Partial Pulpotomy with BioAggregate in Complicated Crown Fractures: Three Case Reports

Nuray Tuloglu*/ Sule Bayrak**

This report describes three cases of complicated crown fractures treated with partial pulpotomy using BioAggregate. Three maxillary permanent central incisors with complicated crown fracture were treated by partial pulpotomy using BioAggregate and reviewed clinically and radiographically for 24 months. Throughout this period, there was no spontaneous pain, periapical radiolucency, and coronal discoloration; the pulp was observed to be vital. Based on these findings, it was concluded that BioAggregate can be used in partial pulpotomy treatment of complicated crown fracture.

Key words: *BioAggregate, complicated crown fracture, partial pulpotomy.*

INTRODUCTION

A complicated crown fracture is defined as an enamel/dentin fracture with pulpal exposure[1]. Complicated crown fractures have been reported to comprise approximately 20% of all traumatic injuries in permanent teeth.[2] Treatment and prognosis of complicated crown fracture depends on the size of pulpal exposure, the time elapsed between trauma and treatment, the degree of root development, and the restorability of the tooth.[3,4] The primary aim in the treatment of complicated crown fractures should be to preserve vital, non-inflamed pulp by covering it with a continuous hard-tissue barrier. In most cases, this can be achieved by pulp capping or pulpotomy.[5] When compared to direct pulp capping, partial pulpotomy, or 'Cvek's technique', offers a number of advantages, including removal of superficially inflamed pulp tissue and creation of a space for dressing material that can provide a seal for the cavity.[6]

From Department of Pediatric Dentistry, Faculty of Dentistry, University of Eskisehir Osmangazi, Eskisehir, Turkey.
* Nuray Tuloglu, DDS, PhD, Assistant Professor.
** Sule Bayrak, DDS, PhD, Associate Professor.

Send all correspondence **to:**

Nuray Tuloglu
Department of Pediatric Dentistry, Faculty of Dentistry,
Eskisehir Osmangazi University,
26480, Eskisehir, Turkey
Phone: +90 222 2393750/1485
Fax: +90 222 2391273
E-Mail: nuraytuloglu@yahoo.com

BioAggregate is based on nanotechnology that ceramic particles upon reaction with water produced biocompatible and aluminum-free ceramic biomaterials. It has been recommended for clinical applications such as perforation repair, vital pulp therapy and as a root-end filling material.[7-9]

The following three case reports describe treatment of complicated crown fracture by partial pulpotomy using BioAggregate.

Case 1

A 10-year-old girl with no remarkable medical history was referred to pediatric dental clinic two days after falling at school. Clinical examination revealed a complicated crown fracture of the maxillary right central incisor (Tooth 11) and an uncomplicated crown fracture of the maxillary right lateral incisor (Tooth 12) (Figure 1a). Soft tissue appeared normal, and teeth showed no pathologically mobility, no sensitivity to palpation and percussion, and responded positively to electric pulp testing (Digitest, Parkell Electronics Division, Farmingdale, USA). The maxillary right central incisor was sensitive to cold and heat (Tooth 11) as a result of pulpal exposure. Radiographic examination of Tooth 11 showed just about complete apex formation, and both of teeth showed no periapical injury and no alveolar bone fracture (Figure 1b).

After obtaining written informed consent from the patients' parents, the maxillary right lateral incisor (Tooth 12) was restored with composite resin (Grandio, Voco, Cuxhaven, Germany). Given the condition of the pulp, the degree of root development and the time elapsed between trauma and treatment, the maxillary right central incisor (Tooth 11) was treated with a partial pulpotomy using Cvek's technique.[3] Local anaesthesia (Ultracaine DS-Fort Ampul, Sanofi Aventis Ilaclari Ltd. Sti., Istanbul, Turkey) was administered, and the maxillary right central incisor (Tooth 11) was isolated with cotton rolls and a saliva ejector. The exposed area was cleaned with

