Case Report

# Regenerative Endodontic Therapy for Management of an Immature Permanent Tooth with Recurrent Post-treatment Apical Periodontitis: A Case Report

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ABSTRACT

This case report describes the treatment outcome and further retreatment of an immature permanent maxillary right central incisor with necrotic pulp and chronic apical abscess using regenerative endodontic therapy (RET). The patient had a history of traumatic injury. The initial periapical radiographic and cone-beam computed tomographic (CBCT) examinations revealed tooth #8 had incomplete root formation, thin dentinal walls, and pulp necrosis associated with a large apical periodontitis lesion. RET was conducted in two visits and included a disinfection protocol with 5.25% NaOCl irrigation and medication with a double antibiotic paste (metronidazole and ciprofloxacin). At the second visit, a blood clot was induced, and the cervical third was sealed with a mineral trioxide aggregate plug and the coronal portion with light-cure composite. The tooth was asymptomatic at the 12-, 24-, and 36-month follow-ups, and radiographs showed continued root development with healed periradicular tissues. However, the 4-year radiographic follow-up revealed a recurrent apical periodontitis lesion. A second attempt of RET was conducted in one visit using 1% NaOCl irrigation and stimulation of a blood clot. A double seal with silicate-based cement and composite was placed. At the 24-month follow-up, the tooth remained asymptomatic, and both radiographic and CBCT examinations showed apical closure and complete repair of the periradicular tissues. When a tooth develops recurrent apical periodontitis, a second attempt of RET is a feasible option to control infection, helping to promote tooth retention associated with healthy periradicular conditions.

KEYWORDS: *Dental trauma, post-treatment endodontic infection, recurrent apical periodontitis, regenerative endodontic therapy, revascularization*

## INTRODUCTION

Regenerative endodontic therapy (RET) was inspired by tissue engineering, which requires essential interactions among stem/progenitor cells, growth factors, and extracellular matrix scaffolds.[1-3] The purpose of RET is to replace damaged tooth structures, including dentin and root structures, as well as pulp–dentin cells.[4] Since the first clinical report of RET for the treatment of an infected avulsed immature permanent tooth,[5] its use has been extensively documented in immature permanent teeth with pulp necrosis and apical periodontitis or abscess teeth[6-8] and has also been explored in mature permanent teeth.[9,10]

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RET has been used as a predictable alternative to apexification using long-term calcium hydroxide therapy or one-visit placement of a mineral trioxide aggregate (MTA) apical plug along with root canal filling.[8,11] Although no significant differences have been found between these procedures,[11] RET has more advantages. It is more predictable in promoting root development with increased canal wall thickness and/or apical closure, strengthening the root structure against the fracture.[8,12,13] Treated teeth with RET have shown root development in 84.1% and healing of apical periodontitis in 79.8%.[14]

A recent systematic review revealed that persistent endodontic infection is the main cause of RET failure.[15] However, other etiological factors could affect the survival and differentiation of stem cells, such as cytotoxic effects of intracanal irrigants[16] and/or high concentrations of the antibiotic intracanal paste.[17]

Post-treatment apical periodontitis is caused by persistent or secondary intra-radicular bacterial infection. It is classified as emergent (developed after therapy), persistent (persisted despite treatment), or recurrent (redeveloped after healing had occurred).[18,19] There are case reports of RET showing post-treatment disease successfully managed by retreatment or a second attempt of RET.[20-23] The present case report aims to present the clinical success of a second attempt of RET in an immature permanent tooth with recurrent post-treatment apical periodontitis.

## Case Report

The Preferred Reporting Items for Case Reports in Endodontics (PRICE) was followed to describe the present case.[24] A 7-year-old Caucasian boy with non-contributory medical history suffered a traumatic injury to his immature maxillary right central incisor during soccer practice. The next day, his parents took him to a general dentist because they were concerned about the coronal fracture. The patient was referred to a pediatric dentist, who advised the parents to visit an endodontist for evaluation. Meanwhile, the tooth was left untreated for 4 months.

Intraoral clinical examination showed that the maxillary right central incisor had an enamel–dentin coronal fracture, whereas the maxillary left central incisor had an enamel fracture, both without pulp exposure. A sinus tract was observed, associated with the maxillary right central incisor [Figure 1(a) and (b)]. Sensitivity pulp tests were negative, and the tooth was tender to palpation and percussion. The adjacent teeth responded normally to diagnostic tests. Periodontal examination was within normal limits.

