Received date: 21 November 2024 / **Accept date:** 03 January 2025
DOI: 10.61139/ijdor.1589194

Regenerative Endodontic Treatment of Immature Permanent Tooth With Necrotic Pulp: Case Report

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Abstract

Regenerative endodontic therapy represents an innovative treatment approach designed to restore the physiological functions of the pulp-dentin complex and facilitate continued root development in immature teeth with necrotic pulp. This method holds promise for reducing the risk of fractures in immature teeth by encouraging the thickening of the root canal structures and facilitating ongoing root development. This case report details a 24-month follow-up of an immature permanent tooth with necrotic pulp managed using a regenerative endodontic treatment approach. As part of the regenerative endodontic treatment protocol, 1.5% sodium hypochlorite and 17% ethylenediaminetetraacetic acid were used as irrigation solution, and a dual antibiotic paste (1:1 ciprofloxacin: metronidazole) was applied as intracanal medication. Following the induction of bleeding into the root canal, mineral trioxide aggregate was placed as a coronal plug over the formed blood clot, and the tooth was subsequently restored with composite resin material. At the 24-month clinical and radiographic assessment, the tooth exhibited a favorable response to cold and electric pulp testing, with no signs of sensitivity upon percussion or palpation. Periapical radiographs showed resolution of the periapical lesion and indicated ongoing root development. In conclusion, regenerative endodontic therapy offers a promising substitute for traditional apexification, particularly for immature permanent teeth, by promoting the thickening of the root canal structures and supporting the restoration of the tooth's physiological function.

Case Report (HRU Int J Dent Oral Res 2025; 5(1): 40-44)

Keywords: Immature tooth, MTA, necrotic pulp, regenerative endodontic treatment.

Introduction

Both traditional apexification using calcium hydroxide and apical plug formation with mineral trioxide aggregate (MTA) are common methods for managing immature permanent teeth with necrotic pulp. Both techniques aim to create a hard apical barrier but are limited in fostering continued root development. Calcium hydroxide requires prolonged treatment and may weaken the root dentin, increasing the risk of fractures [1]. Apical plugging using MTA involves fewer visits and creates a rapid apical barrier; however, this technique does not facilitate the thickening of the root canal walls or encourage continued root growth. As a result, it can increase the tooth's fragility and elevate the risk of long-term failure [2, 3]. These challenges have spurred interest in alternative treatment approaches that foster biological root growth, such as regenerative endodontic therapy, for the management of immature permanent teeth with necrotic pulp that have not yet completed apex development. Regenerative endodontic treatment can stimulate both root growth and the thickening of root canal walls, thereby enhancing the biomechanical strength of the tooth and promoting long-term success. Regenerative endodontic treatment has been developed to facilitate the repair and regeneration of the pulp-dentin complex. It involves minimal or no instrumentation, intra-canal disinfection using various

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irrigation solutions and medicaments, followed by the placement of MTA or bioceramic-based cement over the blood clot formed by inducing bleeding into the root canal, and finalizing the treatment with coronal restoration [4-6]. In light of this information, this case report presents the clinical and radiographic outcomes of a 24-month follow-up of an immature permanent tooth with necrotic pulp treated using regenerative endodontic therapy.

