Management of Crown-root Fracture with 180-degree Rotation Replantation: a Report of 2 Cases

Lin YANG[1], Qiang LIU[1], Ming Wen LIU[2], Fan GU[2], Zi Jun WANG[2], Yan ZUO[1], Yao LI[1], Bin PENG[2]

Intentional replantation involves a combination of periodontics, endodontics, prosthodontics and oral surgery. Crown-root fracture management is still complicated nowadays. A fracture line extending longitudinally to the subgingival area and intruding bioogical width could affect infection control, gingival health and crown restoration. In the present study, we present two cases. Case 1 involved a 23-year-old man who presented at our hospital with crown-root fracture of the maxillary left central incisor. A radiographic image of the tooth revealed a fracture line under the alveolar crest. The fractured tooth was treated with intentional replantation with 180-degree rotation, root canal treatment and veneer restoration. The patient was followed up for 60 months. The replanted tooth functioned well, and no symptoms of resorption or ankylosis were observed by radiographic examination. Case 2 involved a 20-year-old woman who was referred to our hospital for crown-root fracture of her maxillary teeth. A radiographic examination revealed complicated crown-root fracture of the maxillary right lateral incisor and both maxillary central incisors. The central incisors were treated with intentional replantation with 180-degree rotation. At the 48-month follow-up, the fractured teeth were found to have regained normal function based on clinical and radiographic examination. Limited case reports are available on a long-term follow-up of intentional replantation with 180-degree rotation. These two cases, particularly case 2, presented optimal healing after 4 years with unideal crown–root ratios. This case report suggests that this old method of preserving teeth with crown-root fractures can be used as a last resort to save teeth owing to its timesaving and microinvasive procedure.

Key words: *180-degree rotation, crown-root fracture, intentional replantation*
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Maxillary anterior teeth are prone to dental trauma[1]. Crown-root fractures account for 5% of dental injuries. The fracture lines always appear from the crown on the labial side to the subgingival palatal region, travelling longitudinally across the pulp chamber. In most patients with crown-root fracture, tooth extraction is advised due to invasion of the biological width; however, in some cases with a considerable crown–root ratio, the fractured tooth can be saved using methods such as crown lengthening, orthodontic extrusion and intentional replantation.

1 Hangzhou Stomatology Hospital, Hangzhou, P.R. China.
2 School and Hospital of Stomatology, Wuhan University, Wuhan, P.R. China.

Corresponding author: Dr Bin PENG, School and Hospital of Stomatology, Wuhan University, 237 Luoyu Road, Wuhan 430079, P.R. China. Tel: 86-13971037355; Fax: 86-27-87873260. Email: phs301@whu.edu.cn

Crown lengthening surgery with an apically positioned flap and alveolar bone removal is a minimally invasive procedure; however, it involves the adjacent teeth and potential gingival recession, which may give unfavourable results in the aesthetic zone. Orthodontic extrusion is a relatively safe procedure, but it is time-consuming and orthodontic relapse is possibly inescapable due to stretching of the periodontal fibres. Intentional replantation is also known as intra-alveolar transplantation. Currently, the survival rate of intentional replantation is 88% to 95%[2]. In general, intentional replantation is indicated when periapical surgery requires extensive bone removal or in cases with odontogenic maxillary sinusitis and suspected root fracture. In recent years, a modification of intentional replantation with 180-degree rotation has been proven feasible to preserve teeth with deep subgingival fractures. Several authors have reported many cases of suc-

cessful intentional replantation with 180-degree rotation with a follow-up period of 3 months to 3 years[3-6]. Kim et al reported a case of successful intentional replantation with a 90-month follow-up[7]. Thus, this old technique has been re-evaluated. Limited data are available regarding the success rate of this procedure, with the major concerns being root resorption, ankylosis and inflammatory response.

This case report presents two cases with promising prognosis at a 4- and 5-year follow-up, providing new insights into this longstanding technique.

