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CASE REPORT

Pulp management after traumatic injuries with a tricalcium silicate-based cement (Biodentine™): a report of two cases, up to 48 months follow-up

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Abstract
Background Apexogenesis after traumatic exposure in vital young permanent teeth can be accomplished by implementing the appropriate vital pulp therapy such as pulp capping (direct or indirect) or pulpotomy (partial or complete) depending on the time between the trauma and treatment of the patient, degree of root development, and size of the pulp exposure.
Case report Two children with respectively 2 and 1 complicated enamel dentine fractures in immature permanent incisors were treated with new tricalcium silicate cement (Biodentine™). The treatment plan in these cases was to maintain pulp vitality aiming for apexogenesis which allows continued root development along the entire root length. Endodontic management included partial pulpotomy or pulpotomy using Biodentine™. Clinical and radiographical evaluation (up to 48 months) showed continual apexogenesis with no periodontal or periapical pathology. The appropriate restorations were functionally acceptable and aesthetically satisfying. The three traumatised teeth showed complete success both clinically (vitality and aesthetic outcome) as well as radiographically (apexogenesis and absence of pathological findings) after up to 48 months follow-up.
Conclusion Biodentine™ is a suitable alternative to MTA for vital pulpotomy in traumatised permanent incisors. It is also beneficial as a temporary filling without any risk of discolouration.

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Keywords Dental trauma · Immature teeth · Pulp therapy · Biodentine™

Introduction

Crown fractures with pulp exposure represent 18–20 % of traumatic injuries involving the teeth, the majority being in young permanent central incisors (De Blanco 1996). These injuries produce changes in the exposed pulp tissues, and a biological and functional restoration of immature young permanent teeth represents an important clinical challenge (Ojeda-Gutierrez et al. 2013). The treatment plan in such cases is to maintain pulp vitality via apexogenesis which allows continued root development along the entire root length (Shabahang 2013).

Apexogenesis after traumatic exposure in vital young permanent teeth can be accomplished by implementing the appropriate vital pulp therapy such as pulp capping (direct or indirect) or pulpotomy (partial or complete) depending on the time between the trauma and treatment of the patient, degree of root development, and size of the pulp exposure (AAPD 2008). Histologic examination of traumatised pulp shows that the depth of inflammatory reaction does not exceed 2 mm from the exposed surface within 48 h (Karabucak et al. 2005). Therefore, if treated within 48 h, 2 mm of injured pulp can be successfully removed, leaving the non-inflamed healthy radicular pulp to reorganise.

Calcium silicate-based materials are hydraulic self-setting materials with intrinsic physico-chemical properties suitable for pulp therapy. Biodentine™ (Septodont Ltd., Saint Maur des Faussés, France) possesses superior clinical properties such as good sealing, increased compressive strength, decreased porosity, higher density, bioactivity,

release of ions acting as epigenetic signals, immediate formation of calcium hydroxide, biomineralisation ability, biointeractivity and colour stability compared to mineral trioxide aggregate (MTA) (Gandolfi et al. 2013; Rajasekharan et al. 2014).

Case reports

Two patients with respectively 2 and 1 complicated enamel dentine fractures of their maxillary incisors without luxation were treated with pulpotomy using Biodentine™ and documented for up to 48-months follow-up period. Both patients reported were treated according to the standard protocol of the Department of Paediatric Dentistry of the University Hospital at Ghent, Belgium. All treatments were performed under rubber dam to ensure adequate isolation.

Patient one

An 8-year-old Caucasian male visited the dental hospital suffering from a complicated crown fracture (fracture involving enamel, dentine and pulp) of tooth 21 during sports activity 2 days ago. Medical history of the patient did not reveal any relevant information. The diagnostic radiograph revealed the immaturity of the tooth with wide open apex (Fig. 1). The tooth was sensitive to percussion and palpation with a visible pin point exposure of the pulp (Fig. 2). The tooth was prepared for a partial pulpotomy with a high speed diamond bur and copious irrigation with water under local analgesia. The pulp exposure was rinsed with saline and dried with a sterile cotton pellet. The pulp tissue seemed healthy as the bleeding had stopped and the pulp appeared bright red. The open pulp was gently covered

Fig. 2 Visible pin point exposure of the pulp of tooth 21

with an initial layer of Biodentine™. The Biodentine™ was further placed in layers up to the occlusal level to function as a temporary filling material (Fig. 3).

