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CASE REPORT

Conservative endodontic management using a calcium silicate bioceramic sealer for delayed root fracture: A case report and review of the literature

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Abstract

BACKGROUND

The success rate of conservative endodontic management for root fracture varies greatly based on different methods used. It has been rarely reported that calcium silicate-based materials are applied in root fracture treatment.

CASE SUMMARY

A 38-year-old male patient presented with spontaneous pain from the upper left anterior teeth for 1 wk. The spontaneous pain was subsequently relieved, but pain on mastication persisted for 3 d. The patient had a dental trauma from a boxing match 15 years ago. Cone beam computed tomography showed that the maxillary left central incisor had oblique fracture lines and a radiolucent lesion around the fracture line. The tooth was diagnosed with an oblique root fracture with no healing and symptomatic apical periodontitis. In the following conservative endodontic management, the coronal and apical fragments of the canal both were chemo-mechanically prepared and obturated using a single cone gutta-percha with iRoot SP (Innovative BioCreamix Inc, Vancouver, Canada), a new calcium silicate-based bioceramic root canal sealer. At follow-ups at 1, 6, 12, and 24 mo, the patient was asymptomatic and the radiolucency around the fracture line was healing radiographically.

CONCLUSION

Conservative root canal treatment is an alternative treatment in some cases of oblique root fracture with no healing. The application of bioceramic sealers and single core obturation techniques may also be essential to obtain an excellent outcome.

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Core Tip: This case report describes conservative endodontic management of a delayed oblique root fracture in a maxillary central incisor. In this delayed root fracture case, the coronal and the apical fragments of the canal were both chemo-mechanically prepared and obturated using a single cone gutta-percha with iRoot SP, a new calcium silicate based bioceramic root canal sealer. At follow-ups at 1, 6, 12, and 24 mo, the patient was asymptomatic and the radiolucency around the fracture line was healing radiographically. Conservative root canal treatment should be considered as an alternative treatment in some cases of oblique root fracture with no healing. The application of bioceramic sealers and single core obturation techniques may also be essential to obtain an excellent outcome.

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INTRODUCTION

Traumatic dental injuries (TDIs) of permanent teeth, which occur frequently in children and young adults, have presented a challenge to clinicians worldwide. Consequently, proper diagnosis, treatment planning, and follow-up are critical to assure a favorable outcome[1]. The incidence rate of root fractures in traumatic permanent teeth is approximately 0.5%-7%[2]. There are four types of healing of root factures: (1) Healing with hard tissue; (2) Healing with interposition of hard and soft tissue; (3) Healing with interposition of only soft tissue; and (4) No healing[3]. The management of root fractures is usually to stabilize the tooth when the pulp is vital. If the pulp is necrotic, surgical and endodontic treatment is feasible. Similarly, regular follow-up is indispensable[1,4].

Conservative endodontic management with root fracture was first reported in 1958[5]. Since then, four types of conservative endodontic treatment have been described: (1) Preparing and gutta-percha (GP) filling the coronal fragment only; (2) Preparing and GP filling of the root canal in both fragments; (3) Preparing and GP filling of the root canal of the coronal fragment and removing of the apical fragment surgically; and (4) Dressing the root canal with calcium hydroxide followed by filling with GP. Cvek *et al*[5] reported that the frequency of healing was 76% in the first type, zero in the second type, 68% in the third type, and 86% in the fourth type. However, the selection and roles of root canal sealers (RCSs) in the obturation have not been reported.

New types of sealers containing mineral trioxide aggregate (MTA) and calcium silicate (CS) have been developed. MTA has demonstrated satisfactory outcomes for the endodontic treatment of intra-alveolar root fractures[6]. However, several shortcomings of MTA have been reported, such as the potential release of hazardous substances, the potential for discoloration, and the inconvenience of handling[7,8]. IRoot SP (Innovative BioCreamix Inc, Vancouver, Canada) is a novel premixed, injectable, CS-based bioceramic RCS composed of calcium phosphate, calcium hydroxide, zirconium oxide, and thickening agent[9]. In endodontic treatment, CS-based sealers with the single cone obturation technique can promote apical healing, possess antibacterial activity, bond to tooth structure, and even enhance osteoblastic differentiation[10,11]. Sealer properties may benefit the healing after root fracture.

