



Orthodontic Movement of Central Incisor with Previously-healed Root Fracture associated with Unerupted Canines

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ABSTRACT

Teeth with root fracture may need orthodontic treatment. This case report presents the management of unerupted canines in a patient with previously-healed/untreated horizontal root fracture in the maxillary left central incisor. The malocclusion was treated maintaining pulp vitality considering the principles to improve the eruption path of maxillary canines and move short-rooted teeth. The root-fractured tooth remained symptomless after orthodontic treatment without significant adverse effects, and stayed stable following 2-year follow-up.

Keywords: Impacted Teeth; Tooth Fractures; Tooth Movement Techniques

Introduction

Root fracture is usually diagnosed after trauma/traumatic injuries; yet in some cases, it is identified in routine dental appointments [1]. Some root fractures are not diagnosed at the time of initial trauma management as they can only be shown by radiographic imaging techniques such as cone-beam computed tomography (CBCT), mainly in cases without the displacement of coronal segments [2]. Çalişkan and Pehlivan observed that 31% of patients with root fracture had their injury identified in routine dental care [1].

The orthodontic treatment of individuals with root fracture is viable, provided that special care is taken [3-5]. Detailed clinical/radiographic evaluation and a full history of trauma are essential to treatment planning. Orthodontic movement prior to healing may compromise periodontal and pulp healing, leading to unnecessary complications [6]. Information in the literature to guide the orthodontic management of teeth with root fracture is still sparse [3-6]. Recently, Sandler *et al.* [6] observed a wide variation in the

orthodontic management of traumatized teeth amongst UK-based orthodontists, with most orthodontists interested in further training in the management of dental trauma.

The orthodontic treatment of patients with unerupted canines is usually associated with prolonged treatment time [7], and differential mechanics may be necessary to correct the position of unerupted teeth [8]. Moreover, the canine traction may fail in some cases [9]. The canine management in cases with root fracture has not been found in literature by the best knowledge of the authors. Therefore, the aim of this case report was to describe the management of unerupted canines in a patient with root fracture that was untreated and unknown until orthodontic appointment, with its 2-year follow-up.

Case Report

A 14-year-old post-pubertal girl presented to an orthodontic clinic with the chief complaint of diastema between her upper front teeth. During routine anamnesis, her mother did not report any trauma/traumatic injuries to the oral and maxillofacial regions.





Figure 1. Pre-treatment views, A) No crown fracture or enamel colour alterations were seen; B) Periapical radiograph and C) CBCT image, sagittal view showed simple horizontal root fracture in the middle third of the maxillary left central incisor



Figure 2. Post-treatment views, A) No enamel colour alteration in the maxillary left central incisor; B) Periapical radiograph, root remodeling of the coronal segment of the fractured tooth could be seen, without any periapical lesion; C) CBCT image, sagittal view: the coronal segment was slightly moved relative to the apical fragment

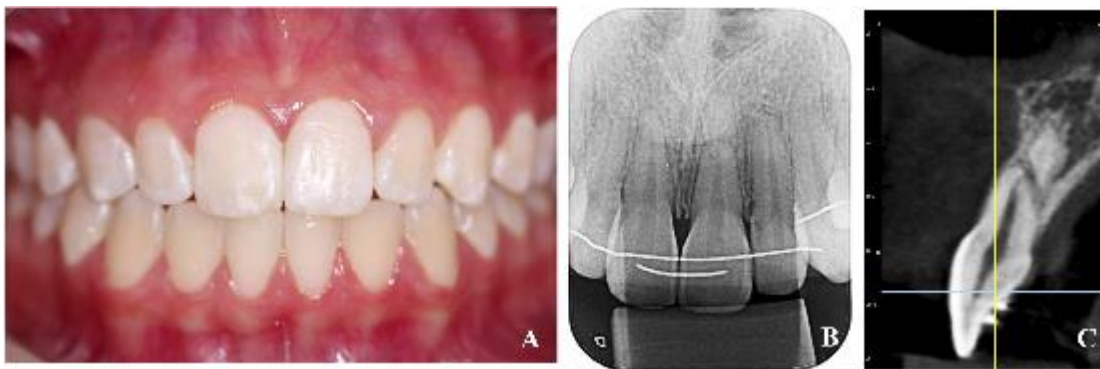


Figure 3. Follow-up after 2 years, A) Maxillary left central incisor without colour alteration; B) Periapical radiograph; fracture with the same extension as at the post-treatment phase; C) CBCT image, sagittal view: fracture line unchanged when compared with post-treatment images

Clinical intraoral and extraoral examination revealed the presence of Class I inter-arch anteroposterior relationship, adequate tooth alignment and leveling, normal overjet, maxillary diastemas, unerupted permanent maxillary canines and no coronal fractures or enamel colour alteration (Figure 1A). The patient and her parents were again asked about any history of trauma; however, they did not remember any fact. No discoloration of the coronal segment, mobility or tenderness to percussion was observed.

