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CASE REPORT

Maintenance of vitality following horizontal root fracture of a lower central incisor

ABSTRACT

Aim: *To maintain vitality in a lower central incisor with a horizontal root fracture. The patient was a seventeen years old male in optimal health conditions. He did not want lose his damage tooth at all costs.*

Summary: *Through of a three-layer glass fiber splinting, the tooth was immobilized by joining it to the adjacent teeth and leaving it in light occlusion. The clinical examination to date confirms the positive vitality of the tooth, with no change in color or presence of fistulas. At the fourteenth month control, the intraoral radiographs show how the lumen of the root canal reduces increasingly into a very thin layer.*

Key Learning Points

- *Horizontal root fracture: if the tooth is vital, you can try to save by a splint of fiberglass.*
- *Maintenance pulp vitality: monitored with vitality test, no change in color or presence of fistulas.*
- *Glass fiber splinting: it's a method to preserve the tooth from possible trauma by joining it to the adjacent teeth.*

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Introduction

Among children and adolescents, the teeth that suffer dental trauma more frequently are the maxillary central incisors (1). Root fracture is a consequence of these dental traumas and represents on average between 0.5% and 7% of all dental traumas occurring in individuals aged 11 to 20 years.
Horizontal root fractures are usually caused by direct physical impact on the tooth, sport activities, traffic accidents and falls (2).
The predisposing factors are childhood obesity, increased overlap, protrusion of the central incisors and labial incompetence; these aspects which are considered as individual predisposing factors.
Root fractures can be divided according to direction; they can be either horizontal or vertical (3).
Radiography is needed to confirm a definitive diagnosis (4). In another study conducted by Barayan et al. (5), it was highlighted that the various filters present in the digital intraoral radiograph program did not improve the identification of the fractures.
Many authors, such as Lo Giudice et al. (6) and Salineiro et al. (7), have stated that endodontic fractures or lesions are better highlighted with CBCT, but in our case, the lesion was already clearly visible with on a periapical radiograph. Furthermore, the first author in his study concluded that CBCT is considered level II exam and could be used to address diagnostic questions, essential to a proper management of the endodontic problems (6, 7).
The (American Academy of Pediatric Dentistry (AAPD) recommends performing the X-ray examinations using different projections and angles (8).
If a fracture is not seen on intraoral radiography, CBCT is the diagnostic tool of choice (in suspected cases) (9).
The most frequent horizontal fractures, occur in the middle third (57%) and in the apical third (34%) and are caused by a frontal impact that involves enamel, dentin, pulp and cement; these fractures are associated with injuries of the periodontal ligament and the alveolar bone. Usually, such fractures are observed on the permanent incisors that have erupted completely with closed apices and fully formed roots. These fractures have longer survival if compared than those in the apical third (10, 11).
After the impact, the pulp and damaged tissues begin the healing process.
The prognosis depends on a range of factors, such as the patient's age, tooth mobility, the state of the pulp and position of the line of fracture, degree of root formation, location of the radicular fracture, diastasis of fragments and time between trauma and treatment (12-14).
According to DiAngelis et al. (8), the treatment of this type of fracture consists of the correct repositioning of the fragment and the stabilization of the fragment through a fixed splinting to the adjacent teeth. These actions can favour the preservation of the pulp vitality and the healing of the tissue around the fracture line. According to IADT guidelines, if the pulp necrosis does not occur, the root canal treatment is not necessary (8).
The tooth may have increased mobility and bleeding from the periodontal ligament. Pulp necrosis of the displaced coronal segment occurs in approximately 25% of patients, and the necrosis of the apical segment is rare (3, 15-17).
This case report highlights the possibility of maintaining pulp viability after a horizontal fracture of the middle third using a glass fiber splint.

