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CASE REPORT

APEXIFICATION USING BIODENTINE IN POST-AVULSION MAXILLARY CENTRAL INCISOR

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ABSTRACT

Introduction: *Permanent tooth avulsions occur in 0.5%–16% of all dental injuries. Treatment for avulsions includes replantation followed by root canal treatment to reduce extraoral dry time and achieve a good prognosis. Avulsions in permanent teeth obstruct vascular circulation, leading to necrosis. Necrosis in immature permanent teeth results in incomplete apical closure. Such cases require apexification treatment to ensure a hermetic root canal treatment. The purpose of this case report is to describe apexification treatment for an avulsed immature maxillary central incisor using Biodentine.* ***Case and Management:*** *This case report describes the case of a 12-year-old boy with a complaint of a loose tooth due to a fall, 3 hours before arriving at RSGM Prof.Soedomo UGM. The patient arrived with the tooth soaked in saline. The socket was cleaned followed by replantation and splinting for 4 weeks. Four weeks later, root canal treatment and apexification using Biodentine were performed. The patient was instructed to return for a follow-up after six months. The results of clinical and radiographic examinations showed good filling, no root resorption, and no complaints from the patient.* ***Discussion:*** *Apexification is a method for creating a calcification barrier on non-vital teeth with open apices. In this case, a one-step apexification procedure was performed to obtain an apical plug using Biodentine. Biodentine exhibits excellent biocompatibility, hydrophilic properties, greater sealing ability, and shorter setting times.* ***Conclusion:*** *Biodentine can be used for apexification treatment of avulsed immature teeth and has demonstrated good efficacy in forming an apical barrier.*

Keywords**:** *apexification, avulsion, biodentine, immature tooth, open apex*

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INTRODUCTION

Dental trauma frequently affects children and young adults, with approximately 25% of school-aged children and 33% of adults reported to have experienced trauma to their permanent dentition.[1] One severe consequence of such trauma is avulsion, the complete displacement of a tooth from its alveolar socket. Avulsion accounts for 0.5%–16% of all permanent tooth injuries, most commonly involving immature anterior teeth in the maxilla.[2] Immediate replantation is considered the standard of care to

minimize extraoral dry time and improve prognosis.[3]

Following avulsion, the disruption of blood supply through the apical foramen often leads to pulp.[4] Concurrently, detachment of the periodontal ligament from the alveolar socket, combined with the effects of extraoral exposure, results in damage to the cemental surface and periodontal membrane.[5,6]

In immature permanent teeth, pulp necrosis can arrest root development, leaving an open apex and necessitating apexification to induce apical closure. This procedure may be performed using various biomaterials, including calcium hydroxide, mineral trioxide aggregate (MTA), or Biodentine.[7,8]

CASE AND MANAGEMENT

A 12-year-old male patient presented to the Emergency Department of Prof. Soedomo UGM Dental Hospital, accompanied by his parents, reporting avulsion of the maxillary central incisors (teeth 11 and 21) approximately three hours prior. The injury occurred after the patient was pushed from behind in the classroom, resulting in a forward fall onto the floor. Upon arrival, the patient brought the avulsed teeth, which had been stored in normal saline.

The patient was in good general condition, fully conscious (compos mentis), and exhibited no lymphadenopathy. Oral hygiene was moderate, with an Oral Hygiene Index–Simplified (OHI-S) score of 2. Intraoral examination revealed avulsed sockets of teeth 11 and 21, filled with blood clot and surrounded by gingival edema (Figure 1). The avulsed teeth were clean and free of debris, with intact root surfaces (Figure 2). No dentoalveolar fractures were observed.

Figure 1. Post-avulsion intraoral conditions

Figure 2. Avulsed 11 and 21 in saline solution

Prior to initiating treatment, the planned procedure was thoroughly explained to the patient's parents. Written informed consent was obtained following a comprehensive discussion of the risks, benefits, and alternatives.