Case

A 23-year-old male patient was referred to the endodontics clinic due to a fractured restoration on his right upper central incisor. From the anamnesis, it was learned that the patient fell and fractured his right upper central incisor when he was 8-9 years old, then the fractured part was restored with composite resin by a dentist and he had no complaints of pain, swelling, etc. until now. Clinical examination revealed no response to cold or electric pulp tests, and the composite restoration was fractured (Figure 1). Radiographic analysis showed a radiolucent periapical area and incomplete apical root development (Figure 2). The tooth was diagnosed with pulp necrosis and chronic apical periodontitis. Treatment risks and alternative treatments were explained to the patient. Conventional root canal treatment and regenerative endodontic treatment options were presented. Regenerative endodontic treatment was decided as the treatment plan. Informed consent form was obtained from the patient. During the first appointment, local anesthesia was administered, and access was gained under rubber dam isolation (Figure 3). The working length was established using an electronic apex locator and radiographic verification. No preparation was performed, and the canal was irrigated with 1.5% sodium hypochlorite and saline. Irrigation was performed using an irrigation needle (Steri Irrigation Tips, Diadent, Cheongju, Korea) with a closed side port, positioned 1 mm short of the apex. A dual antibiotic paste (1:1 ciprofloxacin: metronidazole) was placed, and the cavity was sealed temporarily. The access cavity was provisionally sealed using glass ionomer cement. Three weeks later, on the second visit the patient presented without any symptoms. Local anesthesia with 3% mepivacaine (epinephrine-free) was administered, and rubber dam isolation was achieved. Upon removal of the temporary restoration, the root canal was irrigated with 17% ethylenediaminetetraacetic acid (EDTA) aqueous solution, followed by saline to eliminate the medicament. A K-type file with an anterior beveled tip was advanced 2 mm beyond the apical foramen and rotated to induce bleeding into the root canal. A sterile cotton pellet was used to tamponade the bleeding for 10-15 minutes to stop the bleeding and ensure clot formation. MTA (Angelus Soluções Odontológicas, Londrina, Brazil) in powder-liquid form was mixed and prepared on a mixing pad with the help of a spatula and placed on the blood clot with a thickness of 3-4 mm. After allowing MTA to cure for 15 minutes, the access cavity was sealed with glass ionomer cement and composite (Figure 4). The tooth was referred for restorative treatment. After 3 and 6 months, the tooth remained asymptomatic, and radiographs showed a significant reduction in the periapical lesion (Figures 5 and 6). At the 24-month follow-up, the tooth responded positively to pulp tests, exhibited no sensitivity to percussion or palpation, and showed root development with periapical healing (Figure 7).

Figure 1. Preoperative Intraoral Photograph

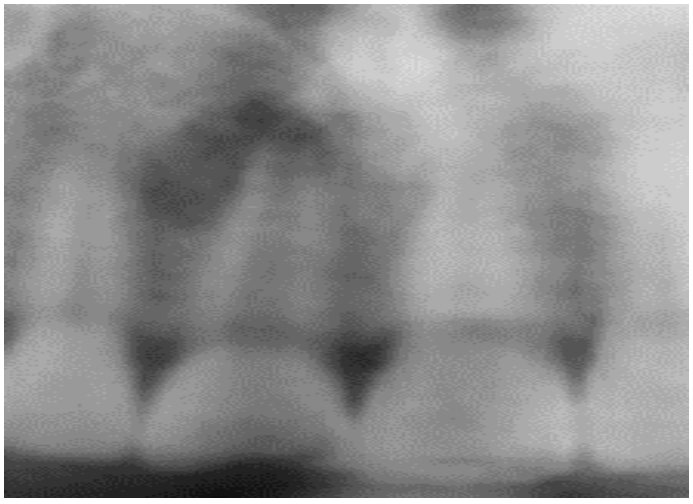

Figure 2. Preoperative Periapical Radiograph

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Figure 3. Rubber Dam Application and Endodontic Entry Cavity Preparation

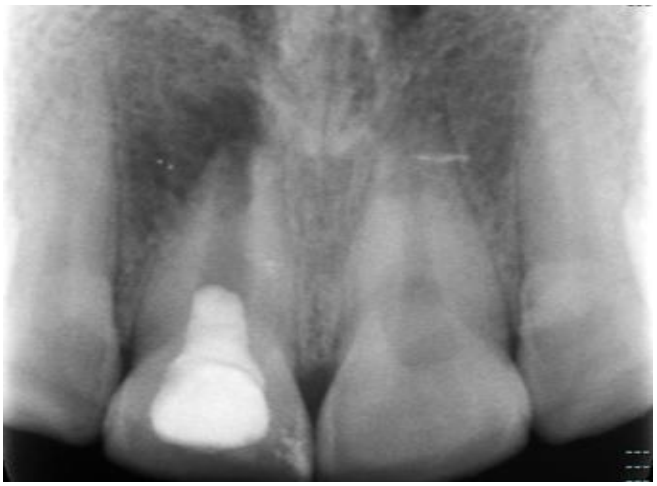

Figure 4. Radiograph taken after the 2nd Session MTA Application

Figure 5. 3rd Month Radiography

Figure 6. 6rd Month Radiography

Figure 7. 24rd Month Radiography

Discussion

This case report evaluates the regenerative endodontic treatment and 24-month follow-up results of an immature permanent tooth with early pulp necrosis and periapical lesions caused by trauma. While apexification and apexogenesis treatments primarily focus on creating a hard tissue barrier at the apical region of the tooth, regenerative endodontic treatment fosters the repair of both dentin and pulp tissues. This makes it possible to thicken the root canal walls and promote apical closure. Furthermore, regenerative endodontic treatment is becoming a more attractive treatment option because it can be performed in shorter sessions and a better biological response can be achieved [7]. In regenerative endodontic treatment procedures, in immature permanent teeth, mechanical preparation may