Four weeks later, there were no pain symptoms after the initial treatment. Tooth vitality was followed up clinically. Radiographically, no pathological findings were observed. The tooth was then restored with composite resin (Clearfil™, Kuraray, New York, USA), replacing the top layer of the temporary filling material (Biodentine™). During further follow-up at 6 and 12 months, symmetric ongoing apexogenesis of both central incisors was observed, referring to a healthy pulp activity in both teeth (Figs. 4, 5). In that period, the boy, in the meantime at an age of 9 years old, reappeared with a second dental trauma, involving tooth 22, suffering from another complicated crown fracture. Due to incomplete eruption, the margin of the fracture mesially, was found subgingival (Fig. 6). Clinically, pulp exposure was visible. Periapical radiograph revealed an immature root with a large open apex (Fig. 7). Local analgesia was followed by isolating the tooth, making an easy entry to the fractured site. A partial pulpotomy was executed exactly as was performed 1 year ago for tooth 21 (high speed bur and copious irrigation with water). The vital pulp was gently covered with a layer of Biodentine™ followed by a permanent composite restoration (Clearfil™,

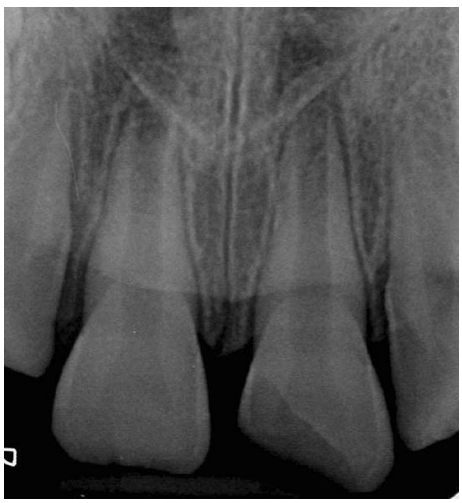

Fig. 1 Immature, wide open apex of tooth 21

Fig. 3 Biodentine™ as a temporary filling material of tooth 21

Fig. 4 Six months radiographical evaluation of tooth 21

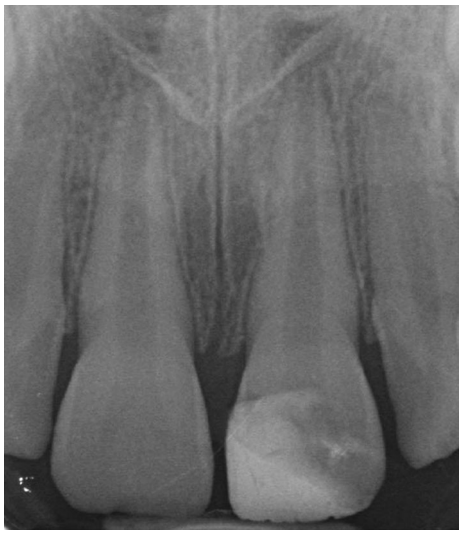

Fig. 5 Twelve months radiographical evaluation of tooth 21

Fig. 6 Mesial margin of the fracture lies subgingivally for tooth 22

Kuraray, New York, USA). Six weeks later, the patient presented for follow-up. He did not complain and no pain was reported. During clinical and radiographical

Fig. 7 Immature, wide open apex of tooth 22

Fig. 8 Fifteen months and 3 months radiographical evaluation of tooth 21 and 22, respectively

evaluation, no pathologic symptoms were found. The radiographs after 3, 6, 12 and 24 months follow-up of 22 and up to 36 months of tooth 21 showed further maturation of both teeth (Figs. 8, 9, 10, 11).

Patient two

A 7-year-old Caucasian female visited the emergency service after she had an accident in the playground. Medical history of the patient revealed negative relevance. An

Fig. 9 Eighteen months and 6 months radiographical evaluation of tooth 21 and 22, respectively

Fig. 10 Twenty-four months and 12 months radiographical evaluation of tooth 21 and 22, respectively

enamel dentine fracture with pulp exposure with respect to tooth 11 was diagnosed (Figs. 12, 13). Due to severe anxiety treatment under local analgesia was impossible. The treatment was performed the following day under general anaesthesia. The pulp exposure was further opened with a sterile high speed diamond bur with sufficient water cooling. The pulp tissue until the cement-enamel junction was removed (complete pulpotomy). Pulp capping or partial pulpotomy was not a viable option in this instance as the duration of between trauma and treatment was more than 24 h. Haemostasis was achieved with a moist cotton pellet and the pulp exposure was capped with Biodentine™ and used as a temporary filling. A radiograph at this appointment showed an immature open apex (Fig. 14) and

Fig. 11 Thirty-six months and 24 months radiographical evaluation of tooth 21 and 22, respectively

Fig. 12 Complicated enamel dentine fracture of tooth 11

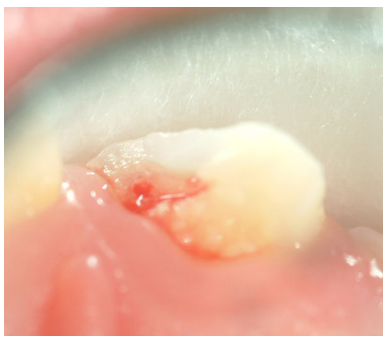

Fig. 13 Pulp exposure of tooth 11

the Biodentine™ capping could be noted at the cingulum level. Three weeks later, a permanent composite restoration was made. Clinical tooth vitality and digital radiographical evaluation was performed after 6, 12, 18, 24 and 48 months (Figs. 15, 16, 17, 18, 19). No subjective discomfort was reported during the entire follow-up period. Clinically, the tooth remained vital and no discolouration was observed. Radiographically, starting from 18 months complete apexogenesis was evident and this was further confirmed at the 24- and 48-month follow-up.