This case report presents conservative endodontic management of a delayed oblique root fracture by applying iRoot SP and single cone obturation.

CASE PRESENTATION

Chief complaints

A 38-year-old male patient presented with spontaneous pain from the upper left anterior teeth for 1 wk. The spontaneous pain was subsequently relieved, but pain on mastication persisted for 3 d.

History of present illness

The patient had dental trauma from a boxing match 15 years ago, which led to fracture of both maxillary central incisors' crowns. At that time, he only received restorative treatment at a clinic due to incisal angle defects. Then, he experienced repeated pain at the upper anterior teeth, which could be relieved by taking anti-inflammatory drugs until this appointment.

History of past illness

The patient had a free previous medical history. He had a history of multiple dental treatments, but details were not available.

Personal and family history

The patient had a free personal and family history.

Physical examination

The composite resin restorations in the mesial incisalangle of both maxillary central incisors were stable, but the margins were stained (Figure 1). Clinical examination of teeth #9 (maxillary left central incisor, the universal numbering system) and #8 (maxillary right central incisor) revealed a probing depth of 2 mm, bleeding on probing (-), and no mobility. However, tooth #9 was very sensitive to percussion and did not respond to clod vitality test and electric pulp test. Tooth #8 was asymptomatic and responded normally to clod stimulation and electric pulp test as control teeth.

Imaging examinations

X-ray images (Figure 2) and cone beam computed tomography (CBCT, Figure 3) revealed that both of the maxillary central incisors had oblique fracture lines, and the coronal portion had no dislocation. A 3 mm × 4 mm radiolucent lesion was noted around the fracture line of the tooth #9. The sagittal pictures of CBCT showed fenestration at the labial of the fracture line. However, no lesion could be found around the periapical condition or fracture line of the tooth #8.

FINAL DIAGNOSIS

According to the clinical examination and radiography, the diagnosis for tooth #9 was oblique root fracture with no healing, and symptomatic apical periodontitis. In addition, the diagnosis for tooth #8 was root fracture.

TREATMENT

Two treatment plans for tooth #9 were provided for the patient. One is endodontic surgery (removing the apical fracture part, reverse root canal preparation, and obturation), and the other one is conservative endodontic management. The patient accepted the latter treatment plan. In addition, long-term observation was necessary for tooth #8.

After access preparation without anesthesia initially, the patient felt pain when the #10 K-file entered 13 mm into the root canal. The radiograph showed that the file stopped at the fracture area (Figure 4A), which implied that the pulp of the apical fragment was still vital. Then, under local anesthesia, the working length (WL) was determined to be 19 mm (Figure 4B). The root canal was prepared until Protaper F3 (Protaper Universal, Dentsply, Switzerland). Sodium hypochlorite solution (3%; Susun, Harbin QuanKang Medicine Company, China) and 17% EDTA (root canal lubricating solution, LongLy Biotechnology, China) were used for irrigation. After the coronal and the apical fragments had been chemo-mechanically prepared, the root canal was dried and dressed in calcium hydroxide paste (Multi-Cal, Pulpdent

Figure 1 Pre-operative photograph from the lip-side of the anterior teeth. The composite resin restorations in mesial incisal angle of both maxillary central incisors were stable, but the margins had been stained.