sterile saline solution, and pulp tissue was removed to a depth of two mm using a round diamond bur (801H012, Hager&Meisinger GmBH, Heisinger, Germany) in a high-speed turbine with water cooling. Bleeding was controlled with sterile saline solution and cotton pellets to avoid clot formation. BioAggregate (DiaRoot BioAggregate, Innovative BioCeramix Inc., Vancouver, BC, Canada) powder was mixed according to the manufacturers' instructions and placed on the wound surface using a carrier without any pressure. The BioAggregate was covered with a cotton pellet moistened with sterile saline solution, followed by a dry cotton pellet, and the cavity was sealed with improved zinc-oxide eugenol cement. The patient was recalled after four days, at which time the tooth showed no sensitivity to cold, palpation, or percussion and responded positively to electric pulp testing. The temporary filling and cotton pellets were removed, and the tooth (Tooth 11) was restored permanently with composite resin (Grandio, Voco, Cuxhaven, Germany).

The patient was recalled for follow-up clinical and radiographic examinations at six weeks, 12 months and 24 months, in line with International Association of Dental Traumatology guidelines.[10] Throughout this period, teeth were clinically asymptomatic and showed normal color (Figure 2a). Radiographic examination showed closed apexes and a dentin bridge at the pulpotomy site (Figure 2b).

Case 2

A 10-year-old boy applied to pediatric dental clinic three days after a traumatic sports accident. Clinical examination revealed a complicated crown fracture of the maxillary left central incisor (Tooth 21), an uncomplicated crown fracture of the maxillary right central incisor (Tooth 11) and normal soft tissue appearance (Figure 3a). The child's medical history was non-contributory, and there was no complaint of spontaneous pain. Teeth showed no pathologically mobility, did not respond to palpation and percussion, and responded positively to electric pulp testing (Digitest, Parkell Electronics Division, Farmingdale, USA). Radiographic examination of both teeth showed incomplete apex formation, no periapical injury, and no alveolar bone fracture (Figure 3b).

After receiving written informed consent from the patient's parents, Tooth 11 was restored with composite resin (Grandio, Voco, Cuxhaven, Germany), and Tooth 21 was treated with a partial pulpotomy according to Cvek (1978) using BioAggregate. Endodontic and restorative procedures were performed as described above for Case 1. The patient was recalled for follow-up clinical and radiographic examinations at six weeks, 12 months and 24 months, during which time teeth were observed to be vital, of normal color, and showing evidence of complete root formation with no periodontal/periapical pathology (Figure 4a,b).

Figure 1. Initial appearance of complicated crown fracture in the maxillary right central incisor a) Intraoral appearance b) Radiographic appearance

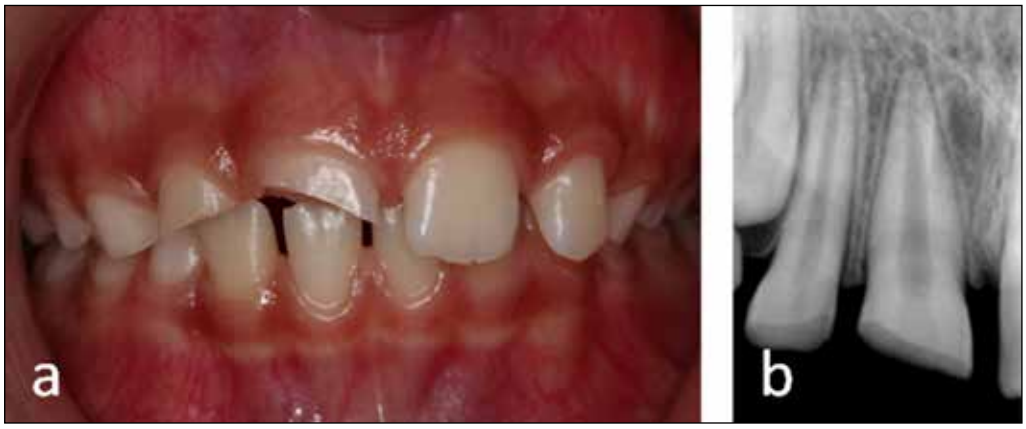
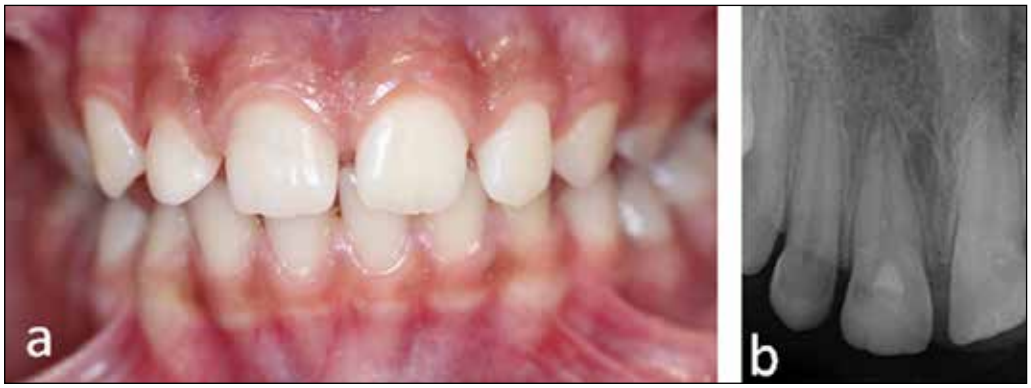


