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CASE REPORT

Intentional replantation and Biodentine root reconstruction. A case report with 10-year follow-up

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Abstract

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Aim To describe the innovative use of intentional replantation for Biodentine root reconstruction of a previously treated immature maxillary central incisor with vertically extended crown root fracture and root detachment.

Summary In the present case, the intentional replantation of a failing, previously treated maxillary central incisor with a vertical crown/root fracture in a 12-year-old male patient is reported. The gross extrusion of gutta-percha points beyond the apex and the pre-existing extensive, trauma related, distal cervical dentinal detachment justified the intentional replantation treatment plan as an option for tooth retention. After controlling the infection by oral administration of antibiotics, the immature tooth was extracted atraumatically and kept in gauze embedded with tooth replantation medium. The apical third of the immature fractured tooth was treated with ultrasonics and an MTA plug (MTA Angelus White, Londrina, Brazil). The distal cervical dentinal root defect was reconstructed with Biodentine (Septodont, St. Maur-des-Fosses, France). The tooth was reinserted and stabilized to the adjacent teeth for 2 weeks. The total extraoral time before replantation was 25 min. In the 10 years since the initial trauma (9 years after the intervention) radiographic and clinical evaluation revealed uneventful healing of the periapical lesion, normal mobility and no detectable signs of external replacement resorption.

Key learning points

- Intentional replantation may provide a viable treatment alternative in cases of severe complicated crown/ root fractures
- Biodentine may be useful in the reconstruction of external root defects in crown root fractured traumatic dental injuries

Keywords: Biodentine, crown root fracture, dental trauma, intentional replantation.

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Introduction

Traumatic dental injuries (TDIs) in children and adolescents are a common clinical dilemma particularly in children between 7 and 12 years of age (Andreasen & Ravn 1972, Bastone *et al*. 2000). Usually these injuries present as emergency situations needing immediate attention. From all the TDIs, complicated crown root fractures of immature permanent teeth are amongst the most severe injuries that may result in early tooth loss (Andreasen *et al*. 2007). A complicated crown root fracture is defined as a fracture involving enamel, dentine and cementum exposing the pulp (DiAngelis *et al*. 2017). They are the least observed crown-related injuries amongst all TDIs, with a prevalence ranging from 2% to 2.5% in primary teeth (Andreasen *et al*. 2007, Gong *et al*. 2011) and 0.5%–5% in permanent teeth (Andreasen *et al*. 2007, Hecova *et al*. 2010). Crown root fractures require a multidisciplinary approach, which involves contributions from Oral Surgeons, Endodontists, Orthodontists, Paediatric Dentists, Periodontologists, and Prosthodontists (Güngör 2014).

The prognosis of complicated crown root fractures in immature permanent teeth is questionable and depends on the stage of root development and the location of the fracture along the root (DiAngelis *et al*. 2017). Several treatment options have been proposed for the management of such fractures, such as; fragment rebonding, fragment removal followed or not by crown lengthening, followed by restoration of the crown of the tooth, fragment removal and orthodontic extrusion followed by restoration of the crown of the tooth, surgical extrusion or intentional replantation with restoration, root submergence and eventually complete removal of the affected tooth and autotransplantation or replacement with an implant (DiAngelis *et al*. 2017).

However, in young patients with immature teeth the extraction and implant placement alternatives are impractical since the maxillofacial development of the young patient is complete. Until the completion of maxillofacial development, intentional replantation or autotransplantation might be the last resort treatment options, so as to preserve the bone and to achieve uneventful maxillofacial development.

Intentional replantation has been defined as the deliberate extraction of a tooth and after evaluation of root surfaces, endodontic manipulation, and repair, replacement of the tooth into its original socket (Grossman 1966). Autotransplantation is defined as the movement of a tooth or dental germ from one position to another, within the same person (Andreasen *et al*. 1990a,b,c,d). Both techniques are rarely used in private practice because of the wide variance in reported success rates (Grossman 1966, Kingsbury & Wiesenbaugh 1971, Bender & Rossman 1993) and the absence of an established protocol (Natiella *et al*. 1970, Torabinejad *et al*. 2015) Although it is suggested only for limited cases, intentional replantation has been reported with a success rate of up to 95%, if done by following the guidelines (Messkoub 1991). However, a recent systematic review and meta-analysis reported a weighted mean survival of 88% for intentional replanted teeth (Torabinejad *et al*. 2015) and a survival rate ranging from 74% to 90% for autotransplantation (Czochrowska *et al*. 2002, Mensink & Merkesteyn 2010).

