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Intraradicular splinting of a horizontally fractured central incisor: a case report

CASE REPORT

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Abstract – This case report presents the endodontic management of a horizontally fractured right incisor involving healing with granulation tissue using an intraradicular splinting technique. We also discuss the spontaneous healing of the fractured left central incisor with calcified tissue. A composite resin splint was made for all of the upper anterior teeth. The root canal of the right incisor was temporarily filled with calcium hydroxide slurry. The intraradicular splinting involved placing a file in the canal. Sealer was introduced into the canal and then a no. 110 K file was fixed in the canal with polycarboxylate cement. The tooth was asymptomatic and the composite splint was removed after 1 month. The right incisor appeared normal clinically and radiographically at the 30-month recall. This case demonstrates that intraradicular splinting can be used to manage horizontally fractured teeth with necrotic and mobile coronal segment.

The incidence of horizontal root fractures ranges from 0.5% to 7% in permanent teeth and from 2% to 4% in primary teeth for all traumatic dental injuries (1–3). These fractures usually occur in maxillary central incisors and are observed more in the middle root segment than in the apical and coronal segments. The fractures tend to be oblique in the apical and middle root segments and horizontal in the cervical segment. A single fracture occurs in most cases and multiple root fracture is a rare finding. Unilateral root fracture of thin canal walls can be seen in teeth with incomplete root formation. Clinically, the more coronal root fractures are usually more mobile (2–4).

The healing of these fractures can be complicated because the wound in root fractures involves damage to all dental tissues, including the pulp, dentin, periodontal ligament and cementum and is sometimes associated with damage to the supporting alveolar bone. Pathological complications following horizontally fractured teeth include pulp necrosis, root canal obliteration, external and internal surface resorption, inflammation around the fracture, and periapical inflammation (1, 2, 5, 6).

The treatment principles for fractured teeth were established as repositioning the coronal segment if needed, stabilization with a rigid splint for 2–3 months, reduction, and recall for at least 1 year (2, 6). Recently Andreasen et al. (7) stated that the splinting for more than 4 weeks does not influence the healing pattern with the exception of cervical fractures, which require a longer splinting period of 2–3 months because of the mobility of coronal segment. Young age and immature root formation were found to be positively affecting pulp healing with hard tissue repair at the injury site. The injury factors such as the increased diastasis between fragments, dislocation of the coronal part, and mobility of the coronal fragment following the trauma may adversely affect the survival of pulp tissue and eventual healing of the fractured tooth (8). If the fracture is below the alveolar crest and no oral contamination occurs, the pulp tissue may survive and repair the fracture with calcified tissue. Or the periodontal ligament with or without bone may invade the fracture site (1, 2). Conservative treatment of such teeth with rigid stabilization and reduction can succeed. If the fracture line is coronal and bacterial contamination is present through the gingival crest, the pulp tissue becomes necrotic (9, 10). Cvek et al. (11) showed that in most of the fractured teeth, pulp necrosis develops only in the coronal segment and the periradicular radiolucency is seen only around the fracture site.

Various treatment techniques for managing fractured teeth with necrotic pulp have been suggested. The proposed treatment modalities include disinfection and obturation of the coronal segment only, surgical removal of the apical segment, removal of the coronal segment and orthodontic or surgical extrusion of the apical segment, removal of the apical segment and stabilization of the coronal segment with endodontic implants, and intraradicular splinting to unite the fracture (1, 12–17). Disinfection of coronal segment with calcium hydroxide followed by obturation with gutta-percha was found to be the superior technique for the treatment of necrotic teeth fractured in the middle or apical part of the root (11).

Intraradicular splinting is indicated in cases in which the fracture line is in the middle or coronal segment. This technique may correct the mobility of the coronal segment and the periodontal tissue around the fracture site may heal. The technique involves connecting the tooth fragments through the root canal using a metal pin together with a root canal sealer (16, 18–22).

This case report presents the endodontic management of a horizontally fractured central incisor using the intraradicular splinting technique. The spontaneous healing of the fracture in the other central incisor is also evaluated.

Case report

A 35-year-old male was referred to the Faculty of Dentistry, Istanbul University. He had suffered a dental injury in the upper anterior teeth during a football game 4 months earlier. Clinically, a crown fracture affecting any of the maxillary incisors was absent. The right maxillary central incisor was mobile (Grade 2, horizontal loosening ≥1 mm) (10). The right central incisor responded negatively to the electrical pulp and cold tests. The remaining anterior incisors were clinically normal.