Figure 2. Appearance of case 1 after 24 months a) Intraoral appearance b) Radiographic appearance



Case 3

An 8-year-old boy presented at pediatric dental clinic six days after falling in the schoolyard and suffering a traumatic injury. Medical history was unremarkable. Clinical examination revealed a complicated crown fracture of the maxillary left central incisor (Tooth 21) (Figure 5a). Soft tissue appeared normal, and the tooth showed no pathologically mobility, no response to palpation and percussion, and a positive response to electric pulp testing (Digitest, Parkell Electronics Division, Farmingdale, USA). The tooth showed sensitivity to cold, but there was no spontaneous pain. Radiographic examination showed a large canal with an immature apex and no periapical injury or alveolar bone fracture (Figure 5b).

After obtaining written informed consent from the child's parents, the tooth was treated by partial pulpotomy according to Cvek (1978) using BioAggregate. Endodontic and restorative treatment was performed as described above for Case 1. The patient was recalled for follow-up clinical and radiographic examinations at six weeks, 12 months and 24 months, during which time teeth were observed to be vital, of normal color, and showing evidence of continuing root development with no periodontal/periapical pathology (Figure 6a,b).

DISCUSSION

Complicated crown fractures may be treated by pulp capping, cervical pulpotomy, or partial pulpotomy. Pulp capping is only appropriate for crown fractures with limited pulpal exposure and when treatment occurs promptly following the traumatic incident.[3] Cervical pulpotomy requires removal of all coronal pulp tissue, leaving only radicular pulp and no physiological apposition of dentin in the coronal area, thereby increasing the risk of cervical fracture.[2,11,12] By contrast, partial pulpotomy removes only that part of the coronal pulp adjacent to the exposure,[11] preserving the cell-rich coronal pulp tissue required for better healing as well as physiological apposition of dentin in the coronal area.[2,11,12] Given the inherent limitations of pulp capping and the disadvantages of cervical pulpotomy, the three cases presented here were treated with partial pulpotomies.

Calcium hydroxide and Mineral Trioxide Aggregate have long been used in partial pulpotomies to treat complicated crown fractures.[2,4,13-16] Whereas calcium hydroxide suffers from lack of adhesion and is degraded by acid-etching,[17] Mineral Trioxide Aggregate possesses low solubility, low cytotoxicity, good tissue biocompatibility and the ability to induce mineralized tissue formation;[18] however, Mineral Trioxide Aggregate also possesses

Figure 3. Initial appearance of complicated crown fracture in the maxillary left central incisor a) Intraoral appearance b) Radiographic appearance

