

# Endodontic and Prosthetic Management of a Mid-Root and Crown Fracture of a Maxillary Central Incisor

## SUMMARY

*Root fractures are relatively uncommon among other dental traumas and mostly affect the anterior dentition. This case report presents the endodontic and prosthodontic management of a maxillary central incisor with a combined fracture in the middle third of the root and the crown, as well as the 7-year follow up of the case. The healing potential of a horizontal root fracture in the middle third of the root is highlighted when appropriate treatment is applied. MTA used for obturation of the coronal fragment, induced hard tissue formation apically and promoted healing in the area, while the 2mm MTA left as apical barrier at the second stage of re-treatment and obturation with gutta-percha prevented its extrusion. The multidisciplinary approach in the management of such cases ensures a long term survival.*

**Keywords:** Horizontal Root Fracture; MTA; Tooth Crown Fracture; Apical Barrier

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**CASE REPORT (CR)**

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## Introduction

Root fractures can be defined as fractures involving the dentine, the cementum as well as the pulp<sup>2</sup>. They are relatively uncommon among dental traumas, comprising 0.5-7% and 2-4% of the injuries affecting the permanent and primary dentition respectively<sup>17</sup>. They are more common in teeth with complete root development<sup>30</sup>. Root fractures usually appear in central (68%) and lateral (27%) maxillary incisors, whereas they rarely affect (5%) mandibular incisors<sup>27</sup>. The International Association of Dental Traumatology (IADT) has recommended a specific protocol to follow in cases of horizontal root fractures. In particular, repositioning and immobilization of the coronal fragment through fixation to neighbouring teeth, as well as endodontic treatment, where appropriate, should be performed in these cases<sup>18</sup>.

The pulp of approximately 5-25% of teeth with horizontal root fractures will become necrotic and endodontic treatment will be required<sup>8</sup>. Endodontic treatment of teeth with fracture in the cervical part of the root has been shown to be of poor prognosis, especially in patients with poor oral hygiene<sup>16</sup>. Removal of the coronal

fragment and orthodontic or surgical extrusion of the apical fragment should be considered in these cases<sup>20</sup>.

Conservative endodontic treatment of teeth with fracture in the middle or apical part of the root may concern the coronal fragment alone or both fragments. The choice depends on radiographic findings, such as peri-radicular changes, the width of the pulp lumen, the separation or not of the fragments, and pulp vitality in the apical fragment<sup>3</sup>. The coronal fragment may be filled with gutta-percha immediately after chemo-mechanical preparation if the anatomy of the root canal permits obturation without the risk of material extrusion. On the other hand, in cases of wide root canals, a hard tissue barrier formation is required prior to final obturation of the coronal fragment. Calcium hydroxide has been widely recommended for this purpose<sup>3,21</sup>.

MTA has also been proposed and used for single visit apexification<sup>31</sup>, presenting successful outcomes<sup>22</sup> and at the same time presenting the highest fracture resistance after one year when compared to untreated teeth and teeth treated with calcium hydroxide<sup>19</sup>. The aim of this case report is to present the endodontic and prosthodontic management of a maxillary central incisor with fracture in the middle third of the root.

## Case Report

A 13-year old male patient with non-contributory medical history presented for evaluation and treatment of his maxillary central incisors suffering traumatic injury due to an accident in the previous day. Clinical and radiographic maxillofacial examination revealed no trauma of the soft tissues and absence of any fracture of the maxilla, mandible or other facial bone. Oblique crown fractures were evident in both maxillary incisors, at the level in-between middle and cervical third of the crown labially, propagating towards the neck of the teeth palatally. Concussion injury of the right incisor was also diagnosed. The incisors did not respond to electrical and thermal vitality tests; their mobility was within normal limits. A periapical radiograph of the affected teeth revealed complete apex formation of both teeth with no obvious sign of a root fracture (Fig. 1).



Figure 1. Radiograph 1 day after the injury. Complete apex formation is observed and absence of root fracture

Repositioning of the coronal fragment of the left incisor was not required since the distance between the 2 fragments was minimal. A soft diet and avoidance of chewing with the anterior teeth were recommended. A recall programme was explained to the patient and the first appointment after 6 weeks was scheduled. The patient did not comply with the recall appointments. He reappeared after 3 months with an endodontic treatment of the right central incisor by his general dentist. A periapical radiograph of the affected teeth revealed the presence of a horizontal mid-root fracture at the left incisor. Due to the negative vitality test at the left incisor at that time, root canal therapy was initiated and was performed only in the coronal fragment (Fig. 2). A week later the instrumented canal up to the fracture line of the left central incisor was filled with MTA. The exposed dentin at both teeth was covered with resin composite crowns serving as interim restorations (Fig. 3).