Radiographically, horizontal root fractures of both the left and right maxillary incisors were observed. The fracture in the right incisor was oblique, starting at the middle root segment mesially and ending at the coronal segment distally. The fracture in the left incisor was horizontal and was located in the middle root segment. The loss of the lamina dura and presence of radiolucency around the coronal fragment were observed in the right incisor (Fig. 1). Periapical radiolucency was seen around the apical fragment. There were no radiographic changes around the left incisor.

Root canal treatment of the right central incisor was initiated. A no. 15 K file was passed through the fracture and we accessed the apical root segment. All the anterior incisors were fixed rigidly using a dentin-bonded composite resin (Filtek Z250, 3M, MN, USA). The root canal was cleaned, shaped with a no. 70 K file and the canal was filled temporarily for 3 months with calcium hydroxide slurry (Sultan Healthcare Inc., Englewood, NJ, USA), which was renewed every month. The evidence of bone healing around the coronal fragment was observed radiographically at the third month (Fig. 2).

At the third monthly visit, the dressing was carefully removed from the canal, and the canal was enlarged to no. 110 K file size. AH26 root canal sealer (Dentsply, Detrey GmbH, Konstanz, Germany) was introduced into the canal using a K file. Zinc polycarboxylate cement (Spofa Dental, Kerr Company, Praha, Czech) was mixed and placed in the canal with a lentulo spiral carefully and then a no. 110 K file (Maillefer, Dentsply, Ballaigues, Switzerland) was coated with polycarboxylate cement and fixed in the canal. After the polycarboxylate cement set, the hand part of the K file was cut away using diamond round burs on a high-speed air turbine with water-cooling. The endodontic access cavity was filled with the dentin-bonded composite resin.

Fig. 1. Diagnostic radiograph of the horizontal root fractures of the central incisors. Note the spontaneous healing of the left incisor with calcified tissue radiographically. Moreover, note the loss of the lamina dura around the coronal fragment and periapical radiolucency around the apical fragment in the right incisor.

Fig. 2. Three months after rigid fixation and disinfection of the right incisor with calcium hydroxide. Note the healing around the coronal fragment.

The tooth was asymptomatic and composite splint was removed after 1 month (Fig.3). The mobility of the tooth was normal. At the 12-month recall, the tooth was normal clinically and radiographically except that there was resolution of the extruded root canal filling in the mesial fracture site (Fig. 4). At the 30-month recall, the right incisor appeared normal clinically and radio-

Fig. 3. One month after intraradicular splinting of the right incisor.

Fig. 5. Thirty months after the treatment. The tooth was functioning properly.

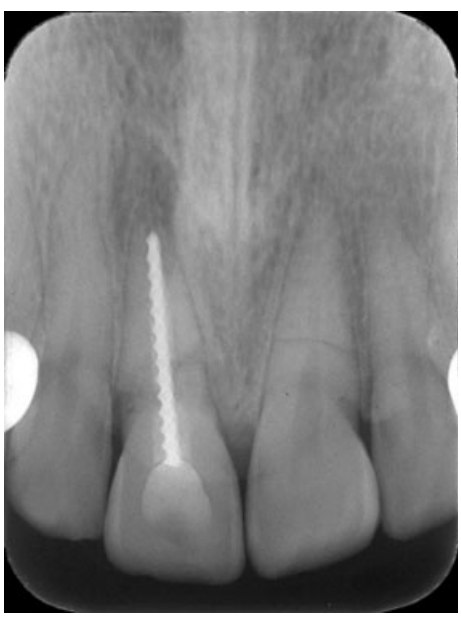

Fig. 4. Twelve months after the treatment. Note the dissolution of the extruded root canal filling in the mesial fracture site.

graphically (Fig. 5). The left incisor was tested vital during the recalls.

Discussion

The treatment principles for horizontally fractured teeth involve maintaining pulp vitality by immobilizing the coronal segment (1, 2, 6–8). When no bacteria enter the coronal pulp space through the disrupted epithelial attachment and proper fixation is used, the fractured teeth can heal spontaneously. Four types of healing can be observed following root fractures: healing with calcified tissue, interposition of connective tissue, the interposition of connective tissue and bone and the interposition of granulation tissue (non-healing).

