Orthodontic treatment in patients with reimplanted teeth after traumatic avulsion: A case report

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Abstract

Introduction: The high prevalence of individuals with dental trauma prior to orthodontic treatment justifies the precautions that should be followed before and during treatment, considering all possible effects of orthodontic movement on traumatized teeth. Among the major traumatic dental injuries, avulsion with subsequent tooth reimplantation entails a higher than average risk of complications, such as pulp necrosis, root resorption and ankylosis. Therefore, it gives orthodontists several reasons for concern. **Objective:** This case report sought to analyze the implications of tooth reimplantation after traumatic avulsion in patients requiring orthodontic treatment. **Conclusions:** Tooth movement of a reimplanted tooth after traumatic avulsion is viable provided no signs of abnormality are present. Ankylosed teeth, however, are not amenable to orthodontic movement but should be preserved as space maintainers until root resorption is completed, provided that the teeth do not present with severe infraocclusion. Should an ankylosed tooth be in severe infraocclusion, crown amputation and root burial are indicated as a means to preserve the alveolar bone in the region, since resorption will occur by replacement of the buried root, as was the case in this report.

Keywords: Tooth movement. Dental ankylosis. Dental trauma.

INTRODUCTION

Orthodontic treatment in patients with traumatized teeth is not contraindicated, but clinical and radiographic repair and/or post-trauma complications must be established before treatment onset.[17]

Dental injuries occur more frequently in children between ages eight and nine, involving

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mostly the upper central incisors.[1,21] Individuals who present with overjet in excess of 3 mm are about twice as likely to suffer damage to the anterior teeth, compared to children with fewer than 3 mm overjet.[20,22]

The high prevalence of individuals with dental trauma prior to orthodontic treatment—approximately 10.7%[23]—justifies the precautions that should be followed before and during treatment, taking into account all possible effects of orthodontic movement on traumatized teeth, as well as how these should be monitored. Thus, during patient history and clinical examination one should seek information on prior dental trauma, as well as clinical signs and symptoms of possible sequelae. A thorough assessment of periapical radiographs and/or CT scans is also indicated. If there is history of dental trauma, the general dental practitioner (GP) and/or endodontist should be consulted since a multidisciplinary approach is the most suitable in this case.

The purpose of this case report is to analyze the implications of tooth reimplantation after traumatic avulsion in patients requiring orthodontic treatment.

LITERATURE REVIEW

Preserving an injured tooth in the oral cavity depends not only on adequate emergency treatment but also on a long and appropriate follow-up period. During this period, clinical-radiographic monitoring is essential. However, treatment of traumatized teeth is not always performed appropriately.[9] Hamilton, Hill and Holloway[10] found an incidence of 34% of children with clinical signs of trauma in a population of 2,022 children. After radiographic analysis of these cases it was found that only 47% of traumatized teeth showed signs of previous treatment. Among these, however, only 41.5% were considered adequate. Some studies conducted in Brazil[8,11] indicate that GPs, in particular, when compared with endodontists, have little knowledge as regards the best treatment for patients with traumatized teeth. This is a disquieting reality which must be reversed by developing strategies to enhance the competence of these professionals.

The prognosis for various types of periodontal tissue injuries seems to depend on the type and severity of the damage, as measured by its extent on the periodontal ligament, i.e., if there was compression or rupture of ligaments. It is true that trauma to the periodontium causes extensive tissue injury, with the death of cementoblasts in large areas of the cementum surface. Hemorrhage and necrosis areas occur in the periodontal ligament, which gradually give way to exudates and inflammatory infiltrates, essential for tissue repair. During the repair process several events occur simultaneously, such as the vital phenomena of differentiation and cell migration.[6] Studies in monkeys[2] showed that when trauma involves small areas of the periodontal ligament, characterized by a moderate amount of surviving cells near the root surface, this is repaired through the intact regions of the periodontal ligament. During this repair process, a surface layer of the root can be resorbed. If this is a superficial resorption, the resorbed cavity is repaired by deposition of new cementum. The cementoblasts located in the neighborhood of the cementoblasts that have succumbed, as well as the pre-cementoblasts, reposition themselves and begin to cover the cementum surface. Thus, if resorption occurs, it will be so minimal that it will not be perceived clinically nor radiographically.[6]