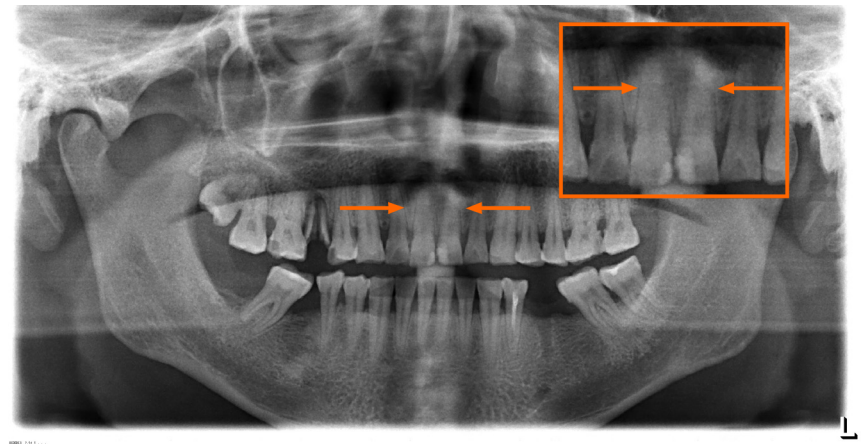

Figure 2 Pre-operative panoramic radiograph. The orange arrows point to the suspected fracture line.

Corporation, United States). The pulp cavity was sealed with glass ionomer cement (Fuji IX GP, GC, Japan).

A week later, the patient returned the second appointment. He presented with no pain on mastication. Tooth #9 was not sensitive to percussion or palpation and had no mobility or swelling. After removing intracanal dressing and irrigation using ultrasonic instruments (SUPRASSON P5 NEWTRON, Satelec, France), the root canal was dried and completely injected with iRoot SP. Then, No. 3006 GP (Bio GP Points, Sure Dent Corporation, Korea) was inserted as single core obturation technique. The immediate postoperative radiograph showed that the root canal was filled correctly in WL without voids and overfilled to the radiolucent lesion area near the root fracture line by the sealer (Figure 5A). Finally, the cavity was closed with composite resin (Filtek Z350XT, 3M, United States).

OUTCOME AND FOLLOW-UP

At the 1-mo follow-up (Figure 5B), the patient was functional with no pain or mobility. The radiograph showed that the periapical lesion around the fracture line of tooth #9 still existed but was not extended. At follow-ups at 6 mo (Figure 5C), 12 mo (Figure 5D), and 24 mo (Figure 5E), the tooth #9 was asymptomatic and functional. The radiolucent lesion was healing, and the fracture line still existed but was indistinct in the radiograph. At the 24-mo follow-up, partial defects in the resin restoration were noted, and gaps could be detected around the margin. However, the patient refused to undergo further restoration using resin or other ceramics.