The intentional replantation technique is considered the treatment of choice when the fracture extends subgingivally and periodontal surgery is not recommended for aesthetic reasons. It is also indicated when a previous root canal treatment has failed and when root canal retreatment or apical surgery are impractical (Filho *et al*. 2004). The

main advantage of intentional replantation is that tooth surfaces, including inaccessible areas, can be visualized and instrumented completely without damaging adjacent periodontal tissues and thus contribute to re-establishment of healthy periradicular tissues. Because intentional replantation is associated with the risk of root fracture, replacement resorption and ankylosis, this treatment modality is considered as a last resort and should be attempted only when no other treatment is feasible (Frank & Torabinejad 1998, Peer 2004, Pruthi *et al*. 2015) The contraindications to intentional replantation are periodontal involvement with extensive mobility of the tooth, destroyed or missing labial or buccal plate, or extensive loss of dental structures rendering the tooth nonrestorable. In such situations, autotransplantation of a suitable donor tooth should be considered (Andreasen *et al*. 2009).

In 2009, an hydraulic calcium silicate cement material, Biodentine™ (Septodont, St. Maur-des-Fosses, France) was introduced as a bioactive dentine replacement material that has been reported to bond to tooth surfaces without prior conditioning (Laurent *et al*. 2008, Koubi *et al*. 2013, About 2016). The biocompatibility of Biodentine to bone cells has been reported to be comparable to MTA (Attik *et al*. 2014). Furthermore, as Biodentine overcomes the major drawbacks of MTA it has great potential to revolutionize several treatment modalities in paediatric dentistry and endodontics especially after traumatic injuries (Rajasekharan *et al*. 2018). A material with such properties might be suitable to be used in various application in the root of human teeth, whenever replacement of the missing / damaged root dentine volume is required (About 2016). Numerous case reports have been published regarding the use of Biodentine and its clinical indications but clinical studies of its long-term efficacy are lacking (Rajasekharan *et al*. 2018). In addition, no case report with a complicated crown root fracture of immature permanent tooth and management by intentional replantation followed by Biodentine restoration has been published.

The purpose of this article is to describe the use of intentional replantation to allow the placement on the external root surface of Biodentine for the reconstruction of a previously treated crown root fracture involving an immature central incisor with persistent endodontic disease. A 10-year follow-up after the initial trauma is reported (9-year follow-up since the intervention).

Case report and clinical techniques

A 12-year-old Caucasian male patient was referred by his private Dentist for evaluation and possible treatment of his left maxillary central incisor (tooth 21). In the dental history, it was reported that the patient had an impact injury after a bicycle accident 16 months ago and his left maxillary central incisor suffered a complicated crown root fracture with pulp involvement. According to the dental history, the fracture line extended 3 mm below the crestal bone on the distal and lingual surfaces of the tooth. The broken fragment had been detached and was lost in the area of the accident. The patient sought emergency treatment in a regional hospital for his general injuries and in a private dental clinic for his dental trauma, some days later. Treatment included pulpectomy, root canal treatment with gutta-percha/ resin-based sealer and composite resin restoration of tooth 21. The patient remained asymptomatic with no further treatment provided over time. A week before presentation, the tooth became painful and a swelling in the anterior area of the maxilla had developed. The patient had been advised by the referring dentist to take a double antibiotic regimen containing amoxicillin 500 mg and metronidazole 500 mg every 8 h for one week. At the time of the appointment, the tooth was painful upon percussion and palpation. Clinical examination revealed an intraoral buccal swelling and pus was draining through the periodontal ligament (Fig. 1a,