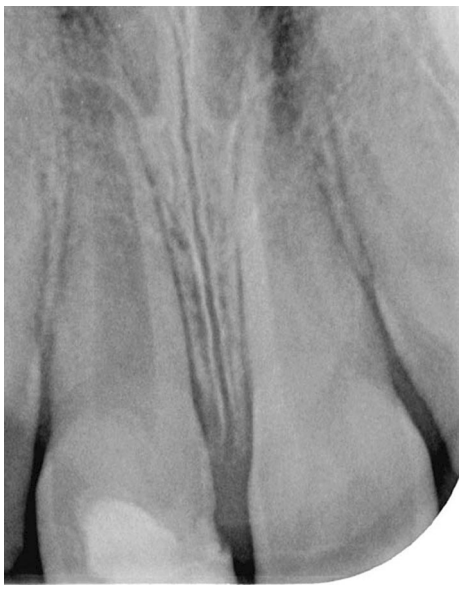

Fig. 14 Immediate post-operative radiograph of tooth 11

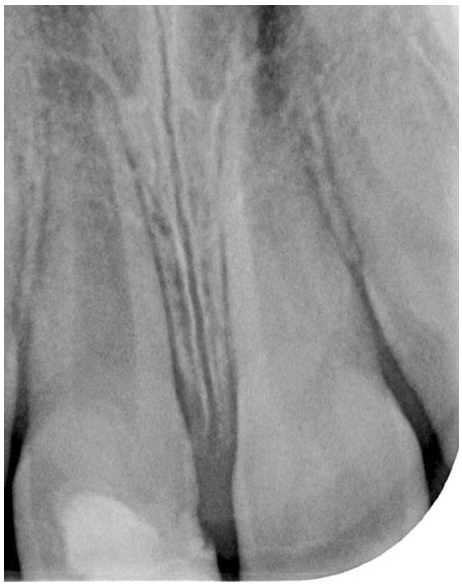

Fig. 15 Six months radiographical evaluation of tooth 11

Fig. 16 Twelve months radiographical evaluation of tooth 11

Fig. 17 Eighteen months radiographical evaluation of tooth 11

Discussion

Partial pulpotomy has shown a high success rate in previous reports with complicated crown fractures in young immature teeth with pulp exposure, however, a long-term follow-up is necessary to establish this success rate (Fong and Davis 2002). The outcome criteria for successful vital pulp therapy treatment after dental trauma include asymptomatic teeth (clinically and radiographically), apexogenesis (indicates ability of tooth to retain vitality) and absence of tooth discolouration (for aesthetic reasons).

A loss of pulp vitality in complicated crown fractures is mainly observed on the day of trauma and within the first 6 months (Bucher et al. 2013). During follow-up of the 3 traumatised teeth reported at different periods, no tooth sensitivity or pain was reported; also, neither clinical symptoms nor radiographic defects were present. Clinical and radiographic examination showed continual apexogenesis with no periodontal or periapical pathology and the restorations were functionally acceptable and aesthetically gratifying.

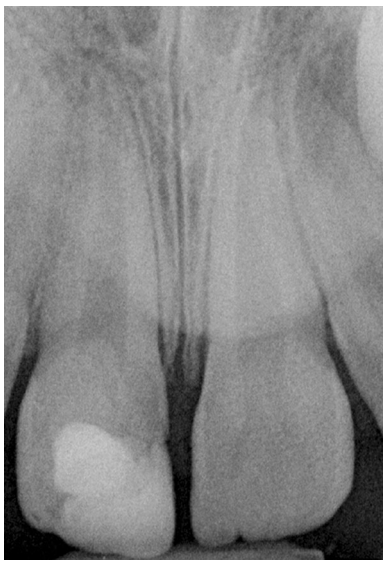

Fig. 18 Twenty-four months radiographical follow-up of tooth 11

Fig. 19 Forty-eight months radiographical follow-up of tooth 11

Difficult handling, long setting time, and potential discolouration are important drawbacks of MTA. The newly developed tricalcium silicate cement (Biodentine™) has overcome these shortcomings. Biodentine™ demonstrated easy handling comparable to that of phosphate cement (Nowicka et al. 2013). In another study, Biodentine™ showed colour stability in light and anaerobic conditions and was suitable for use under light-cured restorative materials in aesthetically sensitive areas (Valles et al. 2013). The latter has been confirmed in the present cases as Biodentine™ did not induce any discolouration. Furthermore, Biodentine™ is advantageous to the clinician as it can also be used as a temporary restorative material for up to 6 months owing to its superior strength and sealing ability (Koubi et al. 2013).

Conclusion

In both cases a complete success both clinically (vitality and aesthetics) as well as radiographically (apexogenesis and absence of pathological findings) were observed for the three traumatised teeth after 48 months follow-up. On this basis, pulp management is highly recommended using Biodentine™ as an effective pulp dressing for the treatment of complicated crown fractures especially in young permanent teeth with incomplete root formation.

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