Other factors that contribute to root resorption are (a) the presence of bacteria in the periodontal ligament, in dentinal tubules or pulp, and (b) the quality of the endodontic treatment, if any.[3] Bacterial contamination contributes to the persistence of the inflammatory process and, consequently, to induced resorption.[6] If resorption reaches the tubules, two different repair processes may occur: If the root canal contains

infected necrotic tissue or a leukocyte infection area, inflammatory root resorption will occur. On the other hand, if the root canal contains normal or inflamed tissue, there will be cavity repair with the deposition of new cementum.[2]

Orthodontic treatment can cause root resorption. Teeth that have suffered traumatic injuries are more likely to develop root resorption than non-traumatized teeth.[17] Studies, however, are not conclusive because they are based on a small number of patients with different types of injury, appliances and operators.[13] Malmgren et al[18] found no significant differences in prognosis between teeth with intact periodontal ligament that had suffered minor to moderate injuries, and non-traumatized teeth, which had been moved orthodontically.

Tooth avulsion with subsequent reimplantation is the traumatic injury that involves the greatest risk of complications due to a high likelihood of bacterial infection through both the pulp and the periodontium. Incidence is greater among children due to incomplete root development and immaturity of the periodontal ligament.[19] The initial treatment in such cases is often carried out by parents or school teachers, so the community at large should be taught the basics of how to act in the presence of a tooth avulsion. The need to take quick and proper action, namely, transporting the tooth in humid conditions (in milk or saliva, under the tongue) and taking the patient to a GP is fundamental.[21]

A poor prognosis in cases of tooth reimplantation is directly related to the amount of time that the tooth remains in the extra-alveolar medium and in a dry environment.[4,21] When an avulsed tooth is immediately and appropriately reimplanted, it ensures the continued vitality of the periodontal ligament, which is still attached to the tooth.[23] When a tooth is avulsed, the periodontal fibers are fractured exactly in the center, where the collagen fibers stemming from the alveolar bone and the fibers that originate from the cementum are intertwined. Hence, part of the fibers remain adhered to the bone and another part to the cementum. It should be underscored that the fibers that remain attached to the bone can be regenerated, but the fibers connected to the root surface have a reduced capacity for regeneration. Therefore, in cases of avulsion, preserving the fibers that remain attached to the cementum is a decisive factor determining prognosis.[19]

Other factors affecting the prognosis of reimplanted teeth are: Patient age, the nature of the accident and subsequent long-term treatment of the tooth,[14] including adequate endodontic treatment, if indicated.[12]

Pulp necrosis occurs in most cases, except when root formation is still incomplete and a preserved dental papilla helps to maintain pulp vitality.[6] In teeth with an open apex, periodontal healing occurs more frequently than in teeth whose apex is closed.[5] The wider—or more open—is the foramen, the better the prognosis, since pulp revascularization is facilitated. However, bacterial contamination of the pulp and periodontal ligament reduces the likelihood of revascularization.[3]

The worst possible scenario occurs in children and adolescents whose root formation is complete because in these cases pulp revascularization seldom occurs. The result is ankylosis, immediately followed by replacement resorption.[7] In adults, tooth reimplantation in the presence of a necrotic periodontal ligament solely enables the maintenance of alveolar anatomy and symmetry. The reimplantation procedure, however, is worthwhile in all cases, even if only temporarily, since it allows patients, especially children and adolescents, to keep their natural tooth until it is replaced by a prosthesis and/or implant.[14]

Moving reimplanted teeth orthodontically is perfectly viable. According to Malmgren et al,[17] however, after avulsion of a permanent tooth followed by reimplantation, a follow-up period of at least one year is necessary, since most root

resorption occurs during the first year post-trauma. Boyd, Kinirons and Gregg[4] found that a time period ranging between 102 and 997 days[14] had elapsed before root resorption was detected, suggesting the need for a longer follow-up period before starting orthodontic treatment.

When the periodontal ligament experiences extensive damage, a small amount of surviving cells near the root surface triggers a repair process through rapid osteogenesis, leading to ankylosis of the tooth[2] and its subsequent loss by replacement. Dentoalveolar ankylosis involves fusion of the alveolar bone with the root substance and the consequent disappearance of the periodontal space, which loses its structure and function. The close contact between dental tissues and alveolar bone structure furthers the bone remodeling process. This results in resorption of part of the bone tissue and tooth tissue, which will be partially or totally replaced by new bone formation[6].