b). Deep periodontal probing depths were noted all around the tooth and a grade 3 tooth mobility was recorded. The preoperative radiographic evaluation revealed an immature left maxillary central incisor previously treated with gutta-percha points extruding beyond the apex; a diffuse periapical lesion around the root; a composite resin restoration extending subgingivally, and detached distal root structure extending approximately 3 mm below the crestal bone (Fig. 1c). Because of the acute phase of the lesion and the fatigue of the young patient no treatment was performed in the first appointment. Oral rinses with 0.12% chlorhexidine gluconate were advised. Because of the ineffectiveness and tolerance to the previous antibiotic scheme, a decision was made to change to clindamycin 300 mg every 8 h for 7 days (Tancawan *et al*. 2015). Additionally, because of the complexity of the case and the patient's young age and in order to achieve the best possible cooperation, the patient was referred to a Paediatric Dentist for revaluation. The patient was rescheduled for treatment evaluation one week later and advised to keep contact with the clinic everyday in order to monitor his well-being and the progression of the symptoms. After a discussion between the parents, the patient, the Paediatric Dentist and the Endodontist, a decision was made to plan the tooth for intentional replantation and subsequent repair of the external root surface defect. Alternative treatments such as crown lengthening, orthodontic extrusion or surgical extrusion were excluded from the treatment plan because it was felt that the extension of fracture line was too far below the crestal bone and was complicated by the gross extrusion of gutta-percha cones beyond the apex. The sole alternative besides intentional replantation was extraction and orthodontic management. However, extracting a permanent maxillary central incisor in a 12-year-old patient can be detrimental for their maxillofacial and psychological development. The autotransplantation and intentional replantation treatment approaches were explained to the parents. The autotransplantation alternative was rejected by the parents and a written informed consent was obtained for intentional replantation.

The entire procedure was planned in cooperation with the Paediatric Dentist. The dental team consisted of one Endodontist, one Paediatric Dentist and two dental nurses. For the purpose of intentional replantation, Dentosafe tooth replantation medium was obtained (Dentosafe; Medice GmbH, Iserlohn, Germany). After one week of

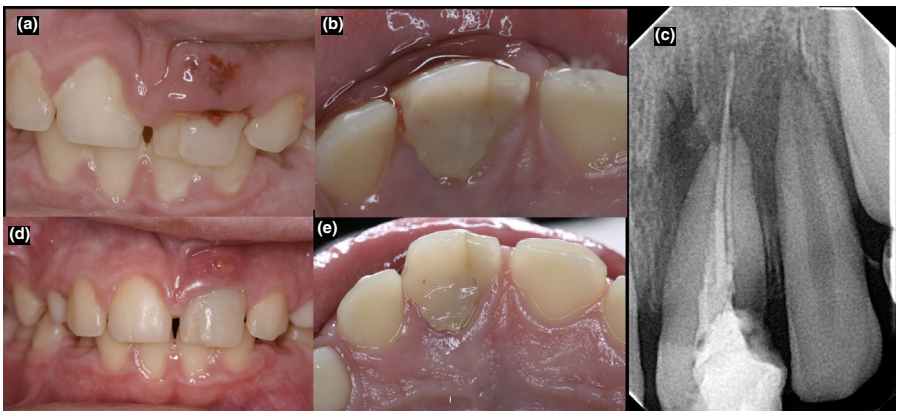

Figure 1 (a) Preoperative Labial Clinical view of tooth 21 (16months after initial trauma), (b) preoperative palatal clinical view of tooth 21, (c) preoperative periapical radiograph of tooth 21, (d) Labial clinical view of tooth 21 after the administration of antibiotics, (e) palatal clinical view of tooth 21 after the administration of antibiotics. (Images taken by a Canon EOS 400D / EF100mmf/2.8 Macro lens, digital sensor Gendex Visualix- eHD).

