Intentional Replantation of an Immature Incisor with a Transverse Root Fracture and Endo-Perio Condition: 4 Year Follow-Up

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This case report describes the importance of continual examination for dental trauma and the efficacy of intentional replantation with retrograde root canal filling for a transverse root fracture in an immature incisor accompanied by subsequent periodontal-endodontic disease. In the treatment of traumatically fractured roots in immature incisors, continual examination is indispensable for the final diagnosis because roots in immature teeth are less calcified, resulting in less detailed radiological examinations. Thus, common dental trauma complications such as pulp necrosis may appear months after the initial examination. Endodontic treatment for transverse root fracture is mainly determined according to radiographic examination findings; for fractured immature roots, apexification with calcium hydroxide of the coronal fragment is generally applied. However, this method requires removal of considerable amounts of enamel and dentin to allow access to the cavity for preparation, which may increase the risk of future fractures. In contrast, intentional replantation with retrograde root canal filling does not require the removal or long-term application of calcium hydroxide. However, it requires careful extraction of the tooth, maintenance of root wetness during the extraoral procedure, rigid splinting, and oral hygiene control. Management of tooth mobility is also important in the post-replantation course.

Key words: Immature incisor, Root fracture, Replantation, Retrograde root canal filling

INTRODUCTION

Early diagnosis of transverse root fractures in immature teeth based on radiographic examination is generally difficult because of high radiolucency of the developing root dentin and immature calcification [1]. The clinical course of these fractures is often accompanied by subsequent complications, such as pulp necrosis and invasive root resorption; thus, these fractures require long, continuous follow-up. Endodontic procedures used to treat transverse root fractures are mainly chosen based on radiographic examination findings. There are two types of conservative endodontic treatment: treatment of the coronal fragment alone or treatment of both fragments [2]. However, there are few case reports of transverse root fracture accompanied by periodontal-endodontic disease in immature teeth. This case report describes continual dental examination and intentional replantation with extraoral retrograde root canal filling for the treatment of a transverse root fracture in an immature maxillary central incisor accompanied by a periodontal abscess with vital dental pulp, which subsequently became necrotic during the treatment period.

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Case report

A 7-year-old boy was referred to the pediatric dentistry clinic in the Dental Hospital of Tokyo Medical and Dental University for treatment of a labial periodontal abscess along the maxillary right central incisor with a fractured root caused by a fall 8 months earlier. According to the referral letter, on the day of the injury, the patient was 6 years and 5 months old (6 y 5 m), and the tooth was only fractured at the incisal margin. Therefore, the dentist repaired the tooth with composite resin and continued to monitor the tooth (Fig. 1A). Eight months later, the patient fell again, and the dentist found a labial periodontal abscess along the maxillary right central incisor, although the tooth had a positive electric pulp test (EPT) response. Radiographic examination revealed a root fracture (Fig. 1B).

At the first visit (at 7 y 1 m of age), intraoral examination revealed a labial abscess along the maxillary right central incisor with class 2 tooth mobility. The depth of the gingival sulcus of the maxillary incisors was normal (Fig. 2, Table 1). The maxillary central incisors had positive EPT responses, however, the patient suffered from occlusal pain in these teeth. Radiographic examination revealed a transverse root fracture with dental lesions on the mesial side of the maxillary right central incisor. The patient had no significant medical history. Based on these findings, the maxillary incisors were splinted, amoxicillin (Sawacillin®, 600 mg/day for five days, Astellas Pharma Inc., Tokyo, Japan) was prescribed, and the patient and his mother were given oral hygiene instructions. After 1 week, the abscess was smaller, but it had enlarged again after 1 month, at which time the depth of the periodontal pocket surrounding the maxillary right central incisor had become 5 mm in the mesial labial region. Accordingly, the patient was diagnosed with a periodontal abscess of the maxillary right central incisor, and curettage of the abscess during gingival flap surgery was planned. The patient and his mother were informed about the purpose of the procedure, what it entailed, and its potential side effects. They agreed to the procedure and provided written consent. During the operation (at 7 y 3 m of age), the abscess was found to be adjacent to the sequestered region, and no vertical crack was observed in the tooth (Fig. 3).