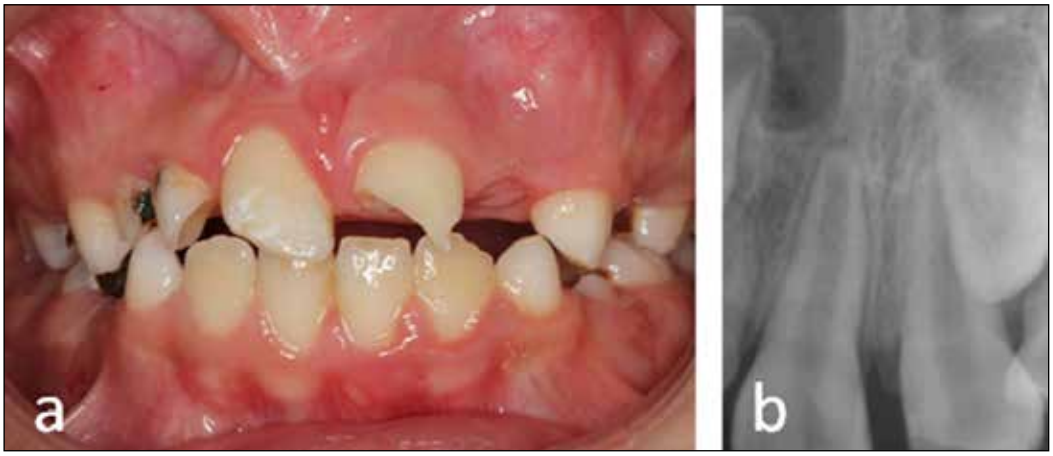
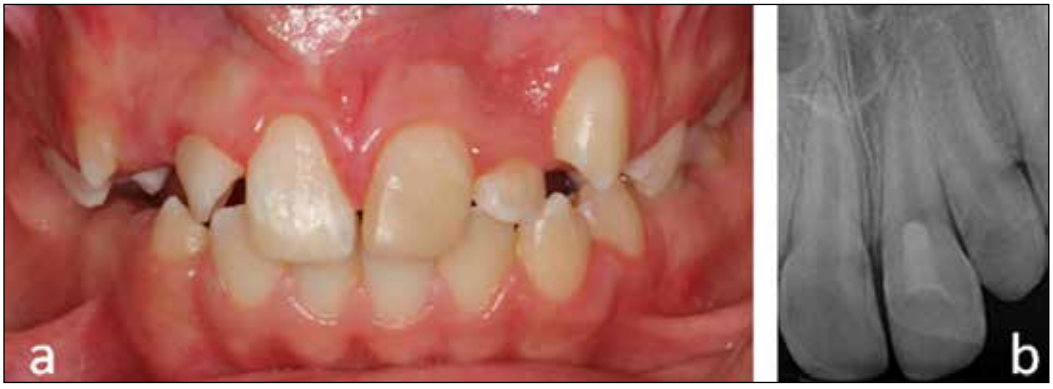


Figure 4. Appearance of case 2 after 24 months a) Intraoral appearance b) Radiographic appearance



several undesirable characteristics, such as long setting time,[19] difficulties in manipulation and insertion,[20] high costs[21] and potential discoloration.[4,16]

Recently, calcium silicate-based nano-particles sized bioceramic material, BioAggregate has been introduced with the intention of preserving the properties and clinical applications of Mineral Trioxide Aggregate without its negative characteristics. BioAggregate is composed of tricalcium silicate, dicalcium silicate, tantalum pentoxide, calcium phosphate monobasic, hydroxyapatite, and amorphous silicon dioxide.[7,8] BioAggregate is also aluminum-free content, a fact that contributes to its greater biocompatibility.[7,22-24] Moreover, the variuos advantages of BioAggregate include easy of application and manipulation; working time is more than 5 minutes and convenient setting time,[8] higher fracture strength,[9] better sealing ability[25,26] and acidic resistance[27] than Mineral Trioxide Aggregate. While indications for dental use are similar between Mineral Trioxide Aggregate and BioAggregate, to date there have been no reports on the use of BioAggregate in partial pulpotomy.