Case 1

A 21-year-old man was referred to the present authors' hospital for pain after having injured his maxillary teeth in an accident while playing basketball the day before. He claimed that he did not experience nausea, tiredness or dizziness after the trauma. The patient's dental, medical and family histories were non-contributory. An extraoral examination revealed no abnormality concerning the temporomandibular joint. An intraoral examination revealed that the maxillary right central incisor had an enamel defect with mild percussion tenderness and mild mobility. The maxillary left central incisor had a fracture line 3 mm above the labial gingival margin, extending to the palatal subgingival side. The fractured part was mobile and attached with gingiva. After removal of the fractured fragment, the palatal tooth margin extended apically 2 mm under the alveolar crest (Figs 1a to d). Radiographic examination revealed a complicated crown-root fracture of the maxillary left central incisor and crown fracture of the maxillary right central incisor (Fig 2a). The maxillary right central incisor was treated with a composite resin restoration. Multiple treatment options were available for the maxillary left central incisor, including crown lengthening, orthodontic extrusion and intentional replantation. After being informed of the risks and benefits of each of the available treatment options, the patient chose intentional replantation by repositioning the root against the socket with 180-degree rotation for the maxillary left central incisor (buccolingual reverse).

Under local anaesthesia, the maxillary left central incisor received pulp extirpation with NiTi instruments, irrigation with 1% sodium hypochlorite and intracanal medication with iodoform calcium hydroxide, then the access cavity was filled with glass ionomer (Fig 1e). The maxillary left central incisor was extracted carefully using forceps, avoiding injury to the alveolar crest and pericementum. The root surface was kept wet with saline and examined under a microscope to rule out suspected root fracture. The blood-filled socket was well protected from saliva contamination using a cotton roll. The prospective crown–root ratio of the maxillary left central incisor after the operation was 0.8. After repositioning the tooth in its socket with 180-degree rotation with slight extrusion, the initial degree of mobility of tooth 21 was 3 degrees, and the labial fracture margin was parallel to the gingival level. The maxillary left central incisor was fixed using steel wire and resin (Figs 1f to h). The patient was advised to avoid biting with his maxillary anterior teeth until the next visit and was prescribed chlorhexidine mouthrinse and antibiotics for 3 days. Instant radiography images showed a wedge-shaped shadow around the apex (Fig 2b). The ligature was removed 10 days after replantation and the degree of mobility of the maxillary left central incisor was 1 degree. After 1 month, the maxillary left central incisor exhibited physiological mobility and was passive to palpation and percussion. It underwent root canal obturation and temporary resin veneer restoration was performed 3 months later. The maxillary right central incisor was subjected to aesthetic resin repair. The wedge-shaped shadow was repaired radiographically at the 3-month follow-up (Fig 2c). After 7 months, porcelain laminate veneer was fabricated for the maxillary left central incisor (Figs 1i to j). The pericementum was continuous and complete at the 7-month follow-up (Fig 2d). At the 12-, 18-, 24- and 60-month follow-ups, the patient was asymptomatic and no symptoms of root resorption or ankylosis were observed radiographically, and the restoration functioned well (Figs 1k to l and 2e to h). Additionally, the supernumerary tooth in the maxillary anterior region without clinical symptoms was suggested to be followed up.

Case 2

A 20-year-old woman presented to our hospital with an injury to her maxillary teeth due to a car accident 2 hours before. The patient reported no other discomfort such as nausea, tiredness or dizziness after the trauma. Her dental, medical and family histories were non-contributory. Clinical and radiographic examinations revealed crown-root fractures of the maxillary right lateral incisor and the maxillary central incisors. Fracture lines were parallel to the gingival margin on the labial side and the subgingival margin on the palatal side (Figs 3a and b and Fig 4a). The risks and benefits of various treatment options were explained to the patient, and she chose intentional replantation with root repositioning against the socket with 180-degree rotation (buccolingual reverse) for the maxillary central incisors. All