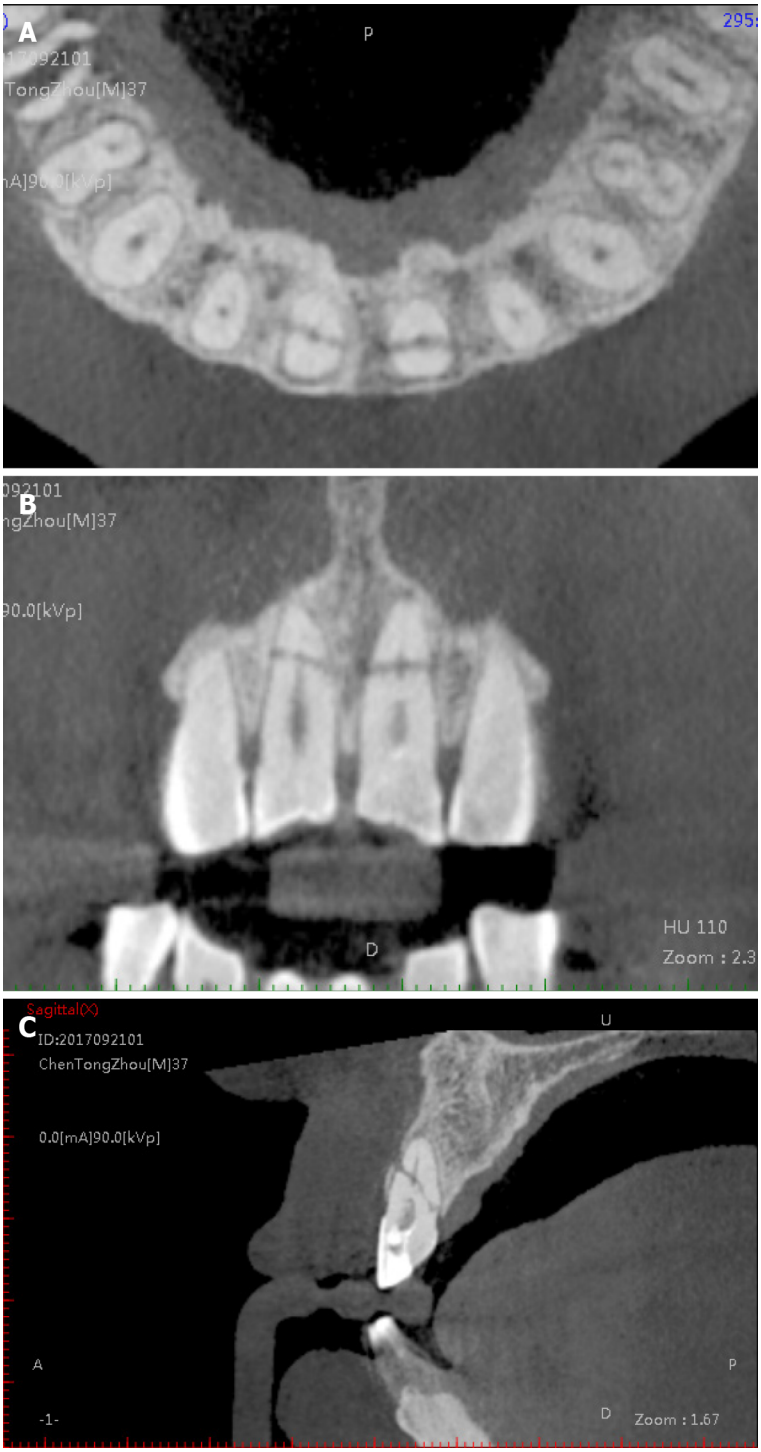

Figure 3 Pre-operative cone beam computed tomography imaging. A-C: Axial (A), coronal (B), and sagittal (C) views of the cone beam computed tomography showed that both of the maxillary central incisors had oblique fracture lines, and a 3 mm × 4 mm radiolucent lesion set around the fracture line.

DISCUSSION

In the current case report, the successful outcome was based on radiographical aspects associated with clinical conditions: The elimination of symptoms and evidence of bony healing[12]. According to the criteria listed by Andreasen *et al*[13], tooth #9 might heal with hard tissue (fracture line is not visible or indistinctly outlined from the radiograph). Endodontic treatment with bioceramic sealers and single core obturation techniques may be beneficial to the healing of root fractures.

Periapical radiographs and panoramic radiographs can be applied to evaluate root fractures. Then, CBCT was used to obtain a more accurate diagnosis, which was in accordance with the position statement of the European Society of Endodontology and American Association of Endodontists[14,15]. CBCT has demonstrated great abilities to

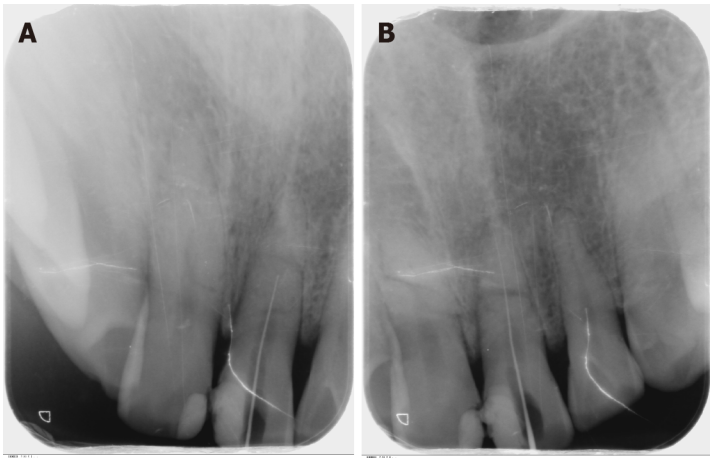

Figure 4 Periapical radiographs. A: Periapical radiograph showing the file at the fracture line; B: Periapical radiograph for determining the working length.