At 2 weeks after curettage, a papilloma-like abscess with a diameter of 4 mm was observed in the same region. At 1 month after curettage, the abscess had created a fistula with a labial periodontal pocket depth of 3 mm, tooth mobility in the absence of a splint had increased to class 2, and the Periotest value ranged 24–29 (high values indicate instability; Periotest, Medizintechnik Gulden, Modautal, Germany). The periodontal pocket depth subsequently increased to 5 mm. At this time, the tooth often had a positive EPT response (Table 1). At 7 y 7 m of age, the EPT response became negative and transmitted light plethysmography (TLP), a noninvasive optical technique for detecting microcirculatory changes in pulp tissue, did not detect any sounds of blood flow. Accordingly, cone-beam computed tomography (CBCT) was performed for three-dimensional examination of the tooth (at 7 y 8 m of age). CBCT revealed the following findings: an apical fragment with hard tissue formation, a thin root dentin wall, a very large pulp cavity with lesions, and labial marginal and mesial interproximal bone loss (Fig. 1C, and 4). Based on these findings, we suspected periodontal-endodontic disease accompanied with root fracture, pulp necrosis in the coronal fragment, and periradicular granuloma with bone loss. To reduce invasion of the tooth with a fractured short root and thin dentin, we changed the treatment plan from conventional root canal treatment to intentional replantation of the coronal fragment with extraoral retrograde root canal filling. The patient and his mother were informed about the purpose of the procedure, what it entailed, and possible failures that could occur. They agreed to the procedure and provided written consent.

Fig. 2. Periodontal abscess adjacent to the maxillary right central incisor at 7 y 1 m of age.

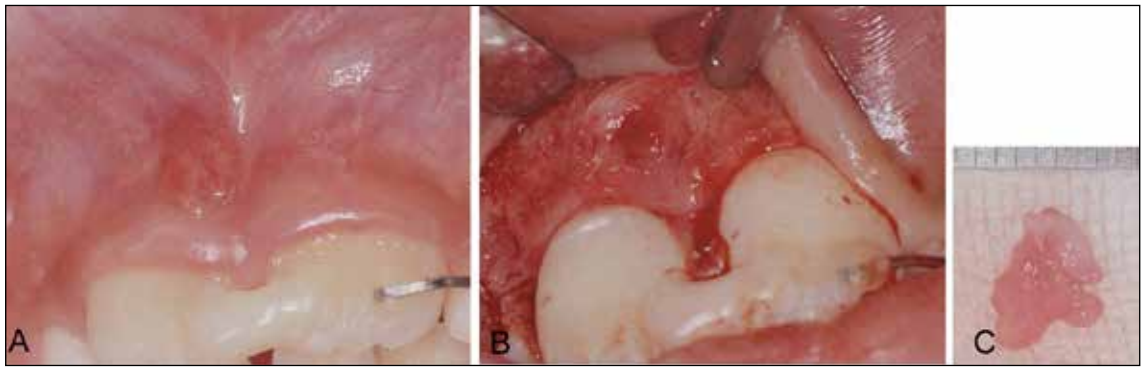
When the patient was 7 y 9 m of age, intentional replantation was performed under local anesthesia (2% lidocaine with 1:80,000 epinephrine; ORA, Showa Yakuhin Kako Co., Ltd., Tokyo, Japan). During intentional extraction, the tooth was found to have a short fractured root with thin dentin, and the pulp cavity was almost vacant but did contain some necrotic tissue on the coronal side. Retrograde root canal irrigation, pulp cavity cleaning, and removal of granulation tissue at the root was performed. Then, retrograde root canal filling was performed using adhesive resin cement (Super-Bond C&B Radiopaque, Sun Medical Company, Ltd., Shiga, Japan), a stainless steel post, and light-cured composite resin for core build-up, and the fractured end was sealed with adhesive resin cement. During the extraoral endodontic procedure, the tooth was wrapped in gauze soaked in Hank's balanced salt solution (HBSS, Oriental Yeast Co., Ltd., Tokyo, Japan). The dental socket contained granulation tissue with spotted yellow tissue at the bottom of the socket. The socket was curetted and irrigated, however, the apical fragment was left untouched. Then, the tooth was replanted in the socket and fixed with a resin splint (Super-Bond C&B Clear, Sun Medical Company, Ltd., and Unifast II Clear, GC Co., Ltd., Tokyo, Japan) (Fig. 5). Additionally, antibiotics were prescribed, and the patient and his mother were again given careful oral hygiene instructions.