clindamycin the patient's symptoms subsided, and the tooth became asymptomatic. Mobility had returned to normal but a sinus tract was present (Fig 1d,e). Buccal and palatal infiltration anaesthesia with 4% articaine (Ubistesin; 3M/ESPE, Seefeld, Germany) was delivered. The supra-alveolar fibres were circumferentially dissected, and the tooth was atraumatically extracted using conventional extraction forceps by the Paediatric Dentist. To prevent damage to the periodontal ligament, the use of an elevator during extraction was avoided. Moreover, the beaks of the conventional forceps are placed firmly on the crown above the cementoenamel junction whilst exerting a slow buccolingual luxation force. The tooth was extracted and the handle of the extraction forceps was secured and handed to the Endodontist (Fig. 2a). After extraction, care was taken to avoid any contact with the socket wall so as to prevent damage to the remaining periodontal ligament which is considered the key in promoting reattachment (Andreasen 1981, Tsukiboshi, 2002). Subsequently, the granulation tissue was removed using a small curette without involving any curettage of the socket wall. Also, to avoid damage to the periodontal ligament, the extracted tooth was always held gently on the crown with a gauze moist with Dentosafe tooth replantation medium (Fig. 2b), whilst the root-end treatment was completed extraorally (Fig. 2c). It was important to keep the tooth in a humid environment, as in Dentosafe solution, to keep it moist (Andreasen *et al*. 1990a,b,c,d, Tsukiboshi, 2002) and maintain the periodontal ligament vital and therefore reduce complications after the replantation procedure. The apical third was retroprepared to a 3–4 mm preparation depth from the apical tip of the immature root with an ultrasonic tip (BL 3A; B&L Biotech, Fairfax, VA, USA) (Fig. 2d) to prepare a thorough preparation of the cavity for the successful placement of an hydraulic calcium silicate cement as a retrograde seal. The Hydraulic Calcium Silicate Cement of choice for the apical seal used here was MTA (MTA Angelus white Londrina, Brazil). The plug was placed with the MAP carrier (Produit Dentaire, Vevey, Switzerland) and the excess material was wiped off and removed with a sterile dry gauze (Fig. 2e).

A new sterile gauze was soaked with Dentosafe replantation solution and the tooth was held from the root to expose the distal defect (Fig. 2f). A new ultrasonic tip (BL 3A; B&L Biotech) was used under continued sterile saline irrigation to prepare the defect for the bioceramic root reconstruction (Fig. 2f). The root was continuously

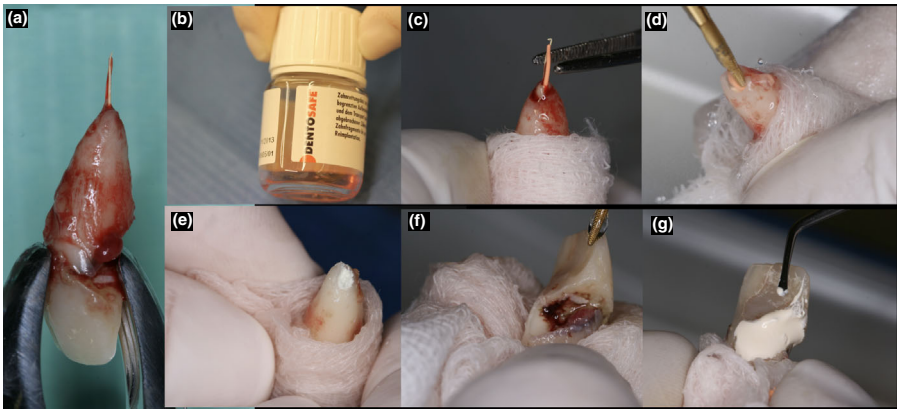

Figure 2 (a) Tooth 21 after the atraumatic extraction fixed in the extraction forceps with a rubber band in the handle, (b) Dentosafe tooth transplantation medium, (c) extruded gutta-percha, (d) retropreparation of the large diameter canal, (e) retrofilling with MTA Angelus White, (f) reburnishing with ultrasonics of the external root defect, (g) Biodentine reconstruction of the missing root tissues. (Images taken by a Canon EOS 400D / EF100mmf/2.8 Macro lens).

irrigated with Dentosafe solution and the external root surface defect was blot dried with a sterile paper point.

Biodentine (Septodont) was used according to the manufacturer's instructions for the reconstruction of the hard tissues that were lost during the traumatic injury. The material was placed in the defect with a microspatula (EVA 9-10 instrument; Hartzell & Son, Concord, CA, USA) and adapted to the external root surface without prior conditioning (Laurent *et al*. 2008, Koubi *et al*. 2013, Malkondu *et al*. 2014) (Fig. 2g). The reconstructed root surface was covered with the moist gauze for 15 min until the material had set, approximately 9–12 min (Laurent *et al*. 2008, About 2016).

