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Revascularization of an Immature Three Rooted First Mandibular Molar Using Concentrated Growth Factor: A Case Report

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Regenerative endodontic procedures (REPs) have emerged as a biologically driven approach for managing immature teeth with necrotic pulp and open apices, providing an alternative to traditional apexification techniques. This case report describes the successful treatment of a three-rooted immature mandibular first molar with necrotic pulp and chronic apical periodontitis in a 9-year-old patient using REPs. The treatment followed the guidelines set by the American Association of Endodontists and utilized a two-visit protocol. Concentrated growth factor (CGF) was employed as a biological scaffold in the root canals, while calcium-enriched mixture (CEM) cement was used for the coronal seal. Radiographic evaluations conducted at 6, 12, and 15 months revealed progressive periapical healing, significant root elongation, increased thickness of the root walls, and partial apical closure. Clinically, the patient remained asymptomatic during all follow-ups. This case highlights the potential of CGF and CEM cement-enhanced REPs to promote continued root development and achieve predictable outcomes in immature teeth with necrotic pulps, offering a biologically based alternative to conventional apexification.

Keywords: Root regeneration; Regenerative endodontics; Tooth apex; Nonvital tooth

Introduction

Treating immature teeth with open apices remains a complex and evolving challenge in pediatric dentistry and endodontics. Traditional methods, such as apexification using calcium hydroxide or mineral trioxide aggregate (MTA), have been widely used to induce root development and closure [1-3]. However, these techniques often fail to restore the vitality of the dental pulp and promote continued root maturation [4]. Many regenerative endodontic treatments (REPs) fail, and retreatment of such cases is challenging. Due to the high failure rate in such cases, we need to find a successful regeneration method [5]. In a recent study by Lee *et al*., the most common reasons for these failures are root resorption and persistent infection within six months of treatment [6].

Immature teeth with open apexes are particularly vulnerable to trauma and infection, leading to complications in conventional endodontic treatments [7, 8]. While effectively creating a barrier at the root tip, Apexification does not facilitate further root growth or reinforce the tooth's structural integrity [9, 10]. Apical regeneration, on the other hand, harnesses the principles of REPs, utilizing biological scaffolds, stem cells, and growth factors to promote the development of a functional, vital pulp-dentin complex [11]. This regenerative approach holds the promise of preserving the tooth and ensuring its continued growth and development, which is critical for young patients [12]. Since it has been witnessed that concentrated growth factor (CGF) has induction properties, we decided to use it as a material to induce the differentiation of stem cells into odontoblasts [13]. Also, calcium-enriched mixture (CEM) cement (BioniqueDent, Tehran, Iran) was used for the coronal seal due to its well-documented favorable properties [14, 15]. Evidence from the literature highlights CEM cement's significant potential in enhancing REPs [14, 16].

In this case, we report a successful REP of a three-rooted mandibular first molar with open apices in a 9-year-old girl who showed chronic apical periodontitis in diagnostic radiographs, which was done with CGF and CEM cement.

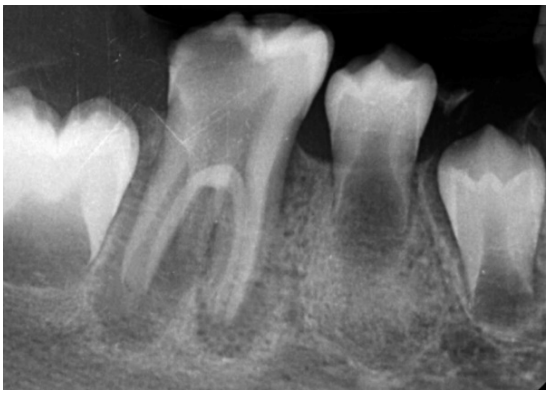

Figure 1. Preoperative radiograph of tooth #30 showing apical radiolucencies in mesial and distal roots, incomplete root development, and the presence of a third root (radix entomolaris)

Case Presentation

A 9-year-old female patient with a chief complaint of pain on chewing in the mandibular right first molar area was referred to the endodontics department of Shahid Beheshti Dental School. The patient claimed, "My tooth aches while chewing food." Medical history was standard, and the patient was categorized as ASA I. The patient was not under any medication. In clinical examination, tooth N #30 did not respond to the cold and electric pulp tests. The tooth was tender on palpation and percussion. The periodontal probing and mobility were normal. During radiographic evaluations, apical radiolucency was noted in the periapical area of mesial and distal roots (Figure 1). Due to apical lesions, both mesial and distal roots were not completely developed. The radiographic examination also showed the presence of the third root, radix entomolaris. The pulp and periapical condition diagnosis were noted as pulpless and infected for pulp and "chronic apical periodontitis" for the periapical area.

The crown was restorable, and the tooth's prognosis was good; hence, after discussing treatment methods with the patient's parents (Apexification, pulp revascularization, and extraction), apical revascularization was selected as a treatment plan. Written consent was obtained from patients. The revascularization procedure was conducted according to the American Association of Endodontics (AAE) guidelines.