Replacement resorption increases if the avulsed tooth is allowed to remain outside the oral cavity for extended periods of time. It ranges from only 9.5% in short periods (less than fifteen minutes) to 100% if periods exceed sixty minutes, in a dry medium.[5]

Ankylosed teeth are not amenable to orthodontic movement due to the absence of periodontal ligament. Once ankylosis has been diagnosed, professionals are left with two alternatives only, extraction, or preservation of the tooth in the arch as a space maintainer until root resorption is completed. In children and adolescents the alveolar bone undergoes considerable vertical growth, which is not the case in the region of the ankylosed tooth, causing increased tooth infraposition and tipping of adjacent teeth (Fig 1).[17] Infraposition evolves differently in different individuals. There is a high risk of severity when ankylosis is established before pubertal growth, at around 10 years of age.[15]

Extraction is recommended in cases of inclined adjacent teeth or extensive infraposition.[17] In other cases, teeth should be examined at intervals of six months until root resorption ceases and the tooth crown either comes loose or can be removed with forceps, after most of the root has been replaced by bone.[16]

Clinical experience has shown that extraction of ankylosed teeth involves substantial bone loss both horizontally and vertically, which affects, in particular, the thin buccal bone wall in the maxilla.[16] To prevent this loss, Malmgren et al[16,17] described a technique that involves removal of the tooth crown with subsequent closure of the alveolus with the root inside it. When root resorption by replacement takes place it preserves or even enhances alveolar bone height in the vertical direction. It also preserves the alveolar bone in the buccolingual direction, which improves the conditions for orthodontic treatment—if necessary—and/or subsequent placement of a prosthesis and/or implant.

In cases of teeth treated endodontically, the filling material must be removed from inside the canal because it is an irritant and because the gutta-percha can hinder the bone healing process. The filling material must be removed prior to closing the mucogingival flap, enabling the invasion of connective tissue, especially if a blood clot is found in the empty root canal.[16,17]

FIGURE 1 - Tooth crown of tooth 11 elongated with composite resin, due to ankylosis. Note height difference between teeth 11 and 21, cervically.

CLINICAL CASE REPORT

Female patient, aged 10 years, was referred by her pedodontist for orthodontic treatment. She presented with a slightly convex profile, good maxillomandibular relationship (Fig 3), Class I malocclusion, constricted upper and lower arches (Fig 4), anterior mandibular and maxillary crowding, and mandibular midline shift (1 mm to the right).

Four years earlier, the patient had suffered a fall with total avulsion of tooth 21 and extrusion of tooth 11 (Fig 2, A). According to her pedodontist, both radiographically and clinically, the teeth had open apices with divergent walls. Tooth 11 was repositioned and tooth 21 was reimplanted (Fig 2, B). A semi-rigid retainer was bonded and fishing line (nylon) was placed around teeth 13, 11, 21 and 23. Amoxicillin 250 mg was prescribed for 7 days, Cataflan drops for three days, and aqueous polyvinylpyrrolidone for cleaning the region. Liquid and semi-liquid food was recommended.

Subsequently, tooth 21 underwent endodontic treatment with calcium hydroxide for root apexification.

At the time of the initial orthodontic examination, tooth 21 showed signs of resorption (Fig 5), light browning of the crown and a slight step between teeth 11 and 22. Tooth 11 appeared normal both clinically and radiographically (Fig 4, B).

The orthodontic plan provided for the use of a standard Bimler appliance for upper and lower arch expansion and a fixed orthodontic appliance in a second stage for tooth alignment and leveling, and occlusion detailing.

After nine months of treatment with the removable appliance, we observed a significant increase in the size of the step between tooth 21 and teeth 11 and 22 due to the ankylosis in tooth 21.

We then decided to amputate the crown of tooth 21 and to bury the intraosseous root (Fig 6) while suspending the use of the removable appliance and mounting a fixed orthodontic appliance, straight wire Roth prescription (Fig 7). A pontic was bonded between teeth 11 and 22 and remained in place until the end of the active orthodontic treatment and retention period (Figs 8, D and 9).

FIGURE 2 - **A)** Periapical radiograph taken immediately after trauma. **B)** After reimplantation of tooth 21 and repositioning of tooth 11.

FIGURE 3 - Extraoral photographs before orthodontic treatment.

FIGURE 4 - Intraoral photographs before orthodontic treatment.

