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Fragment reattachment of fractured anterior teeth with pulp exposure: a 10-year follow-up

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ABSTRACT

Coronal fractures of the anterior teeth are a common form of dental injury. Reattachment of fractured tooth fragments using dental adhesive techniques offers some advantages, including restoration of the function, aesthetics, shape, texture, and brightness of the surface. The present report describes a clinical case of partial pulpotomy by the Cvek technique and reattachment with a 10-year clinical and radiographic follow-up in permanent maxillary central incisors with complicated crown fractures.

Keywords: reattachment; Cvek technique; complicated crown fracture; dental trauma.

INTRODUCTION

Coronal fractures of the anterior teeth are a common form of dental trauma that mainly affects children in the first 2 decades of their life, occurring more often in boys than in girls [1, 2, 3]. The most frequent reasons are accidental falls, traffic accidents, domestic violence, fights, and sports activities [2]. The majority of dental injuries involve the maxillary incisors because of their specific position in the arch and labial proclination. Fortunately, the most common dental injury to the permanent dentition is an uncomplicated crown fracture involving enamel, dentin but without pulp exposure [3]. Complicated crown fractures in permanent teeth ranged between 18–25% of all trauma to dental hard tissues [4].

Trauma-induced damage to the anterior teeth has both physical and psychological impacts on patients. Traumatic injuries that lead to pulp exposure in young patients present a treatment challenge that must be swift and effective for the patient's rehabilitation [5]. Managing coronal tooth fractures depends on several factors, such as the extent and pattern of the fracture, restoration options for the broken tooth, secondary traumatic injuries, the presence or absence of fractured tooth fragments, alignment between the fragment and the remaining tooth structure, occlusion, aesthetics, financial factors, prognosis, and endodontic involvement [1, 6].

The prognosis of a traumatized tooth with complicated crown fractures depends on factors such as the diameter of the pulp exposure, pulp health, time interval between trauma and treatment, patient's age, and stage of root development [7]. Treatment options for crown fractures with pulpal exposure encompass direct pulp capping, partial pulpotomy, pulpectomy, or, in some cases, extraction [2, 7, 8]. For young patients, pulpotomy is often the preferred treatment option, provided there are indications for such treatment [2].

Restoring fractured teeth presents a challenge for clinicians, primarily due to the difficulty in matching the correct colour, achieving the original anatomy, and restoring translucency [3, 9]. When the fractured tooth fragment is available, the optimal treatment option often involves reattaching the fragment. Rejoining the fractured portion of the teeth can lead to pleasing and enduring aesthetic outcomes [1, 10, 11].

The current case report details the fragment reattachment of a fractured tooth with a 10-year clinical and radiographic follow-up in maxillary central incisors treated using the Cvek technique for partial pulpotomy.

CASE PRESENTATION

A 12-year-old boy, accompanied by his parents, was referred to our clinic, with the main concern being crown fractures of the maxillary central incisors. He presented at the clinic 24 h after the trauma occurred, which had happened during sports activities at school. The parents had brought the broken tooth fragments in tissue paper – which were immediately stored in a saline solution to prevent dehydration before dental treatment. According to his medical history, the patient did not have any systemic diseases or relevant issues. No prior treatment had been administered to the teeth. There were no signs of soft tissue trauma observed externally. Upon intraoral clinical examination, complex crown fractures were evident in ⅔ of both the maxillary left and right central incisors (class III according to Ellis's classification) – as shown in Figure 1A. The fractures exposed the pulp (Fig. 1B). The affected teeth exhibited no mobility, were not sensitive to percussion, and had normal periodontal probing.

Periapical radiographic assessments for both teeth showed completed root formation, closed apices, no signs of periapical injury, and fractures in the alveolar bone or root (Fig. 2A). The patient experienced pain upon stimulation. The exposed pulps appeared red in colour, indicating adequate blood supply to the

pulps. The teeth responded appropriately to electric pulp testing, which signified the healthy status of the pulps. It should be noted that a normal response to pulp sensibility tests in teeth following trauma might take several weeks [12]. An evaluation of the masticatory muscles and temporomandibular joints did not show any dysfunction. Intraoral assessment indicated a class I of Angle's classification, with upper canines and all 4 second molars in the eruption phase. After examination, the selected treatment plan consisted of partial pulpotomy with the Cvek technique and reattachment of dental fragments of both involved teeth. The fragments were analysed and temporarily placed in the mouth to verify proper positioning and fit with the fractured coronal structure. Both fractured fragments had excellent marginal adaptation to the teeth.