In the first visit, local anesthesia by Inferior alveolar nerve block (IANB) by 1.8 mL of 2% lidocaine with 1:80,000 epinephrine was administered. (Darupakhsh Co./Tehran/Iran). The buccal mucosa of the discussed tooth was anesthetized by buccal infiltration of 0.5 mL of 2% lidocaine with 1:80,000 epinephrine. The noted tooth was isolated using a rubber dam and a universal molar clamp. An access cavity was prepared. Working length was estimated by periapical radiograph due to the lack of accuracy in using an apex locator in open apex teeth. Minimal mechanical preparation of the canal was done using a #30 Hedstrom with sweeping circumferential movement to disorganize existing biofilm structures on dentinal walls. Chemical irrigation was achieved using 20 mL of 1.5% sodium hypochlorite using a #30-gauge side-vented needle 1 mm shorter than the estimated working length (Canal clean; Biodent, Korea). As the final irrigation, 20 mL EDTA of 17% was used for each canal. The canals were dried with sterile paper points, and calcium hydroxide mixed with normal saline with a creamy texture was used as canal medicament. (Golchadent/Tehran/Iran) A sterile Teflon pellet and Zinc Oxide Eugenol cement were used as the temporary restoration. (Nikdarman, Tehran, Iran) The patient was recalled after three weeks.

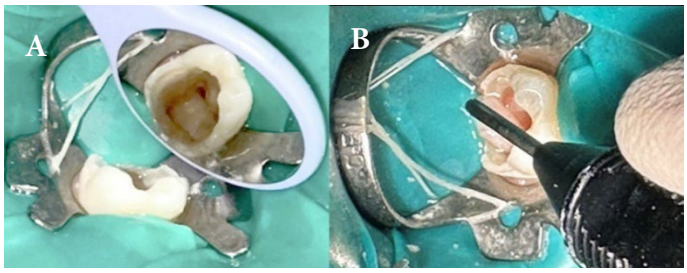

Figure 2. *A*) Preparing access cavity; *B*) Placement of CGF in the root canals

The patient was clinically evaluated, and no signs of infection were seen; the patient reported no symptoms. According to AAE guidelines, 3% mepivacaine without vasoconstrictor was used as the local anesthesia. After administering local anesthesia by the inferior alveolar nerve block, rubber dam isolation was performed, and the temporary restoration was removed. The calcium hydroxide was eliminated from canals by gentle irrigation with 20 ml of 17% EDTA per canal. The canals were dried using paper points. 10 mL of the patient's blood sample was drawn into a non-anticoagulant tube. Then, concentrated growth factor (CGF) was centrifuged at different rpm for 15 minutes, which mainly consisted of 2600 rpm for 4 mins and 2850 rpm for 3 mins. (MEDIFUGE, Silfradent, S.Sophia (FC)-ITALY) After this procedure, three distinct layers appear: the serum layer at the uppermost, the CGF/PRF layer at the middle, and red blood cells at the bottom. The middle layer was separated and transmitted into the compression box to make the membrane form CGF. The CGF membrane was cut into a suitable size to match the root canal.

CGF was placed in the canals (Figure 2). In the coronal third, all three canals were covered with a 3 mm thick CEM cement. 3 mm of Cavit was used as the temporary restoration (3M, Germany). The patient was referred to the restorative department for permanent composite restoration, and post-operative instructions were given.

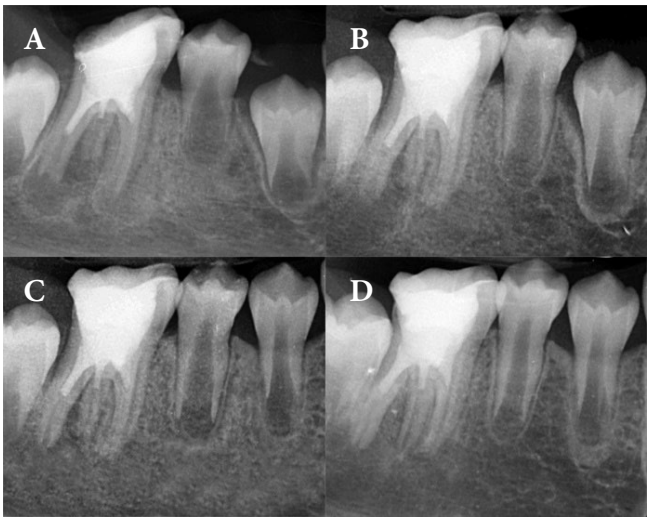

Figure 3. *A*) Immediate post-operative radiograph; *B-D*) Follow-up radiographs at 6-, 12-, and 15-months post-treatment, respectively, showing progressive healing of periapical radiolucency and improvement in root development

The patient was recalled for follow-up examinations in 6, 12, 15 months and was evaluated clinically and radiographically. There were no signs of infection, swelling, or sinus tract. The patient reported no symptoms of pain and discomfort with tooth N#30. The tooth was not tender in terms of percussion and palpation. The probing depth was standard. In a 6-month follow-up appointment, radiographic evaluations showed significant periapical healing. In the 12 and 15-month recall sessions, periapical radiolucency was almost completely healed (Figure 3). Improvements in the lengths and thickness of all three roots were reported radiographically. The apex of the mesial root was almost closed. The distal root's apexes were not still fully closed but significantly smaller in size. The tooth showed a negative response to sensibility tests. According to these findings, a favorable long-term prognosis for this tooth is estimated.

