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Case Report

The Success of Vital Pulp Therapy in a Young Permanent Tooth with a Complicated Crown Fracture Due to Trauma

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Abstract

Aim: Complicated crown fractures are traumatic dental injuries involving the enamel, dentin, and pulp. In young permanent teeth, preservation of pulp vitality is essential to allow continued root development and maintain the tooth in function. This case report aimed to present the two-year clinical and radiographic outcomes of partial pulpotomy and fractured fragment reattachment in a young permanent maxillary central incisor with a complicated crown fracture.

Case Report: An 8-year-old healthy boy presented with a complicated crown fracture of the maxillary central incisor following a fall at school. The fractured fragment had been stored in milk and brought to the clinic. The affected tooth showed a positive response to the cold pulp vitality test, with no evidence of root fracture or dentoalveolar injury. Partial pulpotomy was performed, and mineral trioxide aggregate was placed over the remaining vital pulp tissue. After pulpal healing and maintenance of vitality were confirmed, the fractured fragment was adhesively reattached. Regular clinical and radiographic follow-up examinations were performed for two years. The tooth remained vital and asymptomatic, with continued root development and no evidence of periapical pathology or root resorption.

Conclusion: Partial pulpotomy with mineral trioxide aggregate followed by adhesive reattachment of the fractured fragment resulted in favorable clinical and radiographic outcomes. Preservation of pulp vitality enabled continued root development during the two-year follow-up period.

Keywords: Tooth Fractures; Pulpotomy; Dental Pulp; Dental Trauma

Travmaya Bağlı Komplike Kron Kırığı Olan Genç Daimi Bir Dişte Vital Pulpa Tedavisinin Başarısı

Öz

Amaç: Komplike kron kırıkları; mine, dentin ve pulpa dokularını içeren travmatik dental yaralanmalardır. Genç daimi dişlerde pulpa canlılığının korunması, kök gelişiminin devam edebilmesi ve dişin fonksiyonunun sürdürülebilmesi açısından önemlidir. Bu olgu sunumunun amacı, komplike kron kırığı bulunan genç daimi maksiller santral kesici dişe uygulanan parsiyel pulpotomi ve kırık parça reataşmanının iki yıllık klinik ve radyografik sonuçlarını sunmaktır.

Olgu Sunumu: Sekiz yaşındaki sağlıklı erkek hasta, okulda düşme sonucu maksiller santral kesici dişinde meydana gelen komplike kron kırığı nedeniyle kliniğe başvurdu. Kırık parça süt içerisinde saklanarak kliniğe getirildi. Etkilenen diş soğuk pulpa vitalite testine pozitif yanıt verirken kök kırığı veya dentoalveolar yaralanma saptanmadı. Parsiyel pulpotomi uygulanarak kalan vital pulpa dokusu üzerine mineral trioksit agregat yerleştirildi. Pulpa iyileşmesi ve vitalitenin devam ettiği doğrulandıktan sonra kırık parça adeziv olarak yeniden yapıştırıldı. İki yıl boyunca düzenli klinik ve radyografik takipler gerçekleştirildi. Takip süresince diş vital ve asemptomatik kaldı; kök gelişiminin devam ettiği ve periapikal patoloji veya kök rezorpsiyonu bulunmadığı gözlendi.

Sonuç: Mineral trioksit agregat kullanılarak gerçekleştirilen parsiyel pulpotomi ve ardından kırık parçanın adeziv olarak yeniden yapıştırılması olumlu klinik ve radyografik sonuçlar sağlamıştır. Pulpa canlılığının korunması, iki yıllık takip süresince kök gelişiminin devam etmesine olanak sağlamıştır.

Anahtar Kelimeler: Diş Kırıkları; Pulpotomi; Pulpa; Dental Travma

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Introduction

Traumatic dental injuries are common, particularly among children and young adults, and can have a significant impact on patients' social and psychological well-being (1). Dental trauma-related fractures are classified based on the involvement of enamel, dentin, and pulp, including enamel fractures, uncomplicated crown fractures (involving enamel and dentin), complicated crown fractures (enamel-dentin fractures with pulp exposure), and crown-root or root fractures (2). The majority of dental trauma cases affect the anterior teeth, particularly the maxillary central incisors (3,4). Mandibular central incisors and maxillary lateral incisors are less frequently involved (5,6).