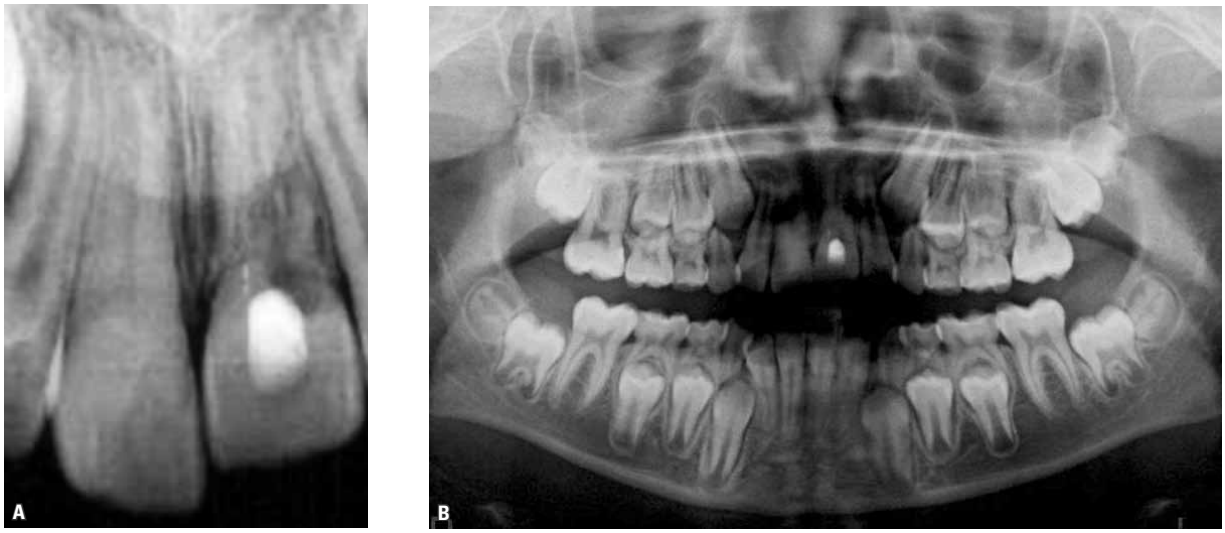

FIGURE 5 - Periapical (**A**) and panoramic (**B**) radiographs showing cervical resorption in tooth 21.

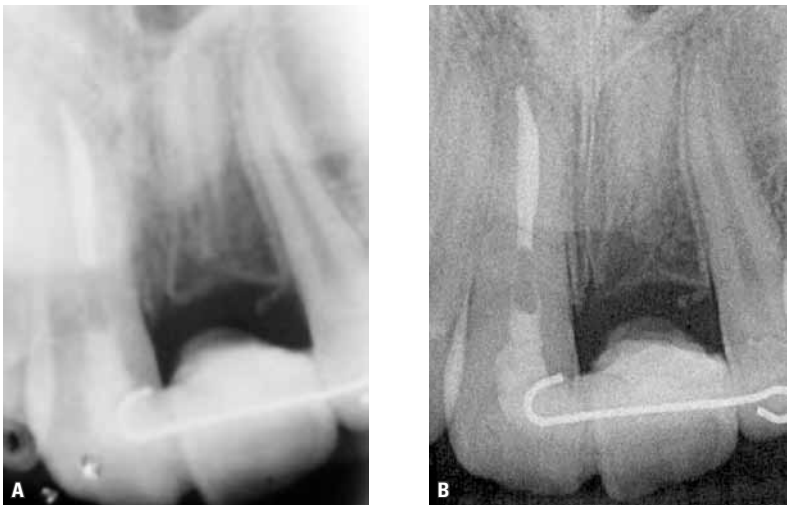

FIGURE 6 - **A**) Periapical radiograph immediately after crown amputation and burial of the root of tooth 21. **B**) Periapical radiograph 8 months after crown amputation.

FIGURE 7 - Finishing phase of orthodontic treatment.