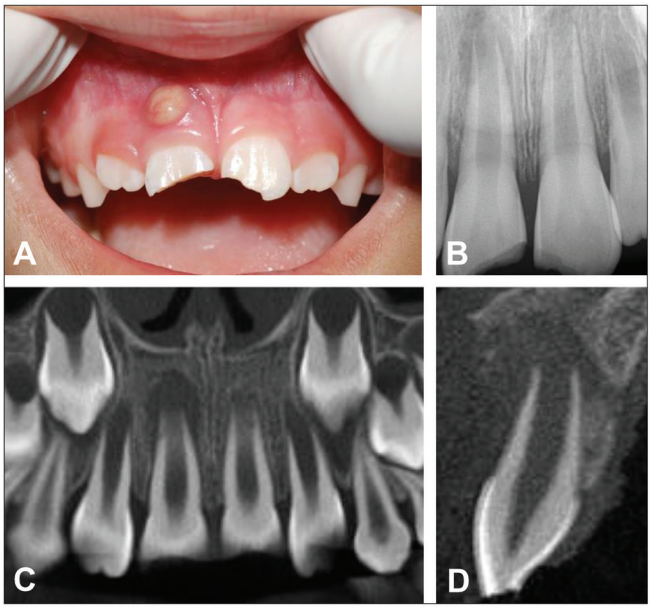


**Figure 1:** Immature maxillary right central incisor (#8) showing pulp necrosis and chronic apical abscess. (a) Clinical aspect. (b) Initial periapical radiograph. (c and d) Cone-beam computed tomographic images

Periapical radiographic and cone-beam computed tomographic (CBCT) examinations revealed incomplete root formation, thin dentinal walls, and a large apical periodontitis lesion on the maxillary right central incisor [Figure 1(b)–(d)]. The diagnosis was pulp necrosis and chronic apical abscess based on clinical and radiographic findings. Treatment options were presented and discussed with the patient's parents regarding outcomes, and the RET was initiated. Informed parental consent was obtained.

In the first RET, all procedures were conducted under an operating microscope. At the first visit, the patient was anesthetized with 2% lidocaine with 1:100,000 epinephrine and infiltration technique for intervention on the maxillary right central incisor. After rubber dam isolation, access to the root canal was performed, and the working length (WL) was established at 0.5 mm short of the radiographic apex with a K-file #30. The canal walls were not enlarged; small files were used in gentle circumferential motion to displace the necrotic pulp tissue, and irrigation was conducted with 30 mL 5.25% sodium hypochlorite (NaOCl). A final flush with saline solution was performed, and the canal was dried with paper points. A double antibiotic paste (400 mg of metronidazole and 500 mg of ciprofloxacin) was placed up to the WL using capillary tips (Ultradent Products, Inc., South Jordan, UT, USA) adapted to a 3 mL syringe. The access cavity was sealed with Dycal® Calcium Hydroxide Liner (Dentsply Caulk, Milford,