During the initial visit, the sockets of teeth 11 and 21 were gently curetted to remove residual granulation tissue. The avulsed teeth were then carefully repositioned in their respective sockets using light digital pressure until fully seated. The patient was guided to close into occlusion to facilitate proper repositioning. A semi-rigid splint was fabricated using a 0.4-mm stainless steel wire extending from tooth 14 to 24, which

was bonded to the facial surfaces of teeth 14, 12, 11, 21, 22, and 24 with composite resin. To provide additional soft tissue adaptation and stabilization, simple interrupted sutures were placed at the distal papilla of tooth 11, the interdental papilla between teeth 11 and 21, and the distal papilla of tooth 21 (Figure 3).

Post-operative instructions included maintaining oral hygiene with a soft-bristled toothbrush and adhering to a soft diet for two weeks. The prescribed medications were amoxicillin 500 mg three times daily, methylprednisolone 8 mg three times daily, and paracetamol 650 mg as needed for pain. A follow-up appointment was scheduled for four weeks later.

Figure 3. Replantation of avulsed 11 21 and fixation with *flexible wire-composite splints*.

A follow-up clinical and radiographic examination was conducted four weeks after the splint placement. The gingival margins surrounding teeth 11 and 21 appeared healthy, with no clinical signs of inflammation or infection (Figure 4). Radiographic evaluation revealed slightly open apices and the presence of periapical radiolucencies associated with both teeth. No evidence of external or internal root resorption was observed (Figure 5). Root canal therapy was initiated on both teeth. The patient was scheduled for a subsequent appointment in one week to proceed with apexification procedures and final obturation.

Figure 4. 11 21 four-weeks post-splinting procedure

Figure 5. Dental radiograph 11 21 after replantation

At the subsequent visit, one-step apexification was performed using Biodentine (Septodont, USA). The material was introduced via the MAP System and carefully condensed to form a 4–5 mm apical plug, thereby creating an adequate apical stop. Obturation was then completed with gutta-percha using the warm vertical compaction technique in conjunction with a bioceramic sealer (CeraSeal,

Meta-Biomed). An orifice barrier was placed with resin-modified glass ionomer cement (Fuji II LC, GC), and the access cavity was sealed with a provisional restoration (Caviton, GC). Post-operative radiographs were taken after Biodentine placement (Figure 6) and following final obturation (Figure 7).

Figure 6. Post-application radiograph *of biodentine* as *an apical plug*

Figure 7. Post-filling radiograph with gutta percha

The patient was scheduled for a one-week follow-up appointment after obturation for definitive restoration with a packable nanofiller composite resin (Palfique Tokuyama) (Figure 8). A final radiograph was then taken to evaluate the restoration (Figure 9).

A

B

Figure 8. Restoration with resin composite labial (A) and palatal (B)

Figure 9. Radiograph after restoration with resin composite

At the six-month follow-up after the apexification procedure, the patient reported no

symptoms and remained asymptomatic. Clinical examination revealed that teeth 11 and 21 were stable within the arch, with no evidence of intrusion, extrusion, or occlusal disturbance. The surrounding gingiva appeared healthy, with no clinical signs of inflammation, infection, or pathological mobility (Figure 10). Radiographic evaluation demonstrated a stable periapical condition with no signs of root resorption or other pathological changes (Figure 11). The patient was advised to continue maintaining good oral hygiene, refrain from biting on hard objects, and scheduled for a subsequent follow-up evaluation in six months.

Figure 10. Clinical appearance 6 month after treatment

Figure 11. Dental radiograph 6 month after treatment

DISCUSSION

Traumatic dental injuries may result in avulsion, the complete displacement of a tooth from its alveolar socket. Avulsion occurs more frequently in permanent dentition, with a reported prevalence ranging from 0.5% to 16%, most commonly involving the maxillary anterior teeth.[2,9] The primary treatment for an avulsed tooth consists of immediate replantation followed by splinting to stabilize the tooth.[3] Adjunctive antibiotic therapy is recommended in cases where the avulsed tooth has been contaminated—for instance, after contact with the ground—to prevent or manage infection and reduce the risk of inflammatory root resorption.[1] Additionally, the administration of anti-inflammatory medication such as methylprednisolone may be beneficial in minimizing post-traumatic edema.[10]