In the three cases presented here, in which BioAggregate was used as partial pulpotomy material in the treatment of fractured teeth with incomplete apex formation, recall examinations showed the treatment to be successful in preserving pulp vitality and securing ongoing root development. Moreover, no coronal discoloration was observed. In contrast, some authors have reported coronal discoloration after partial pulpotomy with Mineral Trioxide Aggregate,[4,16,28] which has been attributed to the metal oxides (Bi_2O_3, Al_2O_3, FeO) contained in the material.[29,30] Unlike Mineral Trioxide Aggregate, BioAggregate contains no metal oxides,[7,8] which could explain the lack of coronal discoloration in these cases.

CONCLUSION

BioAggregate may be considered a suitable alternative to Mineral Trioxide Aggregate for use in the management of complicated crown fractures treated by partial pulpotomy. However, further long-term clinical studies are needed to provide a more definitive assessment of BioAggregate.

Figure 5. Initial appearance of complicated crown fracture in the maxillary left central incisor a) Intraoral appearance b) Radiographic appearance

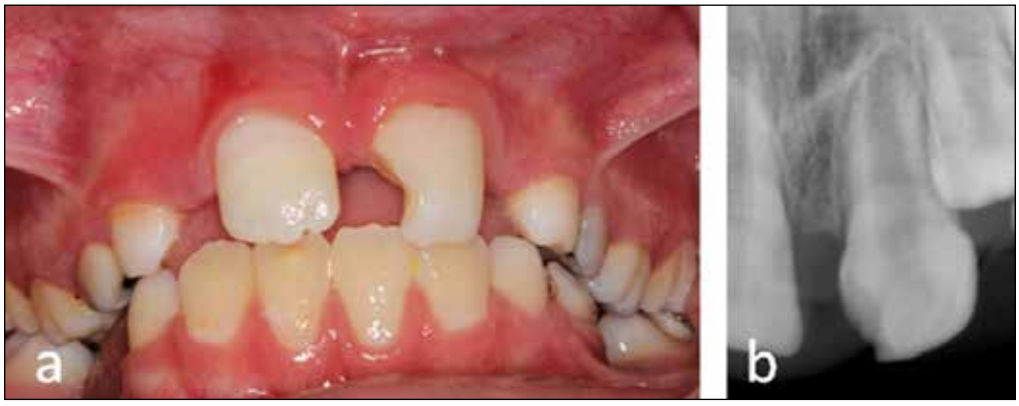
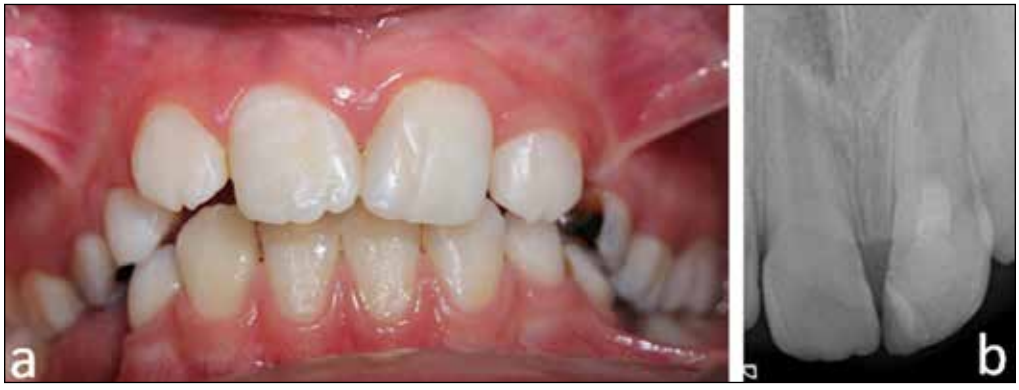


Figure 6. Appearance of case 3 after 24 months a) Intraoral appearance b) Radiographic appearance



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