Crown fractures, whether involving pulp exposure or not, are the most frequently observed type of traumatic dental injury in the permanent dentition (3,7). Complicated crown fractures involve both enamel and dentin with pulp exposure and occur with a prevalence ranging between 2% and 13% (4,7). The most common causes of such injuries include falls, traffic accidents, physical altercations, and sports-related trauma (4,7).

According to the guidelines published by the International Association of Dental Traumatology (IADT), the treatment of complicated crown fractures includes conservative pulp therapy techniques, such as partial pulpotomy, in both mature and immature teeth (8). Prior to initiating treatment, it is essential to assess pulp vitality. However, in cases of dental trauma, false-negative results may be obtained due to the temporary loss of neural response. As a result, sensitivity tests, such as cold testing and electric pulp testing, may yield negative outcomes (9). Nevertheless, pulp vitality tests are recommended immediately after trauma and during follow-up appointments to monitor any potential changes in pulpal status (8,10). Additionally, laser Doppler flowmetry is suggested for evaluating pulpal blood flow (8).

Radiographic examination, particularly periapical radiography, plays a crucial role in diagnosing traumatic dental injuries. Additional radiographs may be required if there are signs or symptoms of other possible injuries (9). In cases of soft tissue trauma, lip and/or cheek radiographs are necessary to identify embedded tooth fragments or external foreign objects. When root fractures, crown-root fractures, or lateral luxations are suspected, cone-beam computed tomography (CBCT) can provide detailed information on the location, extent, and orientation of the injury (10).

In cases of uncomplicated crown fractures, if the fractured tooth fragment is available, it should be reattached to the tooth whenever possible. However, if the fragment is missing, the exposed dentin should be temporarily restored with a glass ionomer cement or composite resin (8).

Successful treatment outcomes in dental trauma include asymptomatic teeth with a positive response to pulp sensitivity tests, high-quality restorations, and continued root development in immature teeth (1,7). The prognosis depends on several factors, including the severity of the trauma, the quality and timing of the initial treatment, and the adherence to follow-up protocols (recommended at 14 days, 6-8 weeks, 3 and 6 months, and 1 year post-injury) (1,8).

Dental trauma is a common emergency in children and adolescents, necessitating prompt and appropriate intervention. Complicated crown fractures, due to pulp exposure, require early and proper management to preserve pulp vitality, ensuring both the function and esthetics of the tooth. The primary goal of treatment is to maintain the vitality of the pulp while restoring the tooth's integrity and function (7).

This case report aims to present the clinical management of a complicated crown fracture in a young permanent tooth, emphasizing the application of partial pulpotomy and the restoration of the fractured segment.

Case Report

An 8-year-old healthy male patient presented to a pediatric dentistry clinic with a complaint of an anterior tooth fracture resulting from a fall at school. The fractured segment had been properly stored in milk shortly after the trauma and was brought to the clinic for clinical evaluation (Figure 1). The patient’s medical history revealed no systemic conditions.

Figure 1. *The fractured tooth fragment stored in milk and brought to the clinic for evaluation.*

Clinical examination revealed that the enamel, dentin, and pulp tissues were affected by the trauma (Figures 2 and 3). The fracture was classified as a complicated crown fracture due to evident pulp exposure. The surrounding soft tissues showed no significant injury, and no mobility or displacement was observed in the affected tooth.

Figure 2. *Occlusal view of the mouth after trauma*

Figure 3. *Frontal view of the mouth after trauma*

A complicated crown fracture was diagnosed in tooth 11, and a positive response was obtained from the cold pulp vitality test. Panoramic radiographic examination revealed no signs of root fracture or dentoalveolar bone injury (Figure 4).