Figure 2. Finding before the treatment of the fractured left incisor. The horizontal root fracture is now evident due to separation of the fragments.



Figure 3. Immediate postoperative x-ray of the left central incisor obturated up to the fracture line with MTA.

The patient was advised to conform to the scheduled recall appointments. However, he came back 5 years later for permanent prosthetic restoration of the involved teeth. Clinical examination at that time revealed no symptoms from the affected area. Radiographic examination revealed normal peri-radicular tissues, formation of a hard tissue barrier apically in the coronal fragment of the left incisor and obliteration of the pulpal lumen in the apical fragment. Permanent prosthetic restoration of the teeth was decided at this time (Fig. 4).

Due to secondary caries in the proximal area, as well as loose of retention of the interim crown and consequently possible recontamination of the root canal, endodontic re-treatment was decided prior to the final restoration. MTA was removed with the aid of ultrasonic tips (EMS, Switzerland) and a modified #3 gates-glidden drill, leaving 2 mm of MTA as an apical barrier and root canal preparation was performed with K-files up to #100

under copious irrigation with 2.5% NaOCl. The root canal was obturated by using the warm vertical gutta-percha compaction technique with epoxy resin based sealer - AH26 silver free Densteply (Fig. 5). Both central incisors were prepared with the use of a cylindrical diamond bar. Axial reduction for 1mm was performed and a 90 degrees shoulder with a rounded internal gingivoaxial line angle was created. Due to the importance of the aesthetic element in the labial area, disilicate glass ceramic was utilized for the crown construction (Empress 2, Ivoclar, Lichtenstein).



Figure 4. The teeth at the 5-year recall. The formation of a hard tissue barrier apically in the coronal fragment and the obliteration of the pulpal lumen in the apical are evident



Figure 5. Re-treatment of root canal of the left central incisor. MTA was removed except for 2mm serving as an apical barrier and the root canal was obturated with gutta-percha

The short root canal length of the fractured left incisor, the need for preservation of the root canal sealing integrity, the extremely narrow buccal-lingual shape of the canal of the right incisor, the willingness for homogeneity

concerning the crowns of both teeth and simultaneously the necessity for root canal access in case of endodontic treatment failure prevented the preparation and fabrication of a typical post. Instead, shallow 3 mm post wells were prepared apically to the pulp chamber, removing the gutta-percha with the aid of system B heat source (SybronEndo-USA) and the ceramic crowns were modified into an extremely short “Richmond” type. For the impression, a 2-phased silicon was used (Silaplast-Silasoft S, Detax GmbH&CoKG, Ettlingen, Germany). After local anesthesia, 2 gingival retraction cords (Ultrapak, Ultradent Products Inc, Utah, USA) were positioned in both teeth (Fig. 6).



Figure 6. Retraction cords placed for the impression making

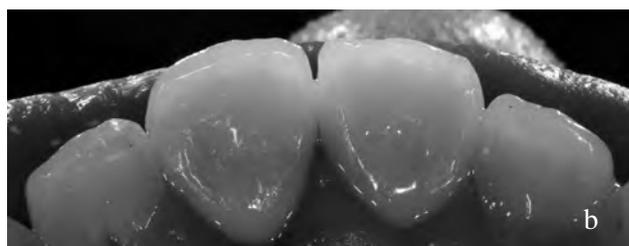
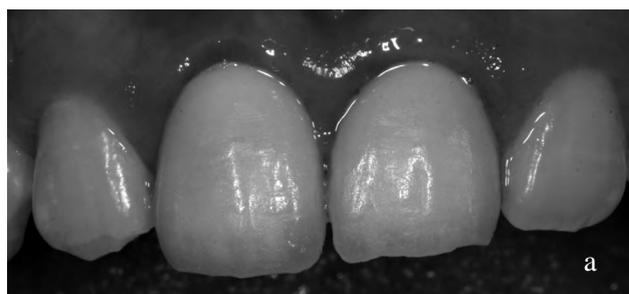


Figure 7. Final ceramic crowns. Labial (a) and palatal (b) view

The colour was selected with the use of a Vita Shade Guide in natural light and was evaluated intraorally during "biscuit" stage; the final shade was verified upon glaze completion and prior to cementation. Further on, the crowns were cemented with a resin cement (Optec, Jeneric/Pentron Inc, Wallingford CT, USA) following manufacturer's instructions, and a fine articulating paper (Accufilm II, Parkell, Farmingdale, USA) was utilized for the occlusal evaluation and adjustment (Fig. 7). Finally, the patient was given instructions for proper oral hygiene and appropriate recall protocol (Fig. 8).



