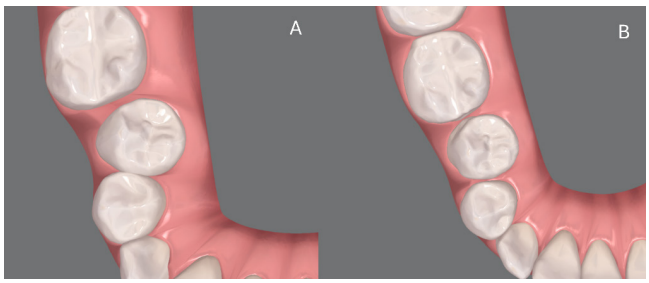

Figure 6 – The initial plan (A) showed a contact point that would prevent vestibularization of tooth 4.5. In a second plan, this was resolved with a 0.5 mm opening mesial to tooth 4.5 prior to vestibularization

After the arrival of the new clear aligner set and removal of previous attachments and installation of the new ones the treatment continued for another eleven months and successful correction of the crowding was achieved (figure 7). A final set of 20 aligners was requested to improve dental relationships and close a lateral open bite that resulted from posterior dental intrusion, probably because of occlusion on the aligner plastic. At the end of this set, buttons for elastics were bonded on the vestibular surface of posterior teeth and 1/4" elastics were placed on these teeth to improve interocclusal contacts.

Figure 7 – Distalization being performed without misfit, supported by a mini-implant in the buccal shelf

After a satisfactory occlusion was achieved (figure 8), the patient was referred to her prosthodontist for rehabilitation of the lost teeth. Unfortunately, the patient needed to move to another city due to work demands. Our team would occasionally contact the patient to be kept on par with her treatment while she was away. After 9 months she returned to our office and because she lost her clear aligners and wasn't using any retention, a minor crowding was observed on the lower anterior segment. A final set of 10 aligners was ordered, this time proclining teeth in order to achieve alignment of the lower anterior teeth.

Figure 8 – Final occlusion after the orthodontic phase. The patient was referred to the prosthodontist to complete the treatment. A Class I molar and canine relationship was achieved, with correction of crowding and proper incisor inclination

After this last step was completed, the patient was referred to her prosthodontist for rehabilitation. A fixed prosthesys was installed to rehabilitate teeth 1.1, 1.2 and 2.3 and ceramic veeners were installed on the upper arch to improve aesthetics. The lower midline had a minor deviation to the patient left side, but despite that, canines were in Class I occlusion and a functional protrusive and lateral mandibular excursion was achieved (figure 9). Clinical examination of the final documentation revealed that the patient presented a rounded shadow aspect over the apex of tooth 1.5 and the implant of tooth 1.3 which prompted the referral of the patient to her GP for reevaluation (figure 10).

Figure 9 – Patient after completion of the rehabilitation phase

Figure 10 – Follow-up radiographic exam showing changes in the periapical region of the implant in 1.3 and the apex of 1.5

Discussion

Orthodontic treatments combined with rehabilitation are challenging due to the biomechanical limitations inherent in the absence of certain teeth. Planning both the anchorage unit and the active unit is essential for achieving clinical success [2, 4, 9, 12]. This case presented two biomechanical challenges: a reduced number of teeth in the upper arch, which could complicate reducing incisor inclination, and a 4 mm distalization in the lower arch. The approach chosen to address both issues was skeletal anchorage—dental implants in the upper arch and a temporary anchorage device in the lower arch.

One of the factors impacting the success of treatment with aligners is the proper staging of movements. This means defining which teeth move at which time and, importantly, how many teeth move simultaneously [1]. In the present case, a staging error in the initial plan resulted in aligner misfit, despite the use of skeletal anchorage, necessitating

a new treatment plan. This underscores that aligner treatment requires careful planning, and that diagnostic and orthodontic planning expertise are critical to achieving successful outcomes [5, 7].

Skeletal anchorage enables various approaches in planning complex orthodontic cases. Choosing an anchorage device should consider treatment objectives, available sites for installation, and the biomechanics to be applied [4]. Skeletal anchorage options include interradicular and extra-alveolar orthodontic mini-implants as well as mini-plates. In this case, extra-alveolar mini-implants were selected in the buccal shelf area, as they allowed distalization of the lower right segment without the need for repositioning (as would be required with an interradicular mini-implant) and were less invasive than a mini-plate [8, 11].

Orthodontic treatment with aligners presents biomechanical challenges that can make the treatment seem deceptively simple. Movements programmed in software do not always translate into biologically compatible movements that occur in reality [6]. Notably, movements such as distalization, expansion, and correction of rotations often show significant clinical differences compared to virtual planning [3, 7, 11]. This may require additional aligners or the use of anchorage resources to achieve the planned movement clinically. In the present case, the planned distalization movement for teeth 4.6 and 4.7 combined for a total of 6.7 mm, in addition to a 5.9-degree rotation for each tooth, exceeding the amount of movement predictable to be achieved with aligners alone.

A concern when applying distalization mechanics is the risk of developing an anterior open bite due to a loss of vertical control during treatment. This can occur from the extrusion of teeth being moved distally or premature contacts that result in clockwise rotation of the mandible. Such an occurrence was not observed in the present case, which may be explained by the fact that the use of aligners creates a bite opening of approximately 1.5 mm, which could contribute to vertical control, as demonstrated previously [13]. The clinician must also be mindful of the potential for distalization with tooth inclination rather than bodily movement, as well as the loss of anchorage leading to mesialization of the anterior teeth, particularly when multiple molars are moved distally at the same time [4, 6, 8, 13]. In the present case, some vestibular movement of the lower anterior teeth was observed, but this was expected during the alignment phase. Both in the upper arch, with the use of dental implants, and in the lower arch distalization, supported by skeletal anchorage, good control of movements and side effects was achieved.

Finally, the use of virtual planning was crucial for communication between the orthodontist and the prosthodontist. It allowed for the real-time planning and simulation of the retraction and inclination of the upper incisors, ensuring not only the aesthetic outcome of the patient's smile but also a favorable position for the installation of the upper implants. Although planning software has limitations, and some overcorrection is often necessary since clinical results frequently fall short of what is observed in the digital setup [1, 3, 5, 8, 11, 13], this resource proved valuable for both planning and communication with the patient.

Conclusion

The present case achieved both aesthetic and functional success. The biomechanical challenges related to anchorage were addressed using temporary anchorage devices and a rehabilitative orthodontic plan that considered both aesthetics and function, while also facilitating the resolution of the case.

The use of virtual planning combined with assertive mechanics that enhance the predictability of treatment execution serves as an important reminder that what we see in digital setups does not always translate into clinical outcomes without the active participation of the orthodontist guiding the treatment.

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