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cause brittleness due to incomplete root development and the thin structure of the dentin walls; therefore, the root canal walls cannot be cleaned with mechanical instruments as in conventional root canal treatment. Hence, low concentrations of sodium hypochlorite, EDTA, and especially biocompatible disinfectants are preferred as antimicrobial irrigation solutions for root canal disinfection in regenerative endodontic treatment applications [8]. The guidelines provided by the 'European Society of Endodontology' and the 'American Association of Endodontists (AAE)' widely endorse the use of a triple antibiotic paste, composed of ciprofloxacin, metronidazole, and minocycline, as an intra-canal medication to eradicate infection within root canals in cases of regenerative endodontic treatment [4, 9]. Since root canal infections are polymicrobial in nature, it is usually not possible to eliminate all pathogens with only one antibiotic. Therefore, the combination of metronidazole, ciprofloxacin and minocycline can help to successfully control infections in the root canal system by providing an effective antimicrobial spectrum against both aerobic and anaerobic bacteria [10, 11]. However, minocycline in the triple antibiotic paste may cause discolouration, especially in the coronal region of the tooth [12, 13]. Some researchers suggest removing minocycline from the paste or using different antibiotics to prevent coronal colouration [14, 15]. Calcium hydroxide ($Ca(OH)_2$) may also be preferred as an alternative to triple antibiotic paste, although there is no definite protocol on the choice of medicament. Calcium hydroxide is an alternative medication that can be used in this situation, but some previous studies have reported better antibacterial activity and a higher rate of root wall thickening with antibiotic paste [16, 17]. In this case, dual antibiotic paste (1:1 ciprofloxacin: metronidazole) was used as an intracanal medication considering that minocycline causes tooth discolouration.

To support the survival of stem cells, it is recommended to use 17% EDTA as part of the irrigation protocol [9]. It is suggested that the use of 17% EDTA in the final irrigation plays an important role in reducing the negative effects of NaOCl, which has a destructive effect on tissues [18]. EDTA also contributes to root development by promoting the release of growth factors from dentin [19, 20]. For these reasons, 1.5% NaOCI and 17% EDTA were used as irrigation solutions in this case.

The formation of a blood clot that serves as a tissue scaffold within the root canal is critical for the success of regenerative endodontic treatment. This blood clot acts as a natural framework for the positioning of stem cells and the release of growth factors [4]. However, forming an adequate blood clot may be challenging or insufficient in certain patients. In these instances, biomaterials such as platelet-rich plasma (PRP) and platelet-rich fibrin (PRF) are recommended as alternatives to blood clots [21].

A proper coronal seal is essential for the success of regenerative endodontic treatment. Effective coronal restorations that prevent leakage play a crucial role in safeguarding the pulp-dentin complex and reducing the risk of post-treatment infection [8]. In the current case, following the formation of the blood clot, it was covered with MTA and a composite resin restoration, as recommended in several previous studies [8, 22].

Conclusion

According to the success criteria established by the American Association of Endodontists (AAE), the primary objective of regenerative endodontic treatment is to achieve biological healing of the tooth. These criteria include the resolution of the periapical lesion, thickening of the root canal walls, and closure of the open apex [9]. In the case presented, it was observed that the periapical lesion healed and the open apex closed, meeting these key success criteria. The results of this case show that a regenerative endodontic procedure can be successfully applied in the treatment of a permanent tooth with arrested root growth due to early pulp necrosis caused by trauma. However, long-term follow-up studies are needed before this treatment option can be used routinely.

Conflict of Interest: There is no conflict of interest the authors.

This study presented as an oral presentation at the Gaziantep University 1st International Dentistry Congress held at Gaziantep Mavera Congress and Art Center between 25-27 October 2024.

AUTHOR CONTRIBUTIONS

The author contributions are listed as follows:

Concept/Idea: BA, AD **Design:** BA, AD **Revision/Consultation:** BA, AD **Data collection or processing:** AD **Analysis and interpretation:** BA, AD **Literature review:** AD **Manuscript writing:** BA, AD **Critical review:** BA

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