Report

On July 14th, 2016, a fifteen-year-old boy appeared at our clinic after a minor motorcycle accident. As a result of falling from his vehicle, he slammed his face and afterwards complained of pain and mobility of one tooth in the lower arch. His general medical history revealed neither loss of consciousness, nor major trauma.
During the clinical check, tooth 31 (international FDA numbering) was noted, which presented an abnormal mobility and a vestibular position compared to the

Figure 1
A) Position of the tooth 31 vestibularized with respect to the normal dental axis. **B)** The intraoral radiograph shows the presence of a horizontal root fracture in the middle third. **C, D)** Splinting of the tooth to the adjacent teeth by glass fibre (vestibular and lingual vision).

characteristics of the adjacent teeth (figure 1A). The internal mucosa of the lower lip was superficially lacerated and not require sutures. An intraoral X-ray (Planmeca Asentajankatu 6, 00880 Helsinki, Finlandia) scan processed with an intraoral phosphor plate (VistaScan Dürr Dental Höpfigheimer Str. 17 74321 Bietigheim-Bissingen Germany) was performed to check the condition of the tooth. The results showed the presence of a horizontal root fracture in the level of the middle third (figure 1B). The vitality of the tooth in question was checked through a **cold vitality test with ice spray Crio Spray** (Sz 114 Carl Sanremo). We performed this vitality test because we did not have the means to perform an electrical test. The vitality of the tooth was positive. Infiltrative anesthesia was carried out in the vestibular area of the tooth with 4% articaine hydrochloride with 1:100,000 adrenaline (Alfacaina Dentsply France S.A.S. 4 rue Michael Faraday Montigny le Bretonneux). We proceeded with the preparation of the fibreglass splint (Fibre-Splint Polydentia SA, via Cantonale 47, CH 6805 Mezzovico-Vira Swiss). We measured the distance between teeth 32 and 41 and we cut three pieces of fibreglass tape.
Based on our clinical experience, it is clear that the splinting using fibreglass and composites is provides a more stable result than the splinting with metal wires and composites. First, a thirty-seven percent orthophosphoric acid (Total Etch, Ivoclar Vivadent Via del Lavoro 47, 40033 Casalecchio di Reno - BO) in gel was used to etch the teeth, and then the primer and bonding (Prime & Bond active Dentsply DeTrey Gmbh, De Trey str. 1 78467 Konstanz Germany) were applied; finally, after polymerizing (B-Cure Carlo De Giorgi S.R. L - Via Tonale N. 1-20021 Baranzate, Milano, Italy) the teeth, glass fibre tapes were applied, one at a time, with flow A3 (Ivoclar Vivadent AG 9494 Schaan/Liechtenstein). Each layer was light-cured for 40 seconds, and finally, the occlusion was checked using an articulation map (Bausch Artikulationspapier 200 µ, 50769 Köln, Germany) to verify that the splinting did not cause pre-contacts (figure figure 1C and and D).

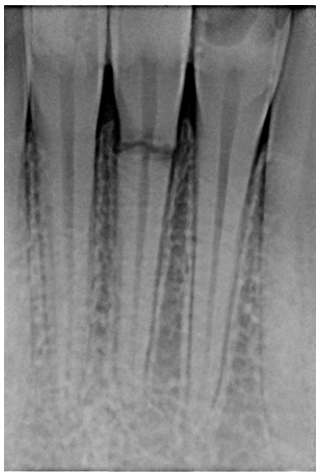


Figure 2
The intraoral radiograph shows that the fracture zone was slightly calcified and that the lumen of the pulp canal had decreased compared to that shown in Figure 1B.

First control
On September 29th, 2016 (75 days later), the cold *vitality* test was performed again with Crio Spray ice and the results were positive.
We proceeded by taking an intraoral X-ray and noted that the fracture zone was slightly calcified and the lumen of the pulp canal was reduced (figure 2).

Second control
Another check was performed on September 13th, 2017, fifteen months after the accident. A pulp viability test was performed, which had a positive outcome, along with an intraoral radiograph. The results showed a further decrease in the lumen of the root canal compared to a normal condition, and the recalcification was complete except in areas that were 0.5 mm both distal and mesial (figure 3).

Third control
On November 14th, 2018, the assessment during the visit showed positive vitality. The intraoral X-ray results appeared very similar to those of the previous assessments regarding the root canal lumen. Furthermore, a better calcification of the fracture was noted (figure 4A). The splinting was renewed because it was worn out (figure 4B and C).