Figure 4. *Panoramic radiograph taken at the initial examination showing no signs of root fracture or dentoalveolar bone injury*

Prior to treatment, written informed consent was obtained from the patient's parents after a detailed explanation of the procedure, possible risks, and alternative treatment options. The parents were informed about the prognosis and the importance of adherence to post-operative care recommendations to optimize treatment success.

The treatment plan was designed with a primary focus on preserving pulpal vitality while restoring the function and esthetics of the affected tooth. Under local anesthesia, the traumatized pulp tissue was selectively removed using a sterile diamond bur to a depth of approximately 2 mm in order to eliminate the compromised pulp portion.

Following pulpal exposure management, a biocompatible material, Mineral Trioxide Aggregate (MTA) (Angelus MTA, Angelus Indústria de Produtos Odontológicos S/A, Londrina, PR, Brazil), was carefully placed over the exposed pulp with a thickness of approximately 2.5 mm. MTA was selected due to its excellent sealing ability, biocompatibility, and potential for dentin bridge formation. After MTA application, the tooth was temporarily restored using a conventional glass ionomer cement to provide an immediate protective barrier (Figure 5).

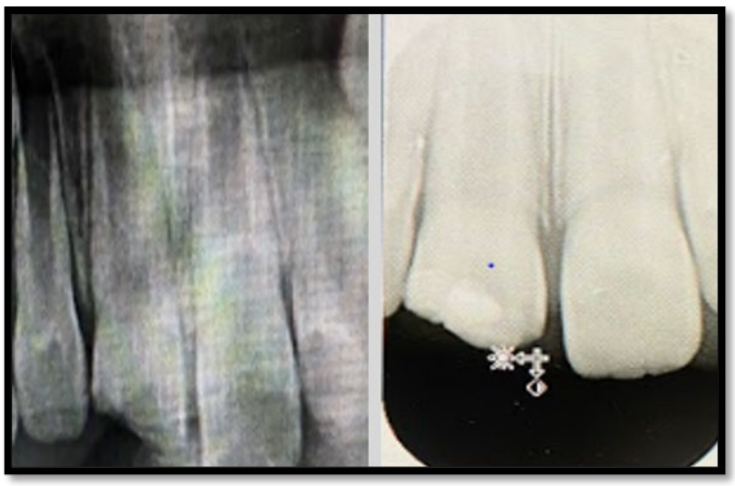

Figure 5. *Pre- and post-partial pulpotomy periapical radiographs.*

In the post-operative care phase, the patient's parents were thoroughly instructed regarding essential maintenance measures. The patient's parents were instructed to protect the traumatized tooth from further mechanical impact and to store the fractured fragment in fresh milk at room temperature (approximately 20–25°C). The milk was replaced daily to preserve the hydration and integrity of the fragment until definitive treatment, and the patient was also advised to follow post-operative hygiene and care recommendations to minimize the risk of complications.

Two weeks after the procedure, clinical and radiographic examinations were performed (Figure 6). The findings indicated pulpal healing, and the cold pulp vitality test showed a positive response, confirming the

maintenance of pulpal vitality. Following confirmation of pulpal health, the fractured fragment was repositioned. The enamel surfaces of both the tooth and the fractured fragment were etched with 37% phosphoric acid for 20 s, thoroughly rinsed with water, and gently air-dried. A one-step universal adhesive (G-Premio BOND; GC Corporation, Tokyo, Japan) was applied to both surfaces according to the manufacturer's instructions, gently air-thinned, and light-cured for 20 s using an LED curing unit (Woodpecker, Guilin, China). The fractured fragment was then bonded using a light-cured injectable resin composite (G-ænial Universal Injectable; GC Corporation, Tokyo, Japan). Excess composite was removed before polymerization, and the restoration was finished and polished to achieve the final esthetic result (Figure 7).

