# Regenerative Endodontic Procedures for Traumatized Teeth after Horizontal Root Fracture, Avulsion, and Perforating Root Resorption

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## Abstract

**Introduction:** Traumatic injury to the teeth can cause horizontal root fractures and inflammatory root resorptions (external and internal). Traditionally, traumatized teeth with horizontal root fractures resulting in pulp necrosis and inflammatory root resorptions are treated with conventional root canal therapy. **Methods:** A 15-year-old boy had a history of traumatic injury to mature tooth #8 resulting in horizontal root fracture and pulp necrosis of the coronal fragment. A 7-year-old girl suffered an avulsion injury to immature tooth #9, which developed inflammatory replacement resorption and subsequently root fractured 15 months later. Another 16-year-old boy also suffered a history of traumatic injury to mature tooth #8, resulting in perforating root resorption. All teeth were treated with regenerative endodontic procedures using chemomechanical debridement, calcium hydroxide/triple antibiotic paste dressing, EDTA rinse, induction of periapical bleeding into the canal space, and a coronal mineral trioxide aggregate plug. In the tooth presenting with horizontal root fracture, only the coronal fragment was treated to preserve pulp vitality in the apical fragment for possible pulp tissue regeneration. **Results:** After regenerative endodontic procedures, clinical signs/symptoms subsided, and inflammatory osteolytic lesions resolved in all traumatized teeth. Two teeth were followed for 19 months and 1 tooth for 5 years. At the last review of the teeth with horizontal root fractures, the first case showed healing by calcified tissue and the second case showed healing by fibrous connective and hard tissue. Tooth with perforating root resorption demonstrated a decrease in size of the resorptive defect. **Conclusions:** Based on these case reports, regenerative endodontic procedures have the potential to be used to treat traumatized teeth with horizontal root fracture and inflammatory root resorption. *(J Endod 2016;■:1–7)*

## Key Words

Avulsion, dental trauma, horizontal root fracture, regenerative endodontic procedures, root resorption

### Significance

Traumatized teeth that became necrotic and infected with horizontal root fracture, avulsion, and root resorptions are traditionally treated with root canal filling. However, regenerative endodontic therapy also has a potential to be used in the management of traumatized devitalized teeth with aforementioned conditions, as demonstrated by the cases presented.

Traumatic injury to the teeth can cause a variety of damage to the teeth and supporting structures including root fractures and root and bone resorptions (1, 2). Horizontal root fracture is caused by direct physical impact to the tooth. External inflammatory root resorption is caused by damage to the root surface in association with the presence of an infected, necrotic pulp in the canal space (3, 4). In order for external inflammatory root resorption to take place, the protective layer of precementum must be damaged, likely because of trauma or inflammation of the periodontal ligament, thus leading to exposure of the underlying dentin (3, 4). In addition, the canal space has to contain infected, necrotic pulp tissue. The toxic products from bacteria and tissue breakdown in the canal space diffuse through the dentinal tubules communicating with the root surface denuded of cementum to initiate inflammatory processes (3–5). Internal inflammatory root resorption occurs in teeth containing infected, necrotic pulps. It is assumed that the odontoblasts and unmineralized predentin lining the canal space must be damaged and the mineralized component of dentin exposed in order for internal inflammatory root resorption to take place (3–5). However, the predisposing factors to the damage of predentin are not clear. Trauma, caries, periodontal infection, calcium hydroxide, vital root resection, orthodontic treatment, and tooth crack have been proposed (5). The cellular and molecular mechanisms of internal/external root resorption are not as clear as that of bone resorption. In bone, there is a cross talk between osteocytes, osteoblasts, and osteoclasts to orchestrate the complex biological processes of resorption and repair (6–8). The primary cause of external/internal inflammatory root resorption and no healing of horizontal root fractures is the presence of infected,

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necrotic pulp in the canal space. Therefore, control of root canal infection should be able to arrest and repair inflammatory root resorption and achieve healing of horizontal root fractures by the formation of hard tissue, soft tissue, or a combination of hard and soft tissue and not by granulation tissue between fracture fragments (3).

Traditionally, traumatized teeth with a horizontal root fracture having pulp necrosis and external/internal inflammatory root resorption associated with infected, necrotic pulp in the canal space are treated with conventional root canal therapy, including chemomechanical debridement of the canal space and root canal filling. Recently, the concept of regenerative endodontic procedures (REPs) has been used to manage horizontal root fractures (9) and external inflammatory root resorption (10, 11) after traumatic injury. The purpose of these case reports was to present the potential of using REPs to manage 3 traumatized teeth, 1 with horizontal root fracture, 1 after avulsion that subsequently root fractured, and 1 with perforating root resorption, in terms of elimination of clinical signs/symptoms and resolution of inflammatory osteolytic lesions as well as tissue responses to REPs.

## Case 1: Horizontal Root Fracture

A 15-year-old boy suffered from a traumatic injury to his maxillary anterior teeth 4 weeks ago. The boy complained of severe pain to tooth #8 to touch and biting. Clinical examination showed that tooth #8 was slightly displaced labially and not discolored. The tooth responded to electric and thermal pulp sensibility tests with prolonged severe pain. It was tender to percussion and palpation. The tooth had grade I mobility. Radiographic examination showed that tooth #8 was fully developed and had a midroot horizontal fracture without displacement of the coronal segment (Fig. 1*A*). The diagnosis was consistent with symptomatic irreversible pulpitis. Treatment options included root canal treatment of the coronal fragment of the root, REPs for the coronal fragment, and extraction. The patient decided to have REPs. Informed consent was obtained.