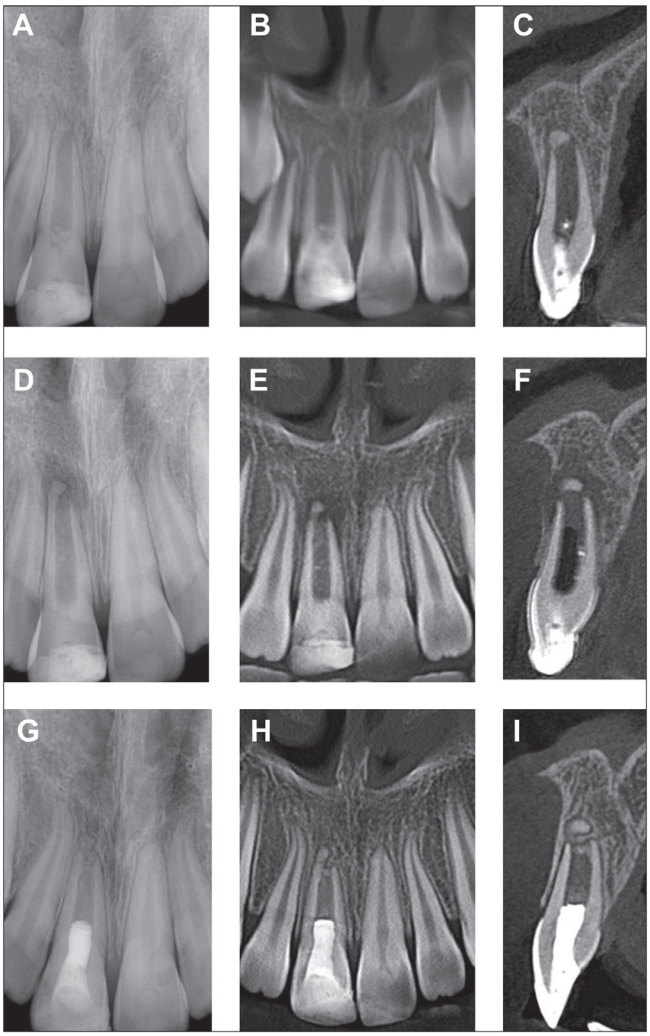


**Figure 2:** Follow-up after regenerative treatment procedures. (a–c) At 36-month follow-up, radiograph and cone-beam computed tomographic scans of tooth #8 show increased thickness of the canal walls, almost complete apex formation, and healing of the apical periodontitis lesion. (d–f) At 48-month follow-up, a radiolucent area around the incomplete root apex is evident, indicating recurrence of apical periodontitis. (g–i) After 25 months of the second RET procedure, the periapical tissues healed again, and a mineralized barrier is now observed at the apical canal

DE, USA) and light-cured composite Filtek™ Z350 XT (3M ESPE, St Paul, MN, USA) [Figure 2].

Four weeks later, the tooth remained asymptomatic, and the sinus tract was healed. The patient was anesthetized with 2% lidocaine without epinephrine by the infiltration technique, isolated with a rubber dam, and the canal was accessed. The double antibiotic paste was removed using 5.25% NaOCl and a final flush with saline solution. All irrigation procedures were performed with 30-G needle NaviTips (Ultradent Products, Inc.), 3 mm short of the WL. A #30 K file was gently introduced in the canal, and bleeding from the periapical tissues was induced until it was visible at the canal coronal opening. After clotting, a 3 mm-thick white MTA (Angelus, Londrina, PR, Brazil) plug was placed without pressure over the blood clot. Access cavity was restored with a Ketac™ Molar-Aplicap glass ionomer (3M ESPE) and light-cured composite Filtek™ Z350 XT.

A 12-month radiographic and CBCT follow-up showed an increase in thickness of the canal walls and healing of apical periodontitis, and the apex was almost complete. Clinical and radiographic follow-ups were performed every 12 months for the following 3 years. Clinically, the tooth remained asymptomatic and functional. Radiographically, the root continued its development, and the canal walls' thickness remained the same [Figure 2(a)–(c)].

At the 48-month follow-up, the tooth remained asymptomatic, and the quality of the coronal restoration was adequate. Periapical radiographs revealed a radiolucent area around the apical part of the root, indicating a recurrent post-treatment apical periodontitis. CBCT showed an empty canal space in the cervical and middle third of the root and incomplete and irregular apical formation. By this time, the patient was 11 years old. The case and management options were discussed with the parents, who agreed to undergo retreatment with a second RET procedure [Figure 2(d)–(f)].

In the second RET, the patient was anesthetized with 2% lidocaine without vasoconstrictor, isolated with a rubber dam, and accessed. The MTA plug was removed with an E3D ultrasonic point (Helsē Ultrasonic, Santa Rosa de Viterbo, São Paulo, Brazil), and the canal was copiously irrigated with 20 mL 1% NaOCl, following the same protocol described for the first treatment, and dried with paper points. Bleeding was induced as described previously for blood clot formation. A double calcium silicate-based plug was placed in the cervical portion of the canal as follows: the Endosequence BC Sealer (Brasseler, Savannah, GA, USA) was carefully placed over the blood clot, followed by a root repair bioceramic material (Brasseler) without pressure. The final restoration was performed with a light cure composite.

After the second RET procedure, clinical and radiographic examinations were performed. At the 6-month follow-up, CBCT showed complete healing of the post-treatment disease and increased thickening of the canal walls. At 18- and 25-month follow-ups, CBCT showed healed periradicular tissues and a hyperdense barrier in the apical canal, indicating the formation

of a mineralized bridge [Figure 2(g)–(i)]. Clinically, the tooth remained asymptomatic throughout the last follow-up.