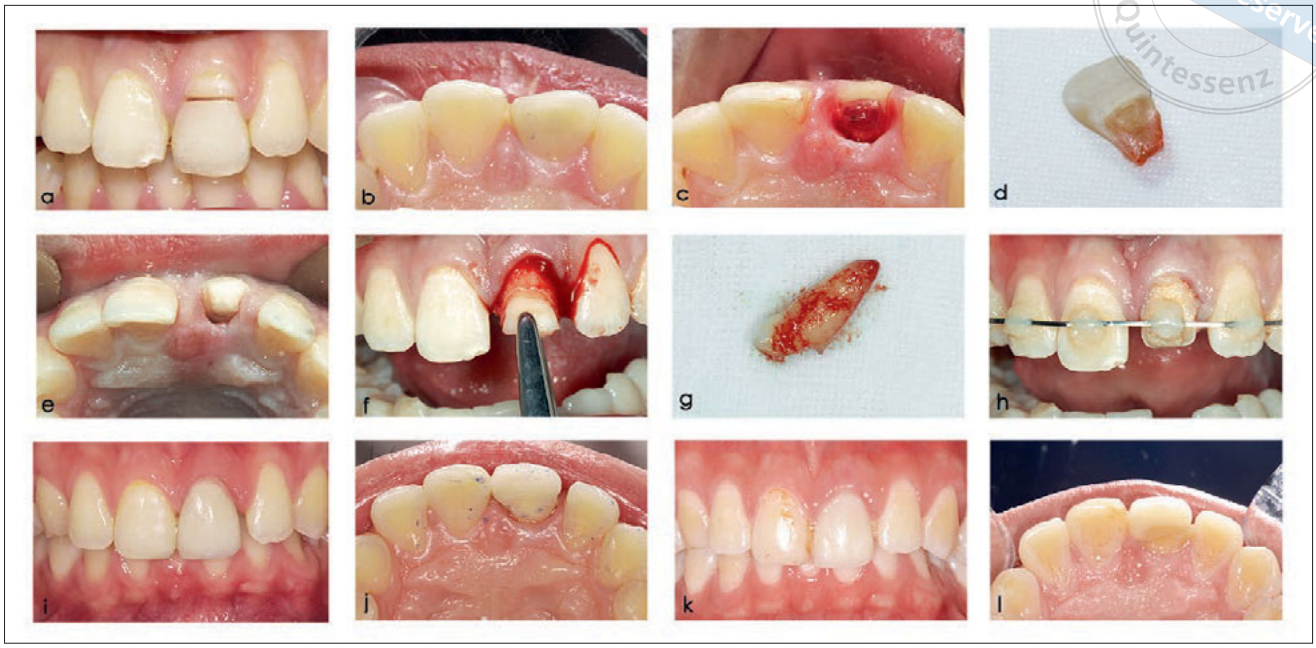

Fig 1 **(a)** Pretreatment labial view of the maxillary central incisors. **(b)** Pretreatment palatal view of the maxillary central incisors. **(c)** Occlusal view after crown extraction of the maxillary left central incisor. **(d)** Clinical photograph of removed crown. **(e)** Clinical photograph after pulp extirpation and temporary filling with glass ionomer. **(f)** Tooth extraction using forceps. **(g)** Evaluation of the extracted root. **(h)** Splinting after intentional replantation with 180-degree rotation and slight extrusion of the maxillary left central incisor. **(i)** Labial view after veneer restoration at the 7-month follow-up. **(j)** Palatal view after veneer restoration at the 7-month follow-up. **(k)** Labial view of the replanted tooth at the 60-month follow-up. **(l)** Palatal view of the replanted tooth at the 60-month follow-up.