At the first visit, local anesthesia with 2% lidocaine containing 1:100,000 epinephrine (Xylestesin-A 2%; 3M ESPE, Seefeld, Germany) was administered. The tooth was isolated with a rubber dam. Under a Zeiss surgical microscope (Oberkochen, Germany), the canal was accessed and a moderate amount of bleeding immediately drained through the access cavity. The canal was gently irrigated with 2.5% sodium hypochlorite solution (NaOCl) (Clorox; Nobelwax Factories for Chemicals, Kaliobeya, Egypt). The working length was determined radiographically with a #20 hand K-file to the midroot fracture line. The canal of the coronal fragment was carefully, sequentially debrided to #50 K-files with constant irrigation with NaOCl to preserve the vital pulp in the apical fragment in order to avoid performing complete root canal treatment because the pulp in the apical fragment usually remains vital in a midroot horizontal root fracture. The coronal canal was dried with paper points and dressed with calcium hydroxide (Metapaste; Meta Biomed, Chungbuk, South Korea). The access cavity was closed with a sterile cotton pellet and

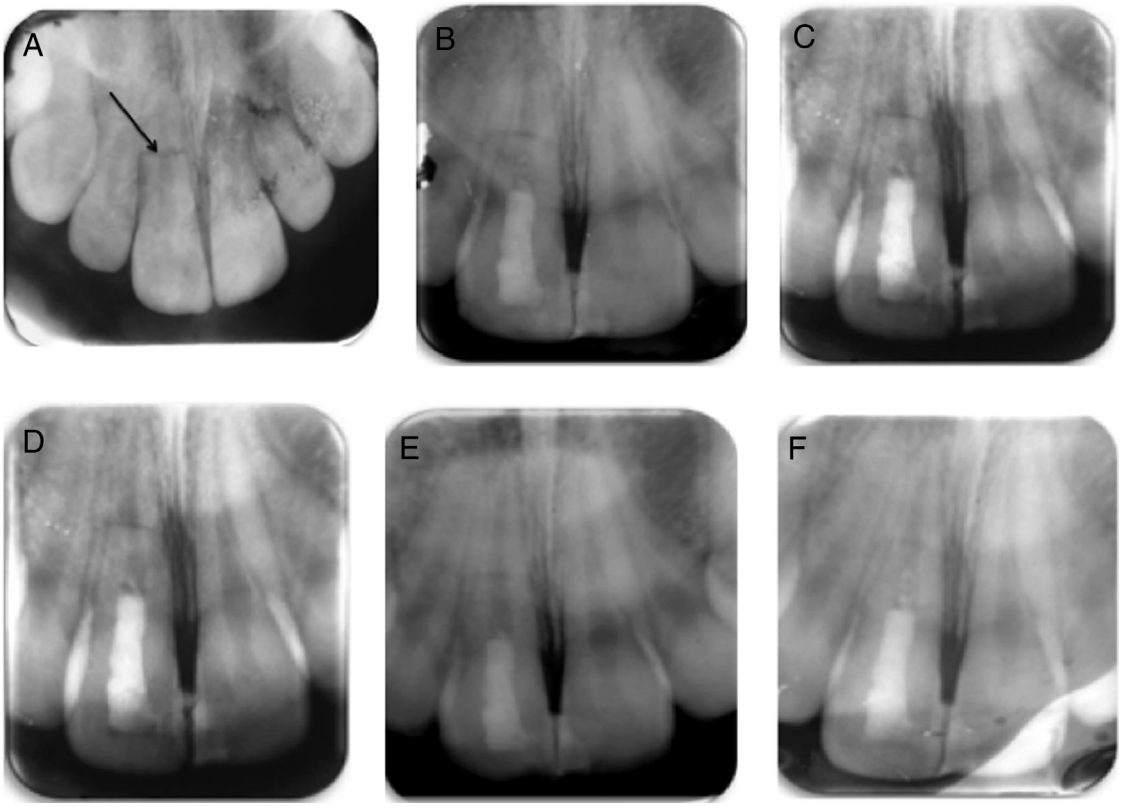


**Figure 1.** (*A*) Preoperative periapical radiograph of tooth #8 in case 1. The root is completely formed. A midroot horizontal fracture (*arrow*) is evident. (*B*) Postoperative periapical radiograph after completion of REPs. (*C*) Postoperative periapical radiograph at the 5-month follow-up. Fracture line still visible. No radiolucent lesion developed at the fracture line. (*D*) Postoperative periapical radiograph at the 8-month follow-up. The radiographic appearance is similar to that at the 5-month follow-up. (*E*) Postoperative periapical radiograph at the 14-month follow-up. Progressive healing of the horizontal root fracture by formation of hard tissue between fragments. (*F*) Postoperative periapical radiograph at the 19-month follow-up. Further healing of horizontal root fracture by formation of hard tissue.