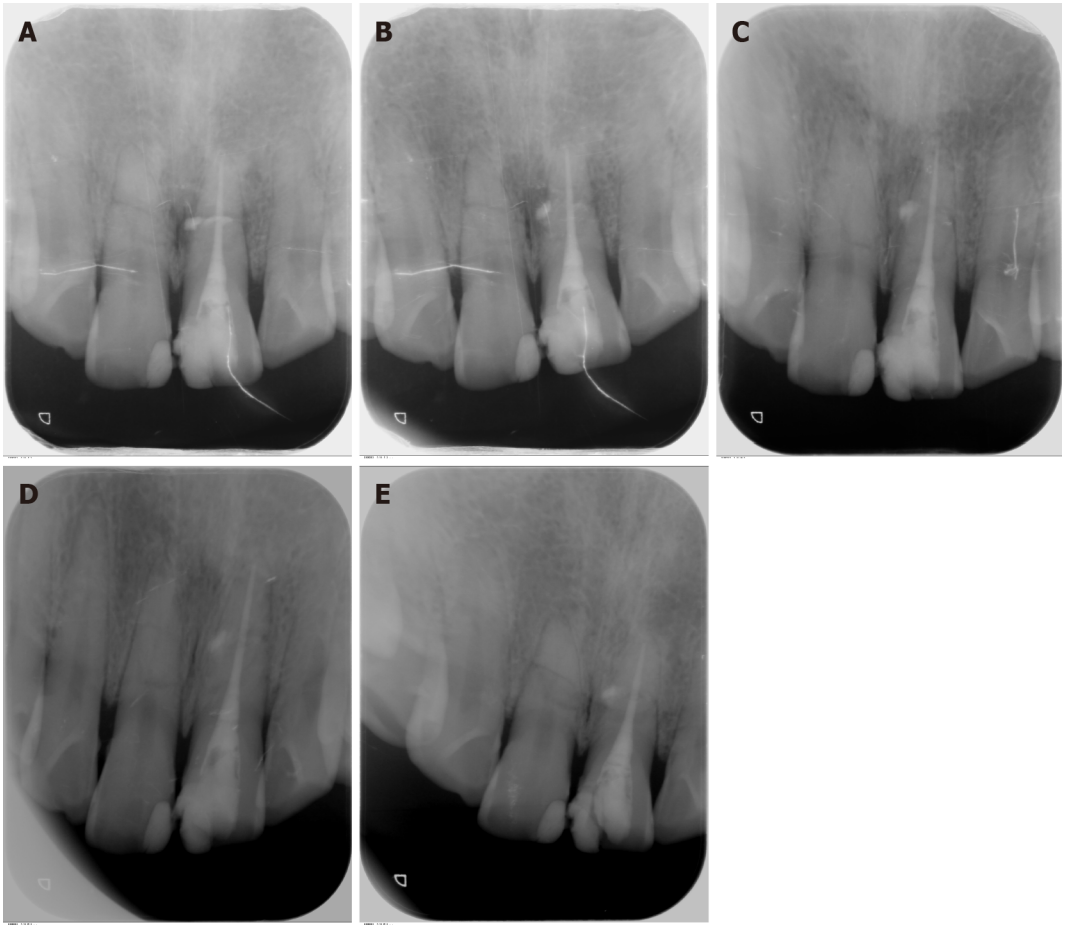

Figure 5 Periapical radiographs. A: At immediate post-obturation; B: 1-mo follow-up; C: 6-mo follow-up; D: 12-mo follow-up; E: 24-mo follow-up.

reveal the location and the type of root fracture, and to investigate the condition of the alveolar bone[16]. In this case, it played a fundamental role in deciding treatment planning and judging prognosis. In particular, the root canal from the coronal to the apical part was still a straight path from a three-dimensional image, offering the possibility of preparing both the coronal and apical parts.