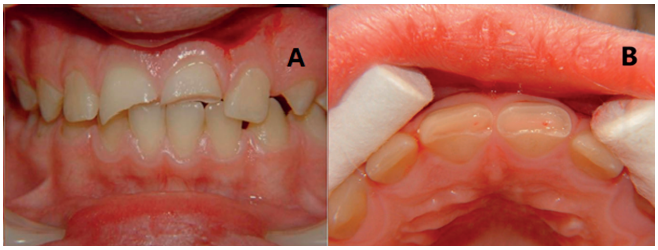

FIGURE 1. A) Intraoral clinical image showing complex crown fractures in the maxillary central incisors. B) Incisal view of the maxillary central incisors highlighting the pinpointed pulp exposures

Following a mouth rinse with 0.2% chlorhexidine gluconate and local anaesthesia (Ubistesin 4%, 3M ESPE, Germany), the teeth were isolated using a rubber dam. The exposed pulp and surrounding dentin of both teeth were rinsed with saline solution. The pulps were amputated to a depth of 2 mm using a small round diamond bur on a high-speed handpiece, with continuous cooling using saline. The surface of the remaining pulp was irrigated with saline, achieving hemostasis. Non-setting calcium hydroxide (Biopulp, CHEMA, Poland), prepared according to the manufacturer's instructions, was applied over the exposed pulps and sealed with glass ionomer cement (Fuji Triage, GC America, USA).

After setting the Fuji Triage, the teeth and fractured segments were etched using 37% phosphoric acid for 30 s, followed by rinsing and drying. The adhesive system OptiBond Solo Plus (Kerr, USA) was applied to both the fractured fragments and the teeth. A small amount of flowable resin composite filling material (Tetric Flow, Vivadent, Lichtenstein) was used on the fragments of teeth. The fragments were positioned correctly, excess resin was removed, and the areas were light-cured for 40 s on each surface. Margins were appropriately finished using diamond burs and polished using Sof-Lex disks (3M ESPE, Germany). Aesthetics of the reattached fragments were evaluated for colour harmony between the fragments and remaining teeth structures (Fig. 2B). Occlusion was meticulously checked and adjusted, and the patient was discharged with instructions to avoid exerting heavy forces on these teeth and to maintain regular oral hygiene practices.

Periodic monitoring of the traumatized teeth's pulp and periapical tissues was conducted at 1, 6 months and 1, 2, 3, 4 and 10 years after the trauma. This included clinical examination, pulp sensibility tests, periodontal probing, and radiographs. The clinical and radiological 10-year follow-up revealed vital pulps with no signs of periapical pathology (Fig. 3A and 3B). The radiograph showed the formation of reparative dentin bridges (Fig. 3A). At 22 years of age, the patient had proper occlusal contact points (canines and molars in class I occlusion), normal overjet and overbite, and upper midline and lower midlines coinciding with the facial midline. The masticatory muscles and temporomandibular joint were asymptomatic upon palpation, with no clicking, crepitations, or movement limitations. The function and aesthetics of both fractured teeth remained satisfactory throughout the follow-up period.

FIGURE 2. A) Post-trauma radiograph displaying fractured lines, fully developed roots, closed apices, and the absence of periapical pathology. B) Clinical view after the reattachment procedures

FIGURE 3. A) A radiograph taken 10 years post-trauma. B) Clinical view after a 10-year follow-up

DISCUSSION

Anterior teeth fractures resulting from injuries are distressing experiences for young patients and their parents, requiring immediate attention. Cases involving young patients with crown-fractured teeth and pulp exposure tend to have a more favourable prognosis compared to cases with caries-related pulp exposure due to the absence of bacteria. Treatment options for traumatic pulp exposure in these cases can include direct pulp capping or partial/full pulpotomy. The choice of treatment depends on various factors, such as the extent of pulp inflammation (clinical diagnosis of pulp status), stage of root development, and the presence of root fractures or luxation injuries that may impact blood and nerve supply.

Some studies have indicated that the interval between trauma and treatment, as well as the size of the exposed pulp,

have limited influence on the long-term outcome of partial pulpotomy, as long as the infected pulp is amputated to a level of healthy tissue [13, 14, 15]. However, clinicians must consider that longer delays between the fracture and treatment may lead to more advanced bacterial invasion [13, 14]. The size of the pulp exposure is a significant factor in choosing between direct pulp capping and pulpotomy. Pulp capping is recommended for cases with either an open or closed apex if treatment is administered within a few hours of the injury and the exposure is pinpoint-sized [2, 16]. However, for pulp exposures larger than 1 mm or if the trauma occurred more than 24 h ago, the Cvek pulpotomy is suggested as a treatment of choice [2, 17]. The Cvek pulpotomy involves removing approx. 1–2 mm of the inflamed coronal pulp to the level of healthy tissue and applying calcium hydroxide paste after achieving hemostasis [18].