Examination of periapical/panoramic radiographs and CBCT demonstrated a simple horizontal root fracture in the middle third of the maxillary left central incisor (Figures 1B and 1C). The pulp chamber and the coronal segment as well as the periapex showed normal aspects. A narrow radiolucent line separated the fractured fragments, suggesting that the healing of tooth was likely related to the healing of interproximal connective tissue.

A pre-orthodontic treatment examination was performed by an endodontist in order to evaluate the pulp vitality using cold and electrical sensitivity tests. The tooth was vital. After discussing the implications and alternatives with the endodontist, a common decision was made to treat the patient. The patient and her parents were advised about the situation and informed consent was obtained from her parents, with specific warning about possible root resorption and/or pulp necrosis during orthodontic treatment. The imaging exams showed favourable prognosis for canine positioning; however, it was necessary to gain space at the canine area to encourage their eruption, using minimal mechanics at the root-fractured tooth.

Rapid maxillary expansion was performed using Hyrax appliance, with further preservation of canines to accompany their eruptions. Six months after expansion, a modified transpalatal bar containing palatal extensions in premolars areas was placed so as to maintain the spaces gained for the eruption of canines. After spontaneous eruption of both canines, pre-adjusted edgewise brackets (3M Gemini metal brackets; 3M Unitek, Monrovia, CA, USA) (0.022"×0.028") were bonded on all erupted teeth. The sequence of archwires used was heat-activated nickel-titanium 0.012", 0.016", 0.018", 0.016×0.022" and 0.018×0.025", followed by stainless steel 0.018"×0.025". To limit the level of orthodontic force applied to the fractured tooth, each archwire remained inserted for 2 months in the maxillary arch. Moreover, the spaces were closed *via* tying the stainless steel wire ligature (0.010"), alternating with the use of long elastic chain. Periodic periapical radiographic evaluation and thermal sensitivity testing of the maxillary left central incisor were conducted every 3 months.

Orthodontic treatment was finished after 29 months with favourable aesthetic and functional results. Then, a bonded retainer was placed in both arches. Mandibular movements were checked using AccuFilm (Parkell, Edgewood, NY, USA) to eliminate any incisal contact interference in the maxillary fixed retention. The maxillary left central incisor remained positive to sensitivity testing. Radiographic and CBTC images demonstrated root remodeling of the coronal segment of the fractured tooth, without periapical lesion. The coronal segment was slightly moved in relation to the apical fragment (Figures 2A, 2C). The cephalometric analysis showed no changes in the skeletal relationship as well as slight proclination of the maxillary central incisors.

At the 2-year follow-up appointment after the orthodontic treatment, the maxillary left central incisor was responsive to

vitality/sensibility testing, non-tender to percussion, without colour alteration, and imaging examinations demonstrated that the fracture had the same extension as at the post-treatment phase (Figures 3A–3C). The bonded retainer is still being used and the patient was instructed to continue wearing the retainer for a long term to maintain the space closure.

Discussion

After root fracture, if there is no crown colour alteration, no mobility and no displacement of the coronal segment, the patient may have no complaints and thus, may not attend a dentist; leaving the injury undetected. In the reported case, the fracture was discovered during routine orthodontic treatment planning. Since orthodontic movement prior to healing of root fractures may compromise periodontal/pulp healing, information on the history and time of injury is very important [6]. However, in the current case, the patient and her parents did not remember any trauma episode; therefore, a detailed examination of the fracture characteristics was important to establish the treatment planning.

The radiographic and scanning suggested that the fractured tooth had healed spontaneously, corroborating the literature reports of spontaneous healing of root fractures without treatment [4, 10-12]. The fractured segments were separated by a narrow line and the edges were rounded, suggesting that the healing process occurred with interproximal connective tissue. The recommended follow-up period of teeth healed with interposition of soft tissue is between 12 and 24 months [13]; however, it is not possible to affirm the mentioned period in the presented case.

The pulp vitality was maintained after treatment and at 2-year follow up, corroborating previous case reports [10, 12, 14]. When root fracture occurs, the force transmitted to the apical region of the involved tooth decreases and revascularization can be achieved at the fracture line, maintaining the pulp vitality [13]. Furthermore, it is speculated that the fractured area provides a pathway for the escape of fluid pressure from edema, allowing collateral circulation from the periodontal ligament to assist in maintaining the vitality of traumatized pulp [15].