The extraoral manipulation time was 25 min. During this time, the Paediatric Dentist fixed an arch wire in the adjacent teeth with composite resin. Before tooth replantation, the socket had been lightly curetted in the apical region to remove any remaining granulomatous tissue or cystic remnants. Surgical suction was used to remove only the blood clot, with careful attention to avoid any contact with socket walls. The primary goal was to avoid removing and/or traumatizing remaining PDL cells attached to the alveolus, as such cells may aid in the healing process. Once the socket had been prepared to receive the tooth and rendered free of any obstruction, the tooth was gently replaced in the socket in an axial direction using digital pressure. Upon resistance, the patient's own biting pressure was used to further seat the tooth into its socket. Once the tooth was completely seated, compression of the socket walls using further digital pressure was applied, to gain a more intimate adaptation of the socket wall and tooth root. An assessment of primary stability of the tooth was made and although the tooth was stable, it was splinted to the adjacent teeth via the arch wire and composite resin (Fig. 3a,b). The occlusion was adjusted to relieve the contacts and postoperative instructions were given including oral rinses with 0.12% chlorhexidine gluconate 3 times daily and a soft diet for 2 weeks. Antibiotics were not prescribed. The splint was left in place for 2 weeks.

After 2 weeks the patient was asymptomatic. The splint was removed (Fig. 3d,e), and tooth mobility was found to be within normal limits. A periapical radiograph was taken as a baseline for the review period (Fig. 3c). The patient was recalled after seven days for assessment and review of the surgical site and had experienced minimal

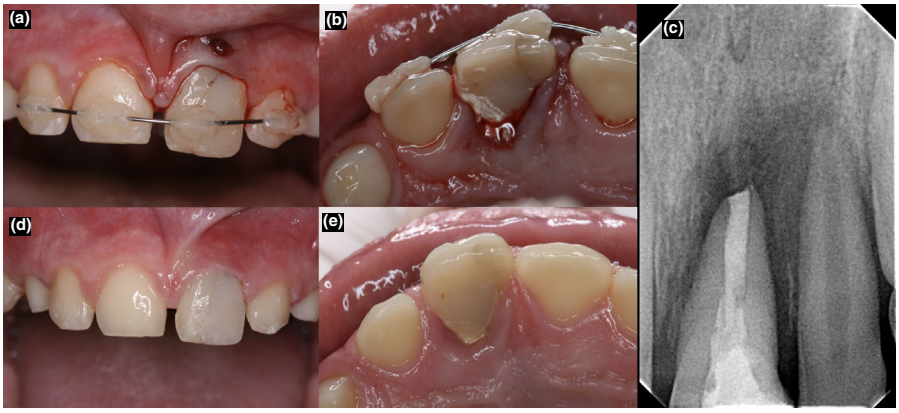

Figure 3 (a) Postoperative labial clinical view, (b) Postoperative palatal clinical view, (c) periapical radiograph after splint removal, (d) postoperative labial clinical view after splint removal, e. postoperative palatal clinical view after splint removal. ((Images taken by a Canon EOS 400D / EF100mmf /2.8 Macro lens, digital sensor Gendex Visualix- eHD).

postoperative discomfort and the soft tissues were healing well. The patient was recalled again at 3, 6, 12 months, 6 years (Fig. 4a,d) and 9 years since the intervention (10 years since initial trauma) (Fig. 4b,c). At these recall appointments tooth mobility, periodontal probing depths and percussion sounds were evaluated, and all found to be within normal limits. Probing depth at the 10-year follow-up (9 years since the intervention) was 5 mm palatally over the Biodentine material reconstruction (Fig. 4e) and 3 mm all around the tooth. No bleeding on probing occurred. The follow-up radiographic examination revealed no periapical radiolucency or evidence of inflammatory or replacement resorption (Fig. 4c).

Discussion

Fractures of permanent teeth can be classified, according to the severity of the injury and the damaged tissues involved to; infraction, enamel fractures, enamel dentine fractures, enamel dentine-pulp fractures (complicated), crown root fractures without pulp involvement (uncomplicated) and crown root fracture with pulp exposure (complicated) with the later being the most severe (Andreasen *et al*. 2007, DiAngelis *et al*. 2017). Little information is available with regard to pulp prognosis in crown–root fractures. Existing data are mostly related to the survival of the affected teeth following various treatment procedures. Immature permanent maxillary incisors are most susceptible for these injuries causing either pulp inflammation or necrosis (Bastone *et al*. 2000). One of the most critical factors in assessing the restorability of a tooth with a crown root fracture is the location and extension of the subgingival fracture margin. If the apical extent of the crown root fracture violates the 'biological width' (Gargiulo *et al*. 1961), and there is insufficient tooth structure available for restoration, surgical or orthodontic intervention is usually suggested. The aim of this treatment is to convert the subgingival fracture to a supragingival fracture before definitive restoration of the tooth can proceed. (Andreasen *et al*. 2019).