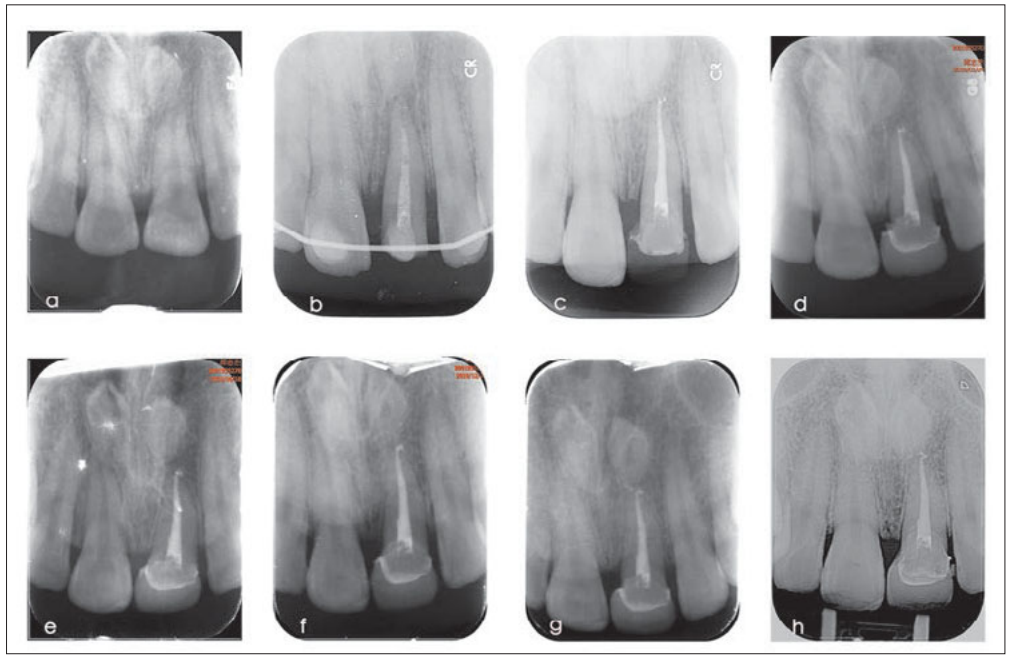

Fig 2 **(a)** Radiograph taken at the time of injury. **(b)** Radiograph taken after replantation and splinting showing a wedge-shaped shade around the apex. **(c)** Radiograph taken after root canal therapy at the 3-month follow up. **(d)** Radiograph taken after veneer restoration at the 7-month follow up. **(e)** Radiograph taken at the 12-month follow up. **(f)** Radiograph taken at the 18-month follow up. **(g)** Radiograph taken at the 24-month follow up. **(h)** Radiograph taken at the 60-month follow up.

three teeth would undergo root canal therapy followed by crown restoration.

Under local anaesthesia, pulpectomy was performed on the three teeth. Root canals were prepared using NiTi instruments and irrigated with 1% sodium hypochlorite and saline, then sealed with glass ionomer. The maxillary central incisors were removed carefully using forceps and examined closely under a