Discussion

This case demonstrates the effective use of REPs in treating a 9-year-old female patient experiencing pain in the mandibular right first molar while chewing. Apical radiolucency was observed around the periapical areas of the mesial and distal roots, which was a sign of apical lesions and incomplete root development.

Several considerations impacted the decision to use REP. While apexification is a possible choice, it requires prolonged treatment durations and poses a risk of root fractures due to the presence of thin walls of dentin [17]. In contrast, REP endeavors to reestablish the pulp-dentin complex's standard structure and function, thereby facilitating the continued growth of the root and the closure of the apex. This method aligns with current trends that prefer biological solutions over mechanical ones in endodontics [18].

The clinical procedure adhered to rigorous guidelines for REPs. During the initial appointment, thorough mechanical cleaning and irrigation were done to eliminate necrotic tissues while preserving the remaining root structure [19].

Calcium hydroxide was employed as an intracanal medicament for disinfection of the canals between two sessions; disinfection is crucial for REPs [20, 21]. Althumairy *et al*. reported that using calcium hydroxide for disinfection, unlike antibiotics, leads to more SCAP cell survival [22]. also, according to a meta-analysis by Báez *et al*., calcium hydroxide resulted in more apical closure than triple antibiotic paste [23]. Irrigants are chosen based on bacteriostatic or bactericidal properties and stem cell survival [24]. 17% EDTA promotes dentin-derived growth factors, while 2% chlorhexidine is cytotoxic [13]. The calcium hydroxide was removed during the second visit, and the dentinal walls were irrigated with 17% EDTA. This irrigation method helps release growth factors important for the REPs [25].

In recent studies, there has been an increase in the use of CGF in different treatments, such as dental implants, surgical endodontics procedures, and sinus ridge augmentation [13]. In this case, the application of CGF for the regeneration process was an important step in the treatment. CGF's environment is filled with molecules that cause stem cells to differentiate into odontoblast-like cells [26]. CGF has a specific 3-dimensional microstructure with a high concentration of nucleated cells and platelets. The expression of various growth factors like TGF-B1, bFGF, VEGF, PDGF-BB, and IFG-1 was reported after the implication of CGF. It has been shown that CGF can enhance the proliferation, differentiation, and migration rate of SCAPs and could be a promising material in REPs [27].

CEM cement was chosen as the capping material due to its proven clinical effectiveness [28]. Its sealing ability is comparable to MTA, with favorable outcomes reported in vital pulp treatments [3, 29, 30]. CEM cement has been widely used in various procedures, including REPs, apical microsurgery, vital pulp therapies, management of complications such as perforations, treatment of root resorption, and as an apical plug/barrier [31, 32]. Compared to MTA, CEM cement offers several advantages, such as a shorter setting time, better-handling properties, improved flowability, and reduced film thickness. Moreover, as highlighted in the literature, CEM

cement exhibits excellent biocompatibility, the ability to form hydroxyapatite, promotes osteogenesis, dentinogenesis and cementogenesis, and possesses inherent antimicrobial properties [33-37]. A systematic review comparing MTA and CEM cement found superior outcomes for CEM in pulpotomy procedures for both primary and permanent teeth [38]. These properties and clinical evidence strongly support the selection of CEM cement for this case.

The post-operative outcomes were positive, with notable improvements in clinical and radiographic measures reported throughout the follow-up. The patient was asymptomatic, with indications of ongoing root development and apical closure. Subsequent follow-ups conducted six, twelve, and fifteen months after therapy demonstrated continued healing and regeneration, verifying the efficacy of REPs in this particular instance.

The study received ethical approval, and the patient's parents were well-informed about the treatment options and potential outcomes. The treatment decisions made have significant long-term effects on oral health. Hence, transparency and a patient-centered approach are crucial in pediatric endodontics [39].

This case shows the ability of REPs to make positive changes in pediatric dentistry. Compared to conventional approaches, the capacity of routine healing and growth processes in underdeveloped teeth signifies a substantial progression. Adhering strictly to established protocols and continuous research and clinical trials is essential for further improving the efficacy of these procedures [40].

Conclusion

This case suggests that the application of CGF in necrotic pulp with open apices holds promise as a potential method for REPs.

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Conflict of interest
None.

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Authors' contributions
Conceptualization: MF/MM, Methodology: MF/MM, Formal analysis and investigation: MM, Writing-original draft preparation: AG/MM, Writing-review and editing: MF/MM/AG, Supervision: MF/MM. All authors read and approved the final manuscript.

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