In the case reported here, the crown root fracture injury had resulted in a distal root defect that extended 4 mm subcrestally. Moreover, the previous emergency

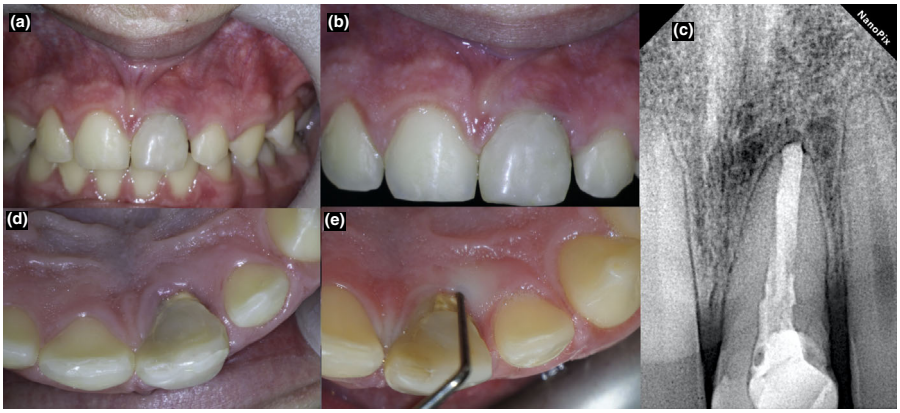

Figure 4 (a) Labial clinical view at the 6 years after initial trauma, (b) labial clinical view 10 years after initial trauma (9 years after the intervention), (c) Periapical radiograph 10 years after initial trauma (9 years after the intervention), (d) palatal clinical view 6 years after initial trauma, (e) palatal clinical view 10 years after initial trauma (9 years after the intervention) highlighting the periodontal probing at the site of the Biodentine reconstruction. (Images taken by a Sony A 6300 DSLR camera mounted on a Global Surgical Microscope G6, digital sensor nanopix by Eighteenth).

endodontic treatment of the immature tooth had resulted in the extrusion of the gutta-percha points beyond the apex. Treatment approaches that aimed at the exposure of the apical extent of the fracture line supracrestally in order to replace the missing tissues with restorative materials (DiAngelis *et al*. 2017), were considered insufficient to manage the persistent periapical infection and the overextending gutta-percha points. Extraction of the compromised tooth and autotransplantation of premolars to the anterior region, although reported to have long-term success ranging from 90 to 98% (Andreassen *et al*. 2009), they always require a second surgical intervention in the recipient site of a suitable donor tooth. This treatment alternative was explained to the parents and considered unacceptable, leaving intentional replantation as the only viable treatment alternative to manage the infection and preserve the bone.

It is reported that avulsed teeth often recover optimal function and aesthetics after replantation under ideal conditions (Andreasen 1981, Tsukiboshi 2002). In immature teeth, pulp regeneration can also be expected if the apical foramina is more than 1mm wide (Andreasen *et al*. 1990a,b,c,d). Creating ideal conditions for favourable periodontal ligament (PDL) healing is the biological principle behind intentional replantation techniques. Optimal PDL healing is expected when an avulsed tooth is immediately replaced into its own socket wall and reattachment between the connective PDL tissues of root surface and the socket wall can be expected in 2 weeks (Andreasen 1981, Andreasen *et al*. 1990a,b,c,d, Tsukiboshi 2002).

In the present case, an attempt was made to create suitable conditions by minimizing the extraoral time. Careful preoperative planning of the whole procedure minimized the time of the extraoral tooth manipulation. Two operators where involved. A Paediatric Dentist removed the tooth atraumatically, prepared the socket, managed the anxious young patient and bonded an arch wire splint to the adjacent teeth. An Endodontist treated the tooth extraorally by keeping the time frame as minimal as possible. The whole procedure lasted 25 min in total.