Immediate replantation is critical to minimize further injury to the periodontal ligament and supporting tissues. In immature permanent teeth, a primary objective of replantation is to create conditions conducive to possible pulp revascularization.[4] However, pulpal necrosis is a nearly inevitable sequela of avulsion, even following prompt replantation, thereby necessitating subsequent root canal therapy. Radiographic assessment of a necrotic, immature tooth typically reveals an open or divergent apex, a condition for which apexification is the indicated treatment.[9,11]

The prognosis following tooth avulsion is largely determined by the duration of extraoral dry time. In the present case, this interval exceeded 60 minutes, a delay associated with a poor long-term prognosis. Following extended extraoral exposure, the periodontal ligament

typically undergoes necrosis and is unlikely to regenerate, which can subsequently lead to complications such as ankylosis or replacement resorption. The primary rationale for replantation in such delayed scenarios is to preserve the tooth within the oral cavity for as long as possible, thereby restoring aesthetics and maintaining alveolar bone contour, width, and height. Consequently, the decision to replant a permanent tooth, even with an extraoral dry time greater than 60 minutes, remains a sound clinical choice. It is, however, imperative to counsel patients that replanted teeth are at significant risk for complications including ankylosis, resorption, and infraposition, the progression of which can be highly variable and unpredictable.[3,9]

Apexification is defined as a procedure to induce the formation of a calcified barrier at the apex of a non-vital tooth with incomplete root development.[8,9] The goal is either to stimulate closure of the apical third of the root canal or to create a stable artificial apical plug that permits adequate obturation of the canal space. This treatment can be performed in a single visit or across multiple visits. Among the materials used for apexification, calcium hydroxide ($Ca(OH)_2$) remains one of the most common, particularly in multi-visit protocols. It functions both as an antimicrobial agent and as a stimulant for apical hard-tissue formation. Its prolonged antimicrobial effect is attributed to its high pH and low solubility, which allow it to maintain an alkaline environment within the canal over an extended period.[12]

Despite these advantages, the time required for calcium hydroxide to stimulate a calcified apical barrier is highly variable, ranging from several months to over a year. Although multi-visit apexification is often completed within six months, treatment may extend to two years in some cases. Prolonged use of calcium hydroxide also presents a clinical disadvantage, as it can weaken dentinal structure and increase the risk of root fracture.[9,12]

In the present case, a single-visit apexification was performed using Biodentine to create an apical plug. Biodentine is a calcium silicate-based material widely used in perforation repair, resorption defects, and apexification. It is considered bioactive due to its excellent biocompatibility and tissue-healing properties. Its adhesive capacity surpasses that of mineral trioxide aggregate (MTA), and it offers a relatively short setting time of approximately 9–12 minutes, owing to the inclusion of calcium chloride as an accelerator and a hydrosoluble polymer as a water-reducing agent. These characteristics make Biodentine particularly suitable for single-visit apexification. Furthermore, Biodentine demonstrates greater mechanical strength, improved erosion resistance, and reduced microleakage compared with MTA.[13-15]

Recent evidence supports the use of Biodentine in apexification. Khrisna Prasada et al. (2025) reported that Biodentine achieves better adaptation over time than MTA, with reduced porosity and compressive strength comparable to dentin within one month. The material also produced favorable clinical and radiographic outcomes, including periapical lesion healing.[16] Similarly, Aeren et al. (2021) found that Biodentine exhibited the least

microleakage when used as a retrograde filling material compared with glass ionomer cement and MTA.[17]

When used as an apical plug, Biodentine forms a barrier that closely resembles natural dentin and can produce tag-like crystalline structures within dentinal tubules, enhancing micromechanical retention.[13].[14] Due to its biocompatibility, hydrophilicity, sealing ability, and favorable setting characteristics, Biodentine is regarded as a preferred material for single-visit apexification procedures.[18]

CONCLUSION

The management of avulsed teeth with pulpal necrosis and open apices using Biodentine for apical barrier formation demonstrates favorable clinical outcomes, supporting its use as an effective contemporary alternative in apexification procedures.

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