Figure 8. Follow up radiograph, 7-year recall. The hard tissue formation apically of the coronal segment as well the absence of inflammation in the peri-radicular tissues

## Discussion

Root fractures usually result by a frontal impact, which creates compression zones labially and lingually<sup>2</sup> or by restorative procedures<sup>25</sup>. Horizontal root fractures usually take place in the middle third of the tooth root, whereas they rarely appear in the apical third<sup>5</sup>. Horizontal root fractures may not be visible in the first radiograph taken immediately after the incidence (Fig. 1) but may need more time for the fragments to separate and become evident (Fig. 2). Also the sensitivity results may not reflect the pulpal status and thus monitoring of the healing is recommended<sup>9</sup>.

The healing of transverse root fractures can be accomplished by the interposition between fragments of hard/calcified tissue, connective tissue, both bone and connective tissue or granulation tissue<sup>2</sup>. The first one is considered to be the most favourable type of healing. Some case reports demonstrate spontaneous healing without any treatment<sup>12,14,28</sup>.

According to the IADT, repositioning of the coronal fragment is supposed to be essential for the successful

healing of the horizontal root fractured teeth when the fragment is dislocated. Optimal repositioning (less space between the fragments) leads to healing with disposition of hard tissue more frequently than with incomplete repositioning<sup>6</sup>. The fixation period should be approximately 4 weeks to ensure sufficient hard tissue formation<sup>18</sup>. In the present case, there was no need for splinting due to the absence of fragment mobility.

The evidence of pulpal necrosis in the coronal segment during follow up examinations outlines the need for root canal therapy. The decision may be taken after 3 months of follow up if the results of pulp vitality tests are still negative. Endodontic treatment is not required as long as the pulp retains its vitality<sup>12,32</sup>. In the present case, the vitality tests were negative. This was expected as the risk of necrosis was considered higher when compared to teeth with open apices<sup>7</sup>. The absence of pathologic changes periapically was indication for endodontic treatment only in the coronal fragment. This favoured healing since research has indicated less favourable healing results in cases where endodontic treatment has been performed at both fragments<sup>15</sup>. This could be attributed to complications due to impaction of necrotic tissue and filling debris between the fragments during instrumentation, as well as overfilling with gutta-percha. In cases of delayed necrosis of the apical fragment, its surgical removal may be attempted<sup>26,29</sup>. The proportion of healing of teeth filled with gutta-percha in only the coronal fragment can reach 76%; a higher percentage of 86% has been observed when  $\text{Ca}(\text{OH})_2$  placement has been preceded<sup>3</sup>.

In the present case, MTA was selected to serve as an apical barrier. MTA presents advantages such as: biocompatibility, non-mutagenicity, encouragement of hard tissue deposition, and resistance to bacterial penetration due to its ability to adapt to adjacent dentin and form superior dentin bridges when compared to  $\text{Ca}(\text{OH})_2$ <sup>4</sup>. Furthermore prolong application of  $\text{Ca}(\text{OH})_2$  in extracted bovine teeth has weakened dentin's resistance to fracture. This fracture resistance was improved when  $\text{Ca}(\text{OH})_2$  was replaced with MTA after a month<sup>1</sup>. Holland et al<sup>23</sup>, investigated the periapical tissues' response to MTA in dogs and resulted that MTA exhibited better biological properties and at the same time did not produce inflammatory reactions in the periapical tissues.

A study also demonstrated that MTA favoured both apexification and periapical healing after extrusion of the material into the periapical tissues. A complete resolution of the lesion around the extrusion was observed within 36 to 54 months follow up, resulting that MTA does not affect periapical tissues' healing process<sup>13</sup>. In addition, MTA has been shown to hold several cell-surface interactions such as: cell attachment, cell proliferation, concerning gingival and periodontal ligament fibroblasts and gene expression as well, for example expression of osteoblast-associated proteins<sup>10,11</sup>. For these reasons, MTA

has become a new challenging material when dealing traumatic injuries of the teeth. In the presented case, MTA induced the formation of an apical hard tissue barrier and while serving as an apical barrier, prevented the material extrusion into the peri-radicular tissues.

The interesting aspect of this case report is the simultaneous creation of a crown fracture and a horizontal mid root fracture in the left incisor, which poses a lot of questions concerning the mechanism, the force characteristics leading to it, as well as the prognosis. Vertical forces are considered to cause high stress concentrations in the apical area of teeth and are related to oblique crown-root fractures and oblique root fractures<sup>24</sup>. The analysis of forces in vertical and horizontal components might explain the double fracture of the current case. Furthermore, the significant vertical component of the force might be the cause of the extremely narrow space created in-between the fractured parts that finally favoured the uncomplicated survival of the tooth.

This case report highlights the healing potential of a horizontal root fracture in the middle third of the root when appropriate treatment is applied. The obturation of the coronal fragment with MTA prevented material extrusion into peri-radicular tissues and induced formation of a hard tissue barrier and consequently healing.

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