During intentional replantation, the PDL cells can be damaged mechanically during the extraction or bio-chemically due to the hostile extraoral conditions. For the mechanical damage, the type of healing depends on the surface area of damaged root to be repopulated (Andreasen *et al*. 1990a,b,c,d). If the area is small, cells with the potential to form new cementum and periodontal ligament are most likely to cover the damaged root and result in transient inflammatory resorption and cemental healing. If the damage is large, cells programmed to form bone will attach to some areas of the root and a process of bone turnover will take place. The root will be resorbed but in the apposition stage bone will fill the resorbed area inducing root replacement resorption, a process that is irreversible (Andreasen *et al*. 2019).

To minimize PDL cell damage Dentosafe was used. Dentosafe Cell Culture Medium (SCCM) is a medium based on Roswell Park Memorial Institute (RPMI) medium, formulated particularly for the storage of an avulsed tooth that contains inorganic salts, amino acids, vitamins, glucose, and special preservatives. A tooth rescue box containing SCCM is commercially available as Dentosafe (Medice Arzneimittel Pütter GmbH & Co.) in Europe and as EMT Toothsaver (SmartPractice.com, Phoenix, AZ, USA) in the USA. Laboratory studies have demonstrated that SCCM maintains proliferative activity of PDL cells for up to 48 h and viability of pulp cells better than HBSS for a time longer than 24 h (Le *et al*. 2018) 2016

Two different hydraulic calcium silicate cements were used in the present case. For the apical plug retrofilling MTA Angelus white was used. MTA apical barriers have been reported in previous studies to be reliable and successful methods for filling immature apices (Simon *et al*. 2007, Holden *et al*. 2008). Moreover, the treating dentist was

familiar with the handling of MTA Angelus White for apical plug creation making the apical retrofilling procedure rapid and reliable. For the external root reconstruction Biodentine was selected instead of MTA. The long setting time and the discoloration potential of MTA are considered as drawbacks (Parirokh & Torabinejad 2010) for the application intended here. The long setting time and the blood contamination that is expected in an implantation procedure most probably would have result in the MTA remaining unset and washing out from the reconstructed root surface but not from the apical plug area where the surface in contact with blood is limited (Chaniotis 2014). On the contrary, Biodentine seemed appropriate to be used over the entire defect of the root surface because of its physical and biological properties. Biodentine was introduced as biocompatible restorative material that can bond with dentine without any prior conditioning; similar to resin-modified glass–ionomer cements (Fujii LC) (Raskin *et al*. 2012). The enhanced physical and biological properties of Biodentine could be attributed to the presence of finer particle size, use of zirconium oxide as radiopacifier, purity of tricalcium silicate, absence of dicalcium silicate, and the addition of calcium chloride and hydrosoluble polymer (Rajasekharan *et al*. 2018). The short setting time of Biodentine compared to all other materials is explained by the absence of dicalcium silicate, which is associated with a slower hydration reaction (Darvell & Wu 2011). The compressive strength of the Biodentine is suggested to continue improving with time until it reaches the similar range of natural dentine and is found to be higher than all other restorative materials tested (Grech *et al*. 2013). Microhardness also is reported to be better than other materials (Grech *et al*. 2013, Camilleri 2013). Push out bond strength of Biodentine is also reported to be better than MTA and not affected by blood contamination (Aggarwal *et al*. 2013). Dimensional also stability of the material has been demonstrated with negative solubility values and no discoloration is reported (Malkondu *et al*. 2014). Laurent *et al*. (2008), were the first to show the promising biological properties of Biodentine on human fibroblast cultures. In another study by Laurent *et al*. (2012) Biodentine was found to significantly increase TGF-B1 secretion from pulp cells. TGF is a growth factor whose role in angiogenesis, recruitment of progenitor cells, cell differentiation, and mineralization has been highlighted in recent research (Laurent *et al*. 2012). In a study performed by Zhou *et al*. (2013), where Biodentine was compared with white MTA (ProRoot) and glass–ionomer cement (FujiIX) using human fibroblasts, both white MTA and Biodentine were found to be less toxic compared to glass–ionomer during the 1- and 7-day observation period. When the biocompatibility of Biodentine on human MG63 osteoblast cells was compared with the white ProRoot MTA, it was found to be very similar (Attik *et al*. 2014). In general, Biodentine is biocompatible and does not affect the specific functions of target cells. It can be used safely in the clinic as a single bulk restorative material without any conditioning treatment. It can be used as a potential alternative to traditionally used posterior restorative materials and as a dentine substitute whenever dentine is missing like the case of external root reconstruction that was reported here (Laurent *et al*. 2008, Koubi *et al*. 2013). The use of Biodentine as apical barrier material had been also considered by the treating team. It was rejected however because of the lack of evidence for the use of this material as an apical plug at the time that the reported intervention took place.