According to the chief complaint, clinical examination, and radiography, both maxillary central incisors were diagnosed with root fractures. Interestingly, tooth #8 was functional and asymptomatic without any effective treatment. Cases of healing of root fractures without treatment have been reported[17-20]. The vitality of the pulp tissue improves the healing of the root fracture[2]. In this case, tooth #8 still responded to

electric pulp test. It is an important factor why it could heal spontaneously.

The frequency and type of healing depend on the maturity of the root, type of injury, diastasis between the fragments, and optimal repositioning of dislocated fragments. Immature teeth, no dislocation, and less diastasis are positive for healing[21]. In the present case, the coronal fragment was almost in the normal position, and the diastasis between the fragments was very small. The root of this tooth was mature with an oblique root fracture. The lesion around the fracture had no communication with the oral environment. Depending on the situation of this tooth, we tentatively judged the prognosis and treatment of the tooth. Although root fracture could be treated by endodontic surgery successfully, endodontic treatment is more conservative[22].

Root fracture always leads to pulp necrosis. However, apical fracture part generally remains vital[21]. In some cases, only randomized controlled trials are applied to the coronal fragment, resulting in satisfactory healing[23,24]. But it is difficult to achieve proper mechanical cleansing and adequate filling of the coronal fragment, because an apical stop is impossible to achieve[5].

Bruno *et al*[25] demonstrated that 85% of non-vital traumatized teeth presented microorganisms in the root canal with intact crowns. To eliminate infectious pulp tissue and inflammatory tissue between the fragments as much as possible and prevent apical pulp infection by coronal necrotic pulp tissue, both apical and coronal fragments were prepared and disinfected. A relatively sterile environment that was beneficial to the healing of the lesion was formed by this process. Therefore, if the root canals of both fragments are a straight path that can be well prepared, preparing and filling in both fragments are reasonable. Cvek *et al*[5] reported that all the seven cases in which both fragments were prepared and filled failed to heal. The material for obturation in their report was chloropercha and 5% resin-chloroform, which may influence the effect of the treatment.

IRoot SP is a biocompatible and nontoxic material that includes similar compositions to MTA and has both excellent physical properties, even in an inflamed acidic environment[26,27]. CS molecules within iRoot SP undergo hydration reactions that generate calcium hydroxide, which can inhibit pathogenic microorganisms and then react with phosphate, causing the precipitation of hydroxyapatite. Chang *et al*[11] reported that bioceramic sealers can induce superior osteoblastic differentiation with less of an inflammatory response[28]. In this case, iRoot SP was overfilled to the fracture line and alveolar bone destruction area, which did not affect or hinder the healing of the lesion. Ricucci *et al*[29] also reported the absence of inflammatory or foreign body reactions of the host tissues in contact with CS-based sealers. Wound healing was rapid with repair of lost tissues with cementum and new bone trabeculae. This finding may be attributed to the highly biocompatible and bioactive nature of the sealers.

Cold lateral or warm vertical condensation techniques may not represent appropriate obturation methods for root fracture cases, because pressure can lead to the movement of the fragments and GP may be squeezed into the fracture line. The acceptance of single cone obturation technique with CS root canal sealers has recently increased. A comparable success rate compared to warm vertical condensation technique has been reported[30]. The present case suggests that the single core technique is an effective treatment option for fractured root canal obturation.

It is generally accepted that coronal leakage can permit bacterial elements to penetrate root fillings and result in the failure of endodontic treatments. At the 24-mo follow-up of this case, the resin restoration was not intact. However, coronal leakage did not affect the healing of inflammatory lesions. Regardless of whether the resin defect was caused by additional trauma or secondary caries, the coronal seal might be broken. It is necessary to seal the crown promptly. However, longer observations should reveal the long-term effects of the endodontic treatments[31].

CONCLUSION

This successful case illustrates that conservative root canal treatment may represent an alternative treatment in some cases of oblique root fracture with no healing. The following requirements should be the recommendations of the cases: Mature root, no dislocation, minimal diastasis, and no oral communication with the lesion around the fracture area. The application of bioceramic sealers and the single core obturation technique might also be essential to obtain an excellent outcome.

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