Figure 3
Complete calcification except in areas that were 0.5 mm distal and mesial of the fracture zone and reduction of the canal lumen compared to that shown in Figure 1B.

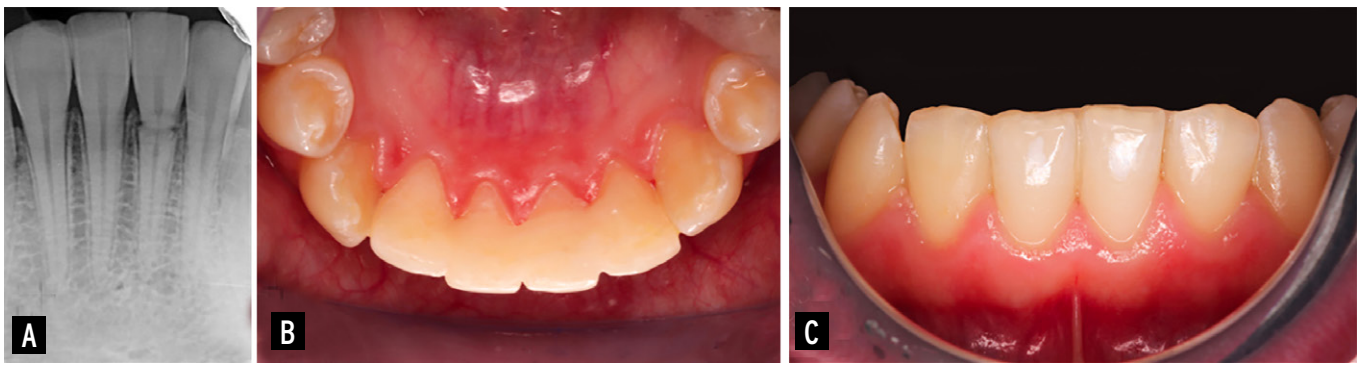
Fourth control
On September 3rd, 2019, the vitality was positive again. As a result of an intraoral radiography, the lumen and the calcification of the fracture were considered superimposable over the previous control (figure 5). The thirty-eight-months point of follow up was reached.

Fifth control
On January 25th, 2021, we again made a control radiograph and conducted a vitality test, which had positive results. The colour did not change, and periodontal probing remained within physiological limits.
It is possible to appreciate the preservation of the interdental bone peaks and the invagination of the alveolar bone at the level of the most proximal portion of the fracture gap. The lumen of the root canal remained very narrow but allowed the flow of a solution of continuity between the coronal and apical parts of the endodontum (figure 6).

Discussion

The distance between fragments greatly influences the possibility of healing by hard tissue fusion. In our case, the radiolucent area of the fracture was significant, and from a diagnostic point of view, the area was immediately noticeable by the intraoral radiographs without having to resort to a CBCT. By comparing the patients' radiographs taken on during the first visit to the last follow-up, the way in which spontaneous calcification of the root united the two parts could be observed. Cvek in 2001 and Andreasen in 2004 in their studies stated that the healing rate for root fractures is was between 77% and 80%. There are 4 types of possible ways of healing for root fractures; Andreasen and Hjorting-Hansen, described these possibilities in their study.
1) Healing with hard tissue across the fracture.
2) Healing with the interposition of hard and soft tissue between fragments.
3) Healing with interposition of soft tissue only.
4) No healing.
The ideal outcome is healing with hard tissue (18).
Andreasen et al (3) stated that the clinical and radiographic findings showed that 120 teeth out of 400 teeth (30%) had healed by hard tissue fusion of the fragments. Interposition of the periodontal ligament (PDL) and bone between fragments was found in 22 teeth (5%), whereas interposition of the PDL alone was found in 170 teeth (43%). Finally, non-healing, with pulp necrosis and inflammatory changes between fragments, was seen in 88 teeth (22%) (14).
The splinting procedure of the tooth made the recalcification manoeuvre safer, ensuring that fragments remained immobilized. As stated by Chala et al. (19), teeth with horizontal fracture have a greater pulp preservation than teeth with dislocation without root fracture.
Therefore, our patient's outcome demonstrates that it is actually worth trying to use a splint it if the tooth has vitality. The procedure should follow the one illustrated by DiAngelis et al. (8): a splint held in place from 4 four weeks up to 4

Figure 4
A) Better calcification of the fracture line and canal lumen similar to that shown in Figure 3. **B, C)** Lingual and vestibular vision splintings were renewed.