For many years, calcium hydroxide has been the material of choice for pulp capping procedures due to its alkaline pH, which offers excellent antibacterial properties and supports hard tissue formation and pulp healing. In addition to its therapeutic potential, calcium hydroxide is easy to apply, less technique--sensitive, and cost-effective [19, 20, 21, 22]. Cvek reported a 96% success rate for partial pulpotomies after complicated crown fractures [18]. Partial pulpotomy has advantages over cervical pulpotomy, including the preservation of cell-rich coronal pulp tissue. This remaining pulp exhibits better healing potential and can continue physiological dentin production in both the crown and cervical areas of the tooth; the dentin formation strengthens the tooth and reduces the risk of coronal fractures. Moreover, even a small portion of pulp inside the crown allows for vitality checks using sensitivity tests [18, 23].

Presently, alternative materials like mineral trioxide aggregate (MTA) or Biodentine (Septodont, France) are widely recommended for vital pulp therapy in both primary and permanent dentition [19, 24, 25, 26]. Despite their favourable outcomes, one drawback of MTA is the potential for tooth discolouration. The radiopacifer bismuth oxide present in grey and white MTA contributes to tooth colour changes [27, 28, 29, 30, 31, 32]. Notably, tooth discolouration can also result from Biodentine use [33, 34], although Biodentine has shown less tooth discolouration compared to MTA [35].

In the presented case, the decision was made to perform a partial pulpotomy using calcium hydroxide as a pulp capping material on the affected teeth. This choice took into account the interval between the injury and treatment, the patient's age, root maturation, and the optimal marginal adaptation of the fractured fragments to the teeth, which prevented proper retention of the pulp capping material. Clinical examination revealed no discolouration either the teeth crowns or the reattachment line of the fractured fragments. After a 10-year follow-up, the teeth displayed normal responses to sensibility tests, and no signs or symptoms of periodontal or periapical issues were observed.

In contemporary dentistry, advancements in restorative materials, preparation design, and adhesive protocols have enabled clinicians to predictably restore fractured teeth. Treatment options may vary depending on the patient's socio-economic status, the intraoral status at the time of treatment planning, and the patient's age. In the presented case, the patient's own tooth fragments were reattached to tooth structures instead of utilizing more advanced dental restorations like veneers or full-coverage crowns. Numerous case reports have described various techniques and materials for reattaching fractured tooth fragments [36, 37, 38, 39]. Some studies recommend preparing grooves, chamfers, or bevels on the remaining tooth to ensure higher fracture resistance compared to single bonding [37, 38, 40]. Other studies recommend no preparation at all [41, 42]. In addition, the use of the simple bond without any preparation or with preparation of a vestibular chamfer determined a resistance equal to 37% and to 70% of an intact element, respectively [43, 44]. All in all, even after careful evaluation of the studies and case reports, there is no consensus about the ideal technique for reattaching a fractured tooth fragment. The choice of technique should be based on the fracture type and the quality (good or poor) of marginal adaptation between the fragment and tooth structure.

The choice of an adhesive system (self-etch, total-etch, or multimode) and bonding materials (conventional composite resin, flowable composite, resin cement, or glass ionomer cements) is another crucial aspect of tooth fragment reattachment techniques [37, 45, 46]. Flowable composites are indicated when there is excellent or good adaptation and a small space between the fragment and remaining tooth structures [37, 47]. Another factor influencing the success of reattachment is maintaining adequate hydration or rehydration of dehydrated tooth fragments before the restorative procedure. The loss of moisture in fracture fragments results in reduced bond strength [48].

In the presented case, reattachment was accomplished using a total--etch, single bonding technique without preparation, and a flowable composite due to the excellent adaptation of the fractured fragments to the remaining teeth structures. Discolouration caused by dehydration was not observed because the tooth fragments were stored in saline solution during treatment until the bonding procedure. After a 10-year follow-up, a natural and aesthetic appearance of the traumatized teeth was achieved. The treatment met the functional and aesthetic expectations of the patient, parents, and dental team.

Restoring proper occlusal conditions after trauma is critical for the overall functioning of the stomatognathic system, maintaining facial harmony (preserved symmetry, the equality of three sections and the correct profile), avoiding the impairment of biting and chewing, and the formation of a gap between upper and lower incisors, which may result in uncontrolled escape of air while speaking and the formation of speech alterations. We also avoid the incorrect position of the tongue, swallowing disorders, and asymmetry of the lips [49].

CONCLUSION

The tooth fragment reattachment procedure offers an ultraconservative, safe, rapid, and aesthetically pleasing outcome when the fractured fragment is available. Partial pulpotomy remains an excellent method for treating traumatized vital teeth.

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