Fig. 1. Radiographs of the maxillary right central incisor. (A) Initial radiograph of the injury at 6 y 5 m of age. (B) Radiograph shows the root fracture and gutta-percha point inserted in the fistula at 7 y 1 m of age. (C) Radiograph at 7 y 8 m of age. (D) Post-replantation 2 months later at 7 y 11 m of age. (E) Post-replantation 4 years and 5 months later at 12 y 2 m of age.

Table 1. Treatment course and periodontal record (MB: Mesiobuccal, B: Buccal, DB: Distobuccal, ML: Mesiolingual, and L: Lingual, DL: Distolingual).

Age	Event	Periodontal pocket [mm]						Mobility (Periotest value)
		MB	B	DB	ML	L	DL	
6 y 5 m	Injury							
7 y 1 m	Splint	2	2	3	2	2	3	31 (splinted 4)
7 y 2 m		4	5	6	3	2	3	splinted 19
7 y 3 m	Recession	5	4	3	3	1	2	splinted 19
7 y 4 m		3	3	2	2	2	3	25
7 y 7 m		2	1	2	2	2	2	33
7 y 8 m		5	2	2	4	2	2	29
7 y 9 m	Replantation	3	2	2	2	2	2	23–26
8 y 0 m		3	4	3	2	2	2	28 (splinted 16)
8 y 1 m		2	3	2	2	2	2	splinted 20
8 y 4 m	Splint removal	3	3	2	2	2	2	splinted 19
8 y 5 m		2	3	3.5	2	2	2	33
8 y 8 m		2	4	2	2	2	2	26
9 y 11 m		2	2	2	2	2	2	28
10 y 9 m		2	1	2	2	1	2	27
11 y 4 m		2	2	2	2	2	2	25
12 y 2 m		2	2.5	2	1	1	2	15

Fig. 3. Photographs during resection. (A, B) Sequestered region of the labial gingiva. (C) Resected abscess and the sequestered region at 7 y 2 m of age.



At 1 month after replantation (at 7 y 10 m of age), the periodontal tissue of the maxillary incisor showed no abnormalities, and the region where the abscess was located showed slight redness. At 2 months after replantation, the periodontal pocket depth had decreased to under 3 mm (Table 1). Additionally, radiological examination revealed alveolar bone regeneration on the mesial side of the root-fractured tooth (Fig. 1D). When the patient was 8 y 2 m of age, tooth mobility in the absence of a splint remained high, with class 2 mobility and a Periotest value of 31. However, because there were no abnormal findings except for the high tooth mobility, we removed the splint and performed a follow-up examination when the patient was 8 y 4 m of age. The patient was seen again approximately 3 months later, and subsequent follow-ups were conducted twice a year for 4 years. At the latest follow-up visit, the patient was 12 y 2 m of age, the Periotest value had reduced to 15 (Table 1), and no additional findings regarding the fractured root were observed by radiographic examination (Fig. 1E). To date, the post-replantation course has been uneventful.

DISCUSSION

Difficulty in early diagnosis of a root fracture in immature teeth

For traumatized teeth with root fractures, placement of a rigid splint for 2–3 months is generally recommended in dental textbooks [3]. However, in the present case, use of a tooth splint as a monotherapy appeared to be unsuccessful. One potential explanation is the difficulty of achieving an accurate early diagnosis of a fractured root, resulting in delayed implantation of a tooth splint, periodontal abscess, pulp infection, and pulp necrosis. The difficulty of achieving an accurate early diagnosis may be decreased by performing frequent radiological examinations using CBCT.

Periodontal abscesses are caused by gingivitis, impaction of foreign bodies, and local factors affecting root morphology [4]. In this case, the periodontal abscess relapsed at 2 weeks after curettage. This implies that the fractured root and dental pulp were already infected when curettage was performed. However, from the first visit at our institution to the time curettage was performed, the tooth had positive EPT responses. Thus, determining the need for a root canal and intentional replantation at the time curettage was planned would have been difficult.

Pulp infection and pulp necrosis

The tooth was considered vital when it had a positive EPT response. However, we subsequently diagnosed pulp necrosis 1 year and 2 months after the injury. Tooth splint treatment and oral hygiene control were well performed, and prevention or an earlier diagnosis of pulp necrosis would have been difficult. Accordingly, to follow precisely the progression of injured teeth, continual examination is essential.