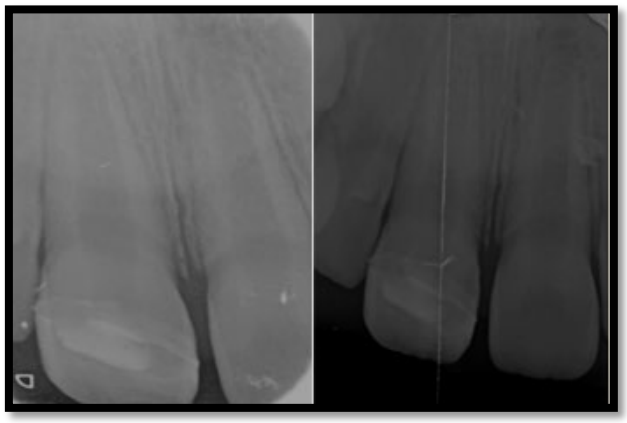

Figure 6. *Follow-up periapical radiographs after treatment. (A) Radiograph at 2 weeks. (B) Radiograph at 4 weeks.*

Figure 7. *Clinical view of tooth 11 after adhesive reattachment of the fractured fragment and completion of the esthetic restoration*

For long-term prognosis, the patient was scheduled for periodic follow-ups to assess the integrity of the restoration and monitor for potential complications such as pulpal necrosis, internal resorption, or secondary infections. Regular radiographic evaluations were recommended to ensure continued pulpal health and to detect any pathological changes at an early stage.

During the follow-up period, regular clinical and radiographic evaluations were conducted at 1, 6, 12, 18, and 24 months (Figure 8).

Figure 8. *Follow-up radiographs at (A) Radiograph at 18 months. (B) Radiograph at 24 months.*

These assessments confirmed the continued vitality of the pulp and demonstrated that root development was progressing normally without any signs of pathological changes. Additionally, no evidence of periapical pathology, internal or external root resorption, or other complications was observed throughout the follow-up period, further supporting the long-term success of the treatment.

Discussion

In cases of dental trauma, particularly in young patients, vital pulp therapies should be prioritized as the primary treatment approach. In this study, partial pulpotomy was performed with the aim of preserving the healthy remaining portion of the pulp. The success of this approach was confirmed by the maintenance of pulp vitality and continued root development throughout the two-year follow-up period.

Kaygusuz (11) reported that partial pulpotomy has a low complication rate and promotes dentin bridge formation in young patients. Similarly, Shetty et al. (12) demonstrated that MTA enhances dentin bridge formation while reducing the pulpal inflammatory response. Additionally, Tan et al. (13) reported that teeth treated with partial pulpotomy maintained long-term vitality and exhibited a high rate of complete root development.

According to a systematic review by Zaghdoudi et al. (14), the biocompatibility and anti-inflammatory properties of materials used in vital pulp therapies play a direct role in treatment success. In the present case, MTA was selected to provide a biocompatible pulp capping material while minimizing inflammation. Previous studies have indicated that MTA exhibits antibacterial properties due to its high pH and promotes dentin bridge formation (14).

Although rubber dam isolation is generally recommended in restorative and endodontic procedures, its use may sometimes be limited in traumatic dental injuries due to the urgency of treatment and the clinical conditions of young patients. In such situations, adequate moisture control can still be achieved using alternative isolation techniques, and successful outcomes of vital pulp therapy have been reported in similar clinical conditions in the literature (7,22).

In this case, the fractured fragment was transported to the clinic under appropriate conditions by the patient's parents and was successfully reattached as part of the final restoration. In traumatic dental injuries, fragment reattachment may be performed after initial stabilization of the pulp and surrounding tissues. Several studies have reported that delayed reattachment following vital pulp therapy can provide favorable functional and esthetic outcomes (15,16). Fragment reattachment offers several advantages, including preservation of natural tooth structure, improved esthetics, and enhanced biomechanical strength. Previous studies have reported that restorations using the original tooth fragment demonstrate greater longevity and patient satisfaction compared with conventional composite restorations (15–17). Furthermore, appropriate storage of the fractured fragment and early clinical intervention play a critical role in treatment success. Educating patients and caregivers about the emergency management of dental trauma significantly increases the likelihood of successful fragment reattachment and favorable vital pulp therapy outcomes (18–20).