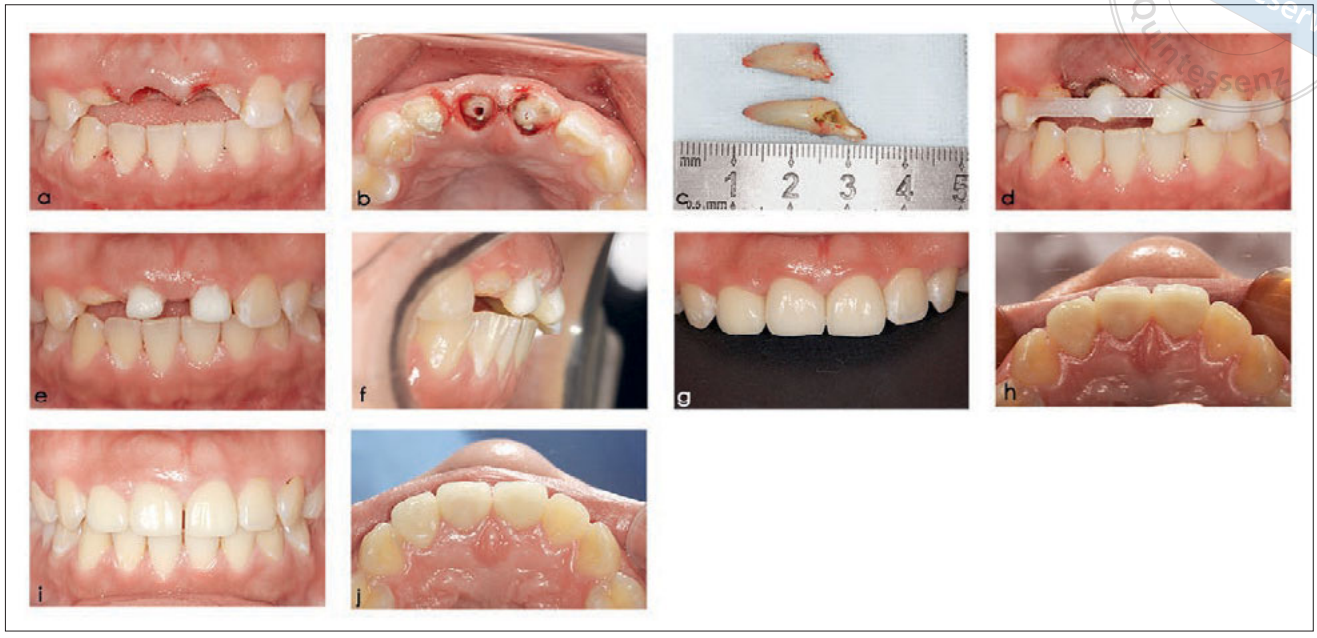

Fig 3 **(a)** Pretreatment labial view of the maxillary right lateral incisor and central incisors. **(b)** Pretreatment occlusal view: the maxillary right lateral incisor had a palatal fracture line parallel to the palatal gingival margin, the maxillary right central incisor had a palatal fracture line 7 mm under the palatal gingival margin and the maxillary left central incisor had a fracture line 5 mm under the palatal gingival margin. **(c)** Evaluation of the extracted roots of the maxillary central incisors: the prospective crown–root ratios after the operation were 1.25 and 1.00 for the maxillary right and left central incisors, respectively. **(d)** Splinting after intentional replantation with 180-degree rotation and slight extrusion of the maxillary central incisors. **(e)** Clinical photograph after splinting removal. **(f)** No occlusal contacts after splinting removal of replanted teeth. **(g)** Labial view after crown restoration at the 4-month follow up. **(h)** Palatal view after crown restoration at the 4-month follow up. **(i)** Labial view at the 48-month follow-up. **(j)** Palatal view at the 48-month follow-up.

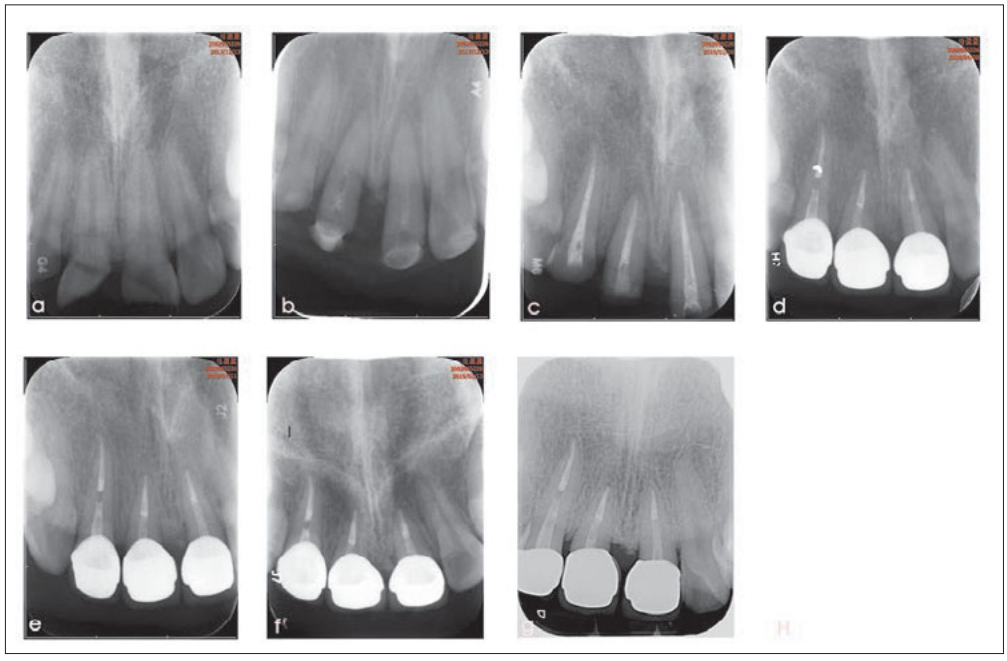

Fig 4 **(a)** Radiograph taken at the time of injury. **(b)** Radiograph taken after replantation showing a wedge-shaped shade around the apex. **(c)** Radiograph taken at the 1-month follow-up. **(d)** Radiograph taken after crown restoration at the 4-month follow-up. **(e)** Radiograph taken at the 7-month follow-up. **(f)** Radiograph taken at the 13-month follow-up. **(g)** Radiograph taken at the 48-month follow-up.

microscope to rule out suspected root fractures. The blood-filled socket was well protected from saliva contamination with a cotton roll. After repositioning the teeth in their respective sockets with 180-degree rotation and slight extrusion, the initial degree of mobility of the maxillary central incisors was 3 degrees and the

labial fracture margin was parallel to the gingival level. The replanted teeth were stabilised with fibreglass splints (Figs 3c and d). The patient was advised to follow a soft diet until the next visit and was prescribed chlorhexidine mouthrinse and antibiotics for 3 days. Instant radiographic images showed an obvious trilateral radiolucent area around the apex (Fig 4b). After 10 days, the splints were removed. Mild mobility was detected for the maxillary central incisors (Figs 3e and f). One month after replantation, both teeth exhibited physiological mobility and root canal treatment was completed (Fig 4c). Post-core crown restoration was performed 4 months after replantation (Figs 3g and h and 4d). At the 7- and 13-month follow-ups, the patient was asymptomatic. Radiographic images showed complete apical healing of the replanted teeth and slightly cervical external root resorption on the distal surface of the maxillary right central incisor (Figs 4e and f). External root resorption appeared to have stopped by the 48-month follow-up (Fig 4g). Intraoral examination at 48 months revealed a gap between the maxillary central incisors (Figs 3i and j), which may have been related to the suboptimal crown–root ratio and occlusal trauma.