TLP is a noninvasive optical technique for detecting microcirculatory changes in pulp tissue [5] and is a more beneficial, objective procedure than EPT or other methods that require the patient's cooperation and recognition. In this case, TLP played an important role in the diagnosis of pulp necrosis. The use of TLP to detect blood flow in dental pulp is an effective method for examining injured teeth.

Apexification with calcium hydroxide of the coronal fragment is generally applied for the treatment of infected root canals with fractured immature roots [1,3,6] because pulp infection is often limited to the coronal fragment [3,7]. However, this method requires the loss of a considerable amount of enamel and dentin to allow access to the cavity for preparation and requires a long time for hard tissue formation at the fractured region, which might increase the risk of additional root fractures [8,9]. Intentional replantation involves invasion of periodontal tissue, while retrograde root canal treatment

Fig. 4. CBCT and radiograph findings indicating transverse root fracture accompanied by severe periodontal-endodontic disease at 7 y 8 m of age.

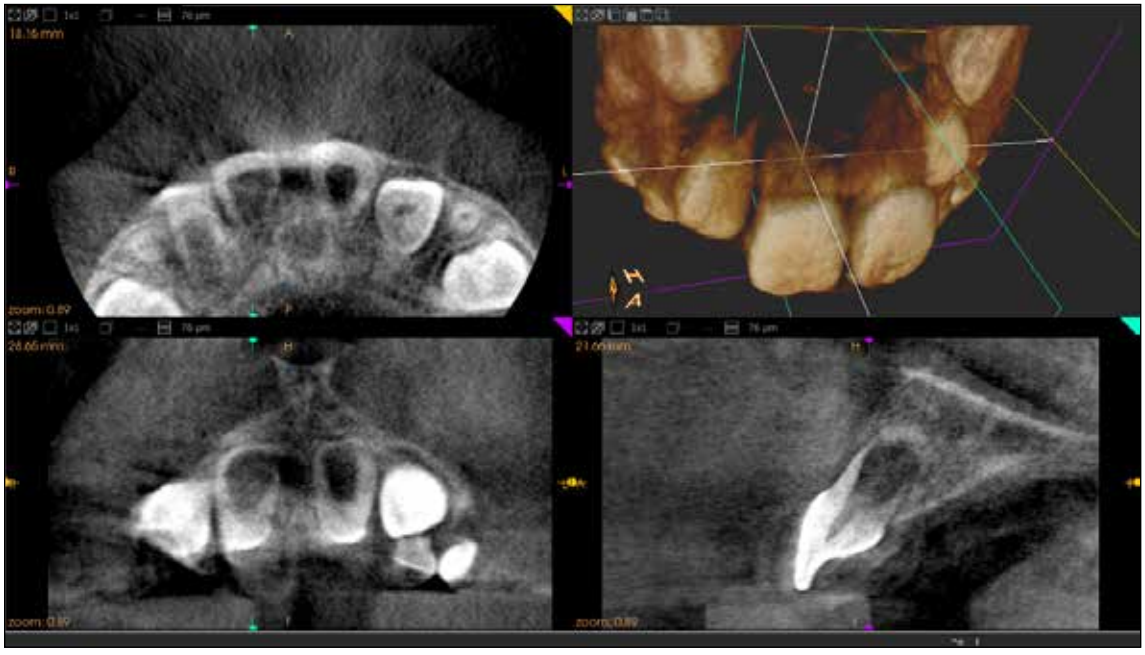
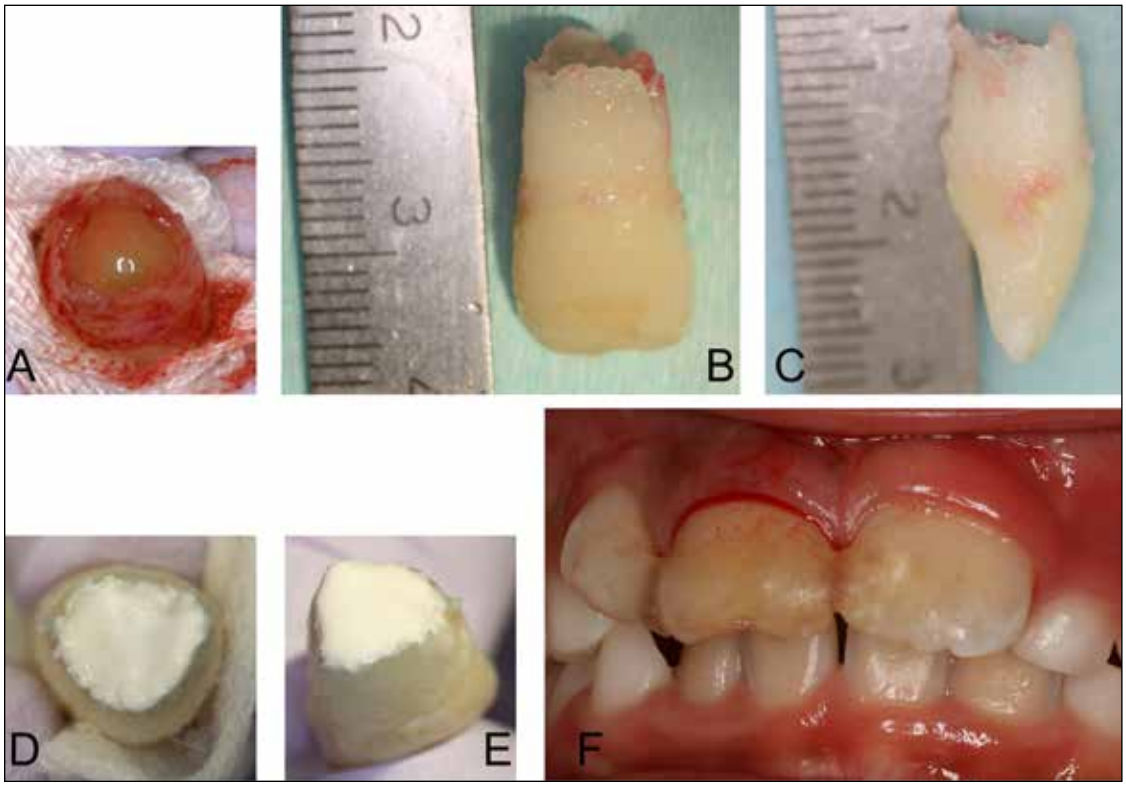