Although primary stability after replantation in the socket was achieved, an arch wire splint was used to secure the tooth for 2 weeks. Splinting types and duration on periodontal healing have been widely studied on replanted teeth (Veras *et al*. 2017). Although, ankylosis and replacement resorption may be observed with a long-term splinting, significant improvements outcomes with short-term splinting have not been shown. It is recommended that the tooth be splinted for up to two weeks contrary to six weeks as before. Despite the fact that the splint type should permit physiological

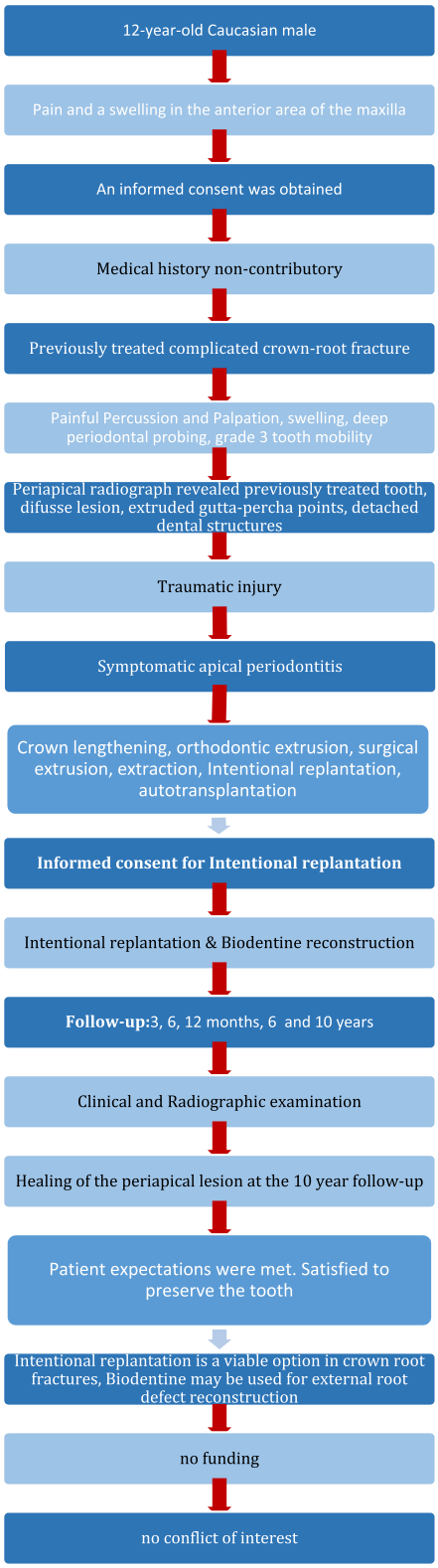

Figure 5 PRICE 2020 Flow chart.

movement during the fixation period, a recent study demonstrates that splint types do not affect the outcome of the periodontal healing process (Veras *et al*. 2017).

The follow-up 10 years after initial trauma (9 years after the intervention) revealed uneventful healing. Tooth mobility was within normal limits and percussion sound was normal. The patient was asymptomatic and periodontal probing was within normal limits other than the area of the Biodentine reconstruction where a 5 mm pocket was present. The radiographic examination revealed minimal bone loss after ten years of survival, complete healing of the periapical lesion and sound lamina dura around the tooth suggesting favourable healing.

The present case indicates that this procedure might be a rapid and cost effective approach for the treatment of severe crown root fractures in children and adolescents.

In the case reported here the guidelines for reporting case reports in endodontics were followed (Figure 5) (Nagendrababu *et al*. 2020a).

Conclusion

Intentional replantation may be a viable option in severe crown root factures traumatic dental injuries. Biodentine might be useful for the reconstruction of external root defects and offer long-term successful outcomes.

Conflict of interest

The authors have stated explicitly that there are no conflicts of interest in connection with this article.

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