In our case, both maxillary central incisors had been fractured horizontally between the coronal and middle root levels. The fracture in the left incisor was more horizontal and both ends of the fracture were under the alveolar crest radiographically. This tooth was diagnosed as vital and the healing was via the interposition of calcified tissue, as no peripheral rounding of the fracture edges and no pulp obliteration in either fragment were observed (2, 6). The left incisor healed spontaneously within 4 months after the accident. Such healing implies that no or minimal displacement of the fragments occurred. The coronal pulp circulation might not have been disrupted following the trauma and hence repair of the fracture site with reparative dentin and cementum could take place. Furthermore, no bacteria could reach the coronal fragment through the gingiva as the fracture line was below the alveolar crest. Other studies have reported spontaneous healing of horizontally fractured teeth (23, 24).

In contrast, the fracture in the right incisor was oblique and the fracture line was under the alveolar crest mesially, but near the level of the crest distally. The coronal fragment of the right incisor might have become infected through the gingiva distally. The healing of this tooth involved the interposition of granulation tissue. Considerable mobility of the coronal fragment was observed. The right incisor was first disinfected with calcium hydroxide and splinted. As the coronal fragment was mobile before treatment and the possibility of reinfection through the distal gingiva existed, this tooth was managed with intraradicular splinting.

Intraradicular splinting of teeth fractured horizontally at the middle root segment has been suggested as an alternative treatment technique. Kröncke (18) reported that fractures of the middle root segment cause the loss of the tooth over time because of pulp necrosis and mobility, and intraradicular splinting is a proven technique for treating such cases. Steel pins, titanium endodontic implants, prefabricated titanium dowels and posts, and ceramic, silver, or alloy cast dowels and posts have been used for intraradicular splinting (16, 18–22). Histologically, Luhr et al. (21) showed that with intraradicular splinting and good adaptation of the fragments, the fracture site could be bridged with a newly formed osteocementum plug. Reuter and Weber (22) reported that seven out of 11 cases treated with intraradicular splinting were functioning normally after 5 years, with no signs of inflammation. Two of the losses were because of secondary dental trauma and the remaining two cases showed periapical and periodontal inflammatory changes. Roland (16) reported two cases of cervical root fractures that were stabilized intracanally with steel pins and Cavit. One of the cases demonstrated resorption after 4 years, while the other case remained successful after 2 years. Bramante et al. (25) used MTA as root canal filling in association with an intraradicular post to reinforce an immature maxillary central incisor with horizontal root fracture. They reported the repair of horizontal root fracture after 18 months but maintaining the splint on the teeth during the period.

In our case, AH26 was placed to seal the root canal and then polycarboxylate cement was used to stabilize the file in the canal. Polycarboxylate cements are not ideal long-term root canal sealers. In the present case, the main considerations for using polycarboxylate cement were its good physical properties, which may prevent mobility of the file in the canal over time, its bonding capacity both with stainless steel and dentin tissue and its acceptable biocompability (26). The adaptation of the file was good in the apical segment, but there was space filled with polycarboxylate between the file and root canal walls in the coronal segment. Distortion of the file in the coronal segment may occur over time because of the mastication forces and cause the failure. The fiber post systems, which are adhesively bonded into the standardized root canal preparations, may be another choice for the intraradicular splinting.

Thirty months after the treatment, the tooth was serving normally and appeared to have no signs of periradicular inflammation clinically and radiographically. The healing of this tooth may have involved the interposition of bone and connective tissue. However, it should be noted that it was not possible to differentiate the presence of a cervical resorption with the classic radiographic technique used in this study. The imperfect contrast in the radiographs may mask the cervical root resorption. Furthermore, absence of clinical signs is not a definitive criterion for success as many asymptomatic endodontic cases may exhibit persistent chronic reactions histologically (27). The disintegration of AH26 and polycarboxlate cement by tissue fluids may cause a foreign body reaction at the fracture site.

This case demonstrates that intraradicular splinting is an alternative treatment technique for managing horizontally fractured teeth with necrotic and mobile coronal segment. Larger files may be used for intraradicular splinting of horizontally fractured teeth.

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