Fig. 5. Photographs during intentional replantation and retrograde root canal filling at 7 y 9 m of age. (A) Apical end of the fractured root containing necrotic tissue in the pulp cavity. (B, C) The fractured root was short and had thin dentin. (D, E) The fractured end of the retrograde root canal filling was covered with 4-META/MMA-TBB resin cement. (F) The replanted tooth was splinted with resin.



is relatively simple for the treatment of a single root and allows for removal of the infected tissue and sealing of the apex region [10] or fractured end. In surgical endodontics for traumatized young permanent teeth, complete removal of granulation tissue or protection of resorption cavities and proper splinting can lead to successful treatment [11]. However, fractured immature roots are very fragile because of their short roots with thin dentin. Therefore, replantation requires carefulness and gentleness; intentional extraction should be performed by cutting the periodontal ligament with a scalpel and spreader and slowly rotating the tooth on its long axis. During retrograde root canal treatment, the root should be wrapped in gauze soaked in HBSS to maintain periodontal tissue vitality [1]. In this case, we used 4-META/MMA-TBB resin cement to fill the fractured end and resorption cavities; this material enables effective sealing under wet conditions and has high biocompatibility [12].

Tooth management

The radiograph obtained at 12 y 2 m of age showed that the fractured root had a dark line between the coronal and apical fragments (Fig. 1E), implying healing of the fractured root with the periodontal ligament (3). The Periotest value after replantation was high, and we believed that this high mobility could not be improved because of the crown-root ratio. However, at the latest visit at 4 years and 3 months post-replantation, the Periotest value was reduced to that of the adjacent teeth and there were no pathological findings. Therefore, we considered the tooth to have acquired a stable periodontal tissue condition. To preserve a tooth, management of the occlusion to avoid traumatic occlusion and good oral hygiene are particularly important.

Fig. 6. Photographs at 3 years and 6 months post-replantation at 11 y 4 m of age.

CONCLUSION

For effective treatment of dental trauma in an immature tooth, an initial examination does not always provide sufficient information. Thus, continual examination is indispensable to obtain the final diagnosis. Intentional replantation with retrograde root canal filling may be an effective treatment for transverse root fracture in an immature incisor accompanied by subsequent periodontal-endodontic disease.

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