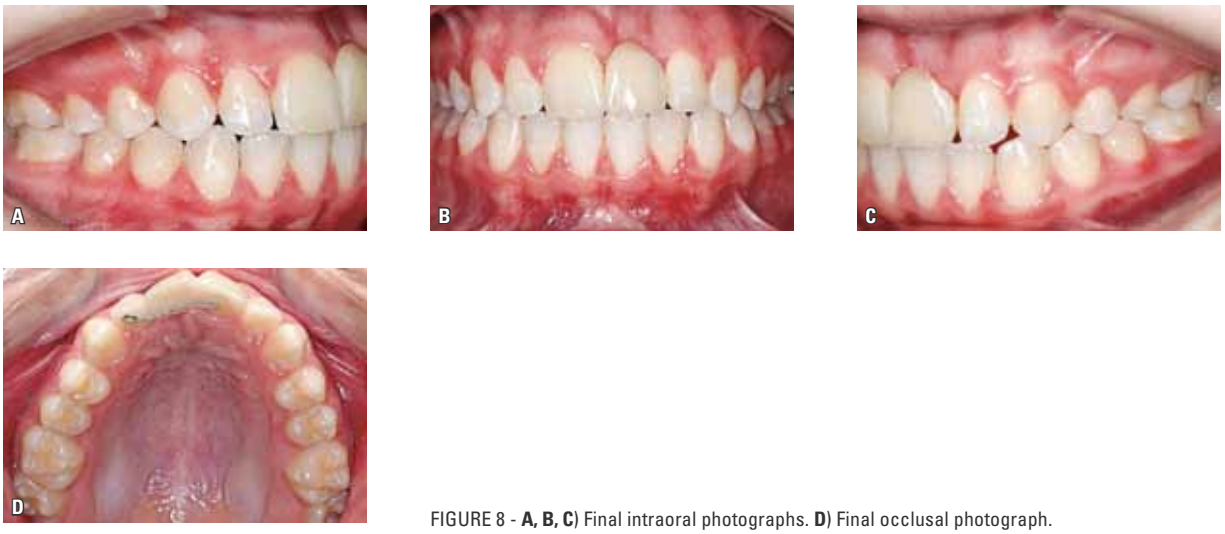

FIGURE 8 - **A, B, C**) Final intraoral photographs. **D**) Final occlusal photograph.

The patient will wait until her growth is completed before having an implant and prosthesis placed in the edentulous area (Fig 10).

DISCUSSION

Dental trauma entails a number of consequences which can lead to tooth loss. Due to the

FIGURE 9 - Final periapical radiograph.

FIGURE 10 - Final extraoral photographs.

high prevalence of this condition in patients at an early age and the possibility that these cases do not receive treatment and proper follow-up,[9] it is of great importance that orthodontists obtain a comprehensive dental history of their patients. The analysis of periapical radiographs allows the diagnosis of root resorption and ankylosis prior to orthodontic treatment. Regular X-ray control during the entire period of orthodontic movement is essential for the diagnosis of root changes.

Dental trauma is not a condition that contraindicates orthodontic treatment, but some studies indicate that it is a predisposing factor to tooth resorption.[6,17] Due to the length of follow-up time required in these cases, a direct relationship between dental trauma and root resorption cannot be established at this time.

In this clinical case we diagnosed a cervical root resorption in tooth 21 prior to orthodontic treatment, and given the likelihood that this tooth was also ankylosed, no orthodontic forces were ever applied to it.

Orthodontic forces were only applied to tooth 11, which had undergone extrusion, in the final phase of treatment, although it did not show any signs or symptoms of abnormality at

the initiation of treatment. During orthodontic treatment, tooth 11 exhibited pulp necrosis, which is probably related to the damage suffered four years earlier. This scenario is to be expected for trauma cases as sequelae can appear years after an injury. Pulp necrosis is among such sequelae[21]. Tooth 11 was then subjected to endodontic treatment.

Tooth avulsion, with subsequent reimplantation, displays the most uncertain prognosis of all dental trauma types. A reimplanted tooth can only be moved orthodontically after two years' follow-up, and only if normal conditions are restored.[4,6,14,17] The likelihood of root resorption and/or ankylosis is extremely high. Should ankylosis occur, orthodontic treatment becomes limited as an ankylosed tooth loses its periodontal ligament, therefore rendering orthodontic movement impracticable. Furthermore, the alveolar bone loses its capacity for vertical growth in this region.

In younger patients, especially those in the growth phase, ankylosis is accompanied by a growing infraposition of the tooth,[17] such as occurred in our clinical case. Given the fact that in this case the degree of infraposition was severe because ankylosis occurred before pubertal growth, we amputated the affected tooth crown and 'buried' its root using the technique described by Malmgren et al.[16,17] This procedure allows the replacement of root tissue by alveolar bone, favoring the maintenance of alveolar bone in the region. In some cases it may lead to increased alveolar bone height, eliminating the need for bone grafting for implant and/or prosthesis placement.

CONCLUSIONS

1. Ankylosed teeth should be preserved as space maintainers until root resorption is completed, provided that the teeth do not present with severe infraposition.

2. Should an ankylosed tooth be severely infraposed, crown amputation and root burial are indicated as a means to preserve the alveolar bone in the region, since resorption will occur by replacement of the buried root, as was the case in this report.

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