Patient and caregiver education is a crucial factor in the successful management of dental trauma. In the present case, educating the caregiver on storing the fractured fragment in milk played a critical role in treatment success. Danish (18) demonstrated that educational programs for caregivers increase early intervention rates in dental trauma cases and facilitate the application of successful vital pulp treatments. In addition, Gill et al. (19) emphasized that educating parents about dental trauma management significantly improves early and successful treatment outcomes. Furthermore, Aminu et al. (20) reported that school-based awareness programs improve both children's and caregivers' knowledge of emergency responses to dental trauma, leading to an increased number of fractured fragments being brought to the clinic for reattachment.

The success of the restorative and vital pulp treatment methods applied in this case was confirmed by regular follow-up examinations. The two-year clinical and radiographic evaluations demonstrated continued root

development and maintenance of pulp vitality. In a long-term study, Li et al. (21) reported a high success rate for vital pulp therapy in complicated crown fractures over an eight-year follow-up period. Similarly, a systematic review by Asgary et al. (22) highlighted the importance of long-term follow-up in patients undergoing vital pulp therapy, suggesting that a minimum of five years of monitoring enhances treatment success. In addition, Chaudhary et al. (23) demonstrated that long-term radiographic monitoring plays a critical role in assessing root development and the functional integrity of the tooth.

Recent studies have reinforced the clinical significance of biomaterials in determining the success of vital pulp therapy. Clinical evidence suggests that material selection directly influences pulpal healing and long-term prognosis, with calcium silicate–based cements emerging as promising alternatives to traditional materials. Recent evaluations have also emphasized the role of advanced adhesive techniques in improving the mechanical stability and esthetic outcomes of reattachment procedures, further supporting their adoption in contemporary dental practice (24). Sung et al. (25) examined the clinical performance of reattachment techniques in fractured teeth and concluded that this minimally invasive approach preserves tooth structure while ensuring long-term functional and esthetic stability.

Moreover, current perspectives on dental trauma management highlight the necessity of regular follow-ups and early intervention strategies to enhance treatment outcomes. The preservation of original tooth structure is particularly emphasized in recent literature, where Çetin and Özkan (26) reported that reattachment using bonding agents provides optimal strength and esthetic integration, reducing the need for more extensive restorative procedures. These findings also underscore the psychosocial benefits of esthetic rehabilitation, as patients treated with fragment reattachment report greater satisfaction and confidence in their dental appearance. Similarly, Esposito et al. (27) highlighted that reattachment techniques not only restore esthetics but also contribute to preserving occlusal function and reducing stress distribution on the restored tooth. Furthermore, a meta-analysis by Komora et al. (28) confirmed that bioactive adhesives used in fragment reattachment provide greater resistance to failure, thereby contributing to long-term stability and improved clinical outcomes.

Conclusion

This case supports the effectiveness of partial pulpotomy with MTA and fragment reattachment in the management of complicated crown fractures in young permanent teeth. The two-year follow-up demonstrated maintained pulp vitality and continued root development, with no pathological findings. These results highlight vital pulp therapy as a conservative and reliable treatment option in traumatic pulp exposures.

Ethics Committee Permission Statement

Ethics Committee permission was not required for this case report. Written informed consent for treatment was obtained from the patient's parents. The study was conducted in accordance with the Ethical Principles of Scientific Research and Publication.

Conflict of Interest Statement

The authors declare that they have no conflict of interest.

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Authors Contribution Statement

Ceren Kaplan: Conception, Data Collection and/or Processing, Analysis and/or Interpretation, Writing.
Tuğçe Akçora: Data Collection and/or Processing, Literature Review, Writing.
Özlem Martı Akgün: Conception, Design, Supervision, Analysis and/or Interpretation, Critical Review.

Data Availability Statement

All data generated or analyzed during this case report are included in this published article.

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