Treatment decisions in the field of dental trauma require multidisciplinary evaluation [6]. In the reported case, the relationship between endodontics and orthodontics during treatment decision-making was extremely important, helping in the prognosis and treatment planning. In cases of pulpal disease,

endodontic management is necessary before orthodontic treatment [3]. Since the pulp vitality/sensibility tests were positive and the radiographic images did not show any signs of pathology, endodontic treatment was not performed in the maxillary left central incisor [11]. The specialists decided in common agreement that the tooth should be treated with caution to avoid further shortening of the coronal segment, which would result in little periodontal support [3, 6]. Periodical assessment including evaluation/presence of crown colour, draining sinuses, swellings, mobility, tenderness, percussion test, radiographies and pulp vitality/sensibility tests were established [6, 13, 14].

The decision to initially use a rapid maxillary expander and monitor the canine eruption using a transpalatal bar was made to reduce possible interference on the maxillary left central incisor. Additionally, rapid maxillary expansion may produce a high improvement rate of the canine eruption path. Barros *et al.* [16] observed changes in vertical, horizontal and angular positions of ectopic canines, lateral incisors and first premolars after rapid maxillary expansion, with favorable impact on the canine's ectopic path, making the challenging eruption path of the maxillary canine more predictable [16].

The literature reports that it is possible to orthodontically move a root-fractured tooth, provided that care is taken [4, 10]. Forces applied in traumatized teeth should be lighter than normal orthodontic forces [17], following the biological and biomechanical considerations applied to teeth with shortened roots [4, 10]. In the case reported, light forces were applied throughout the treatment; the archwire sequence using nickel-titanium heat-activated wires aided to reduce the orthodontic forces, since these wires deliver light and continuous forces with large amounts of activation and for long periods of time. The treatment was completed without correction of incisor root torque; which should be an important consideration in clinical cases with root-fractured teeth as a critical biomechanical aspect. The leveling and alignment result in minor root movement; therefore, it may be performed in similar specific interdisciplinary cases. Moreover, the literature suggests a period of rest of the fractured tooth for the dissipation of stress inflicted to the periodontal ligament, allowing recovery of inflamed tissues and decreasing the possibility of root resorption risk [4, 18, 19]. Therefore, longer intervals between activations were applied [17], maintaining the archwire passive for 1 month before change.

Bonded retainers were placed in the maxillary arch for retention due to the initial interdental diastemas/spacing; nevertheless, they had the added benefit of splinting the root-

fractured tooth. However, attention had to be paid to avoid occlusal trauma to the fixed teeth, eliminating any incisal contact interference in the maxillary fixed retention.

Slight separation between fragments was observed after treatment. This may occur after the orthodontic movement of teeth with root fracture healed with interposition of connective tissue, as previously reported in literature [4, 10].

Some root resorption is expected after orthodontic treatment in normal and traumatized teeth. Malmgren *et al.* [20] demonstrated that the extent of root resorption after the orthodontic treatment of traumatized teeth was the same in both traumatized and contralateral, uninjured control teeth [20]. It is important to treat traumatized teeth with caution; since the coronal segment usually has a compromised crown/root ratio which could be worsened by orthodontic surface resorption [6]. Periodic radiograph control and use of slight forces are important to analyze the tooth during treatment. The combination of trauma with orthodontic tipping may increase the susceptibility to complications, especially to root resorption and loss of vitality. The follow-up evaluation revealed a stable condition, maintaining the pulp vitality and the fracture line unchanged when compared with the post-treatment images.

Imaging exams are important for diagnosis, prognosis and follow-up in similar situations. CBCT exam is currently suggested, since it displays the exact location of fracture and its healing characteristics, improving diagnosis and prognosis. In the case described, CBCT was initially requested to evaluate and plan the unerupted canine, as this exam is useful in the management of unerupted canine, helping to properly plan the orthodontic treatment. Furthermore, it was important to evaluate the healing of the fractured area, since the history of trauma was unknown. The immediate post-treatment and 2-year follow-up evaluations of the maxillary left central incisor were obtained using small field of view for radiation protection. However, despite the advantages, the CBCT exams for tooth fractures should be used in specific cases due to radiation risks.

Conclusion

The result of the presented case report has demonstrated that it may be possible to move spontaneously healed untreated root-fractured teeth maintaining the pulp vitality, provided that careful orthodontic management is taken.

Conflict of Interest: 'None declared'.

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