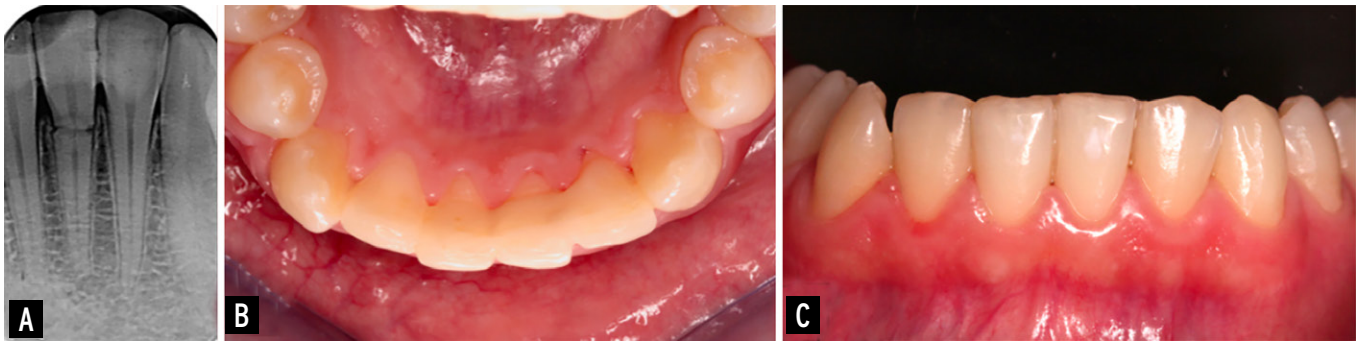


Figure 5
A) Calcification of the fracture and canal lumen similar to that observed during the previous visit. **B, C)** Lingual and vestibular vision.

four months, waiting for the fracture to heal by welding the two fragments. In contrast, we decided to keep the splints in place longer than the indicated time, since this tended to have a positive influence on the tooth stability, as Westphalen et al. (20) said reported in their study.
Many studies have shown a good prognosis for the horizontal fracture of a tooth with vitality even in follow-up evaluations occurring ten or more years later. However, this is not always the case. Evaluating the lumen of the root canal after two years, it was stated that there was a decrease in size. It is important to emphasize that between the first and second controls, the reduction is greater than the others (figures 2 and 3). Instead, between the third and fourth control, the reduction of the lumen appears minimal; this suggests the beginning of calcification of the canal from the outside (figures 3 and 4).

Conclusions

Our case report confirms that if a tooth is subjected to a horizontal root fracture but maintains maintenance of the vital pulps, splinting is an excellent option for safeguarding the vitality of the tooth and the tooth itself.
Surely, a constant monitoring is necessary to check the state of vitality, the position of the coronal fragment and the periodontal situation as well as any colour changes of the crown.
The timely treatment of intra-alveolar horizontal root fractures is important for the good prognosis and long-term success. In our patient after having applied a rigorous therapeutic and control protocol, after approximately sixty-six months of follow-up, we can say that the situation was stable and the prognosis was good with an excellent aesthetic result.

Conflict of Interest

The authors declare that there are no conflicts of interest.

Clinical Relevance

Fiberglass splinting is an effective method that allows the fractured tooth to be im-

Figure 6
A) Intraoral radiograph. **B)** Lingual vision. **C)** Vitality test results.

mobilized to the adjacent ones, to ensure that the horizontal fracture fixes spontaneously, maintaining vitality.

Acknowlegments

None.

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