Discussion

In general, intentional replantation is deemed successful if radiographic observation indicates a complete continuous periodontal membrane with no signs of resorption or ankylosis; if there is no discomfort, palpation or percussion; and if there are no signs of infection or inflammation such as a sinus tract, swelling or deep periodontal pocket[8].

Typically, trauma to the periodontal ligament is the main reason for root resorption and root ankylosis[9]. External surface resorption is defined as pressure-related resorption, and it is noninfective and self-limiting[10]. Nonprogressive root resorption is a common occurrence after replantation, which is observed in 30% of cases (95% confidence interval 25%–37%) according to a recent literature review[11]. The extraction procedure causes injury to the root surface as well as the periodontal cells. After the initial inflammatory reaction, recolonised surrounding periodontal cells could repair this new surface; thus, root resorption is also described as a repair-related process[12,13]. Root ankylosis can be seen as a subsequent replacement of tooth tissue by bone after resorption. The bone tissue laid down by osteoblasts as part of the repair process can replace the resorption area, which results in ankylosis. Ankylosis is more likely to occur when the periodontal ligament defect is > 4 mm^2, where the bone cells can attach to the root surface faster than periodontal cells[14]. Progressive root resorption and ankylosis are minor events. Appropriate medication could arrest the resorptive process. Calcium hydroxide retards resorptive cells and promotes healing[15]. In Case 2, root resorption of the maxillary right central incisor was seen at the 7- and 13-month follow-ups, presenting an irregular-shaped area around the distal root borders. Radiographic observation at the 48-month follow-up revealed that the distal root surface of the maxillary right central incisor had been repaired, and the initial resorption process was proven to be nonprogressive. The intrusion or prolonged extraoral time can cause an irreversible defect that increases the possibility of ankylosis and root resorption. The common ground on this issue is to minimise extraoral time as much as possible. Some authors have suggested that extraoral time > 15 minute has a negative impact on the re-establishment of periodontal cells, which is consistent with previous studies[16,17].

Traditionally, passive and flexible splinting is recommended to promote periodontal healing for a replanted tooth. Research has verified that slight mobility and function after replantation can promote periodontal healing[18]. Physiological splinting, rigid splinting and non-splinting are applicable for the replanted tooth. In these two cases, wire with resin for rigid fixation and fibreglass for physiological fixation both seemed to provide a promising prognosis. When non-traumatised inflammation of the periodontal ligament is minimal, the periodontal ligament cells can differentiate properly and reform a normal structure of the pericementum. The time required for reattachment of the epithelium at the cementoenamel junction is approximately 1 week. The recommended splinting time varies among studies from 2 to 6 weeks according to stability after replantation[19]. Recent studies have demonstrated that successful periodontal healing is probably unaffected by splinting time[20].

With the increased promotion of dental implants nowadays, crown-root fractured teeth are likely to be extracted. In the present two cases, which were followed up for a short time, intentional replantation with 180-degree rotation proved to be an effective option. It reduced clinical time, complications and expenses compared with other options. Additionally, in these two cases, slight resorption was observed on the alveolar crest radiographically. In case 2 specifically, an interval was observed between the maxillary central incisors, and this may be related to the suboptimal crown–root ratio and alveolar crest resorption.

Intentional replantation is not recommended in conditions such as with nonrestorable dental caries or defects, severe periodontal disease, curved roots with the possibility of fracture during extraction and ankylosed teeth[8]. Good case selection and appropriate handing could confer good results. Long-term follow-up of replanted teeth is recommended.

Conclusion

Intentional replantation with 180-degree rotation is an optional treatment for complicated tooth fracture and could provide a good long-term prognosis under appropriate management.

Conflicts of interest

The authors declare no conflicts of interest related to this study.

Author contribution

Drs Lin YANG and Qiang LIU contributed to the conceptualisation, data collection, writing, review and editing of the study; Drs Ming Wen LIU, Fan GU and Zi Jun WANG contributed to the data collection; Drs Yan ZUO and Yao LI contributed to the review and editing; Prof Bin PENG contributed to the supervision of the complete study.

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