## Discussion

This case report describes a successful second RET intervention in a traumatized immature maxillary permanent central incisor, which presented with recurrent post-treatment infection 48 months after the first RET intervention.

Regeneration techniques have made significant and promising advances in promoting the resolution of apical periodontitis and the continued root development in immature teeth. In RET, bleeding into the canal space allows the entry of stem cells and growth factors from the apical papilla and/or the periapical tissues into the canal, as well as the formation of a blood clot scaffold that allows cell attachment, migration, proliferation, and angiogenesis.[25,26] In the present case, bleeding was evoked in the two attempts of RET.

The first intervention was successful in allowing or stimulating further root development, which is the main indication for RET procedures.[12] Histological studies have shown that after RET, the newly formed tissue does not correlate with odontoblast-like and dentin-like tissues,[3] but it is similar to the periodontal ligament, cementum, and bone-like tissue.[27-29] These findings indicate repair rather than regeneration. Most histologic examinations of teeth subjected to RET procedures showed that the "neoformed" or "regenerated" tissues are similar regardless of tooth development.[25] Although pulp sensitivity tests may suggest the viability of newly formed tissue, this does not mean that regeneration has occurred.[12] The absence of signs and symptoms, repair of periradicular tissues, complete root formation, functionality, and pleasing aesthetics of the immature tooth have been considered successful outcomes.[8,30]

In the present case, the first RET was conducted in two visits, and the disinfection protocol consisted of 5.25% NaOCl irrigation and medication with metronidazole/ciprofloxacin. Triple antibiotic paste has been widely used in RET procedures, but minocycline may cause an adverse tooth staining effect.[31] Thus, in the present case, a combination of only metronidazole and ciprofloxacin was used in the first intervention. Tooth discoloration was not observed.

The first treatment succeeded in the short term, as the lesion healed and the root development continued to almost complete apex formation. However, 4 years later, the apical periodontitis lesion recurred. Recurrent lesions may be caused by a persistent infection that survived the first treatment, or a new infection, which may develop because of coronal leakage.[19] The quality of the coronal restoration was adequate over the follow-up years, and no other likely pathway for canal reinfection was identified. Therefore, the cause of recurrent disease may have been a persistent infection in the root canal. Residual bacteria that survived the first treatment may have been insufficient in numbers to maintain the disease, which helps explain the periradicular tissue healing and continuation of the root development process. Residual bacteria that survived the effects of irrigation and antibiotic medication may have occurred in dentinal tubules, canal recesses, ramifications, and unprepared walls,[32,33] especially in teeth not subjected to root canal instrumentation. The blood clot formed inside the canal may also serve as a source of nutrients and growth factors for residual bacteria. Over time, these bacteria may have overcome the host defenses in the newly formed intracanal tissue to reach numbers that were again sufficient to cause the new periradicular inflammatory lesion.

The second RET was conducted in one visit, using intracanal disinfection with 1% NaOCl because the clinician was concerned about the cytotoxic effects of the higher NaOCl concentration used in the first treatment. It was evident that the amount and concentration of NaOCl used were sufficient to control the bacterial infection in the second approach, as demonstrated by complete periradicular tissue healing. A new finding from a CBCT showed that the apical part of the root canal was closed by a mineralized barrier, highly likely to be cementum, and very similar to the outcome of apexification procedures. This finding suggests that there was no longer a source of stem cells from the apical papilla to allow the final modeling of the root apex. It is important to emphasize that despite the optimum outcome of the second RET, this does not mean definitive success, and the case should be continuously monitored.

This case report demonstrates that a second RET intervention can be a reliable and effective treatment for immature teeth with post-treatment apical periodontitis, prolonging tooth function and/or tooth retention, and preserving hard and soft tissues. Clinical randomized controlled trials with long-term follow-up examinations are needed to establish the efficacy of a second RET in teeth with post-treatment apical periodontitis.

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### Conflicts of interest

The authors declare no conflicts of interest.

### Authors' contributions

RL: endodontic treatment and clinical data. SRH: clinical data revision, literature search, and writing. FRFA: text revision. INR and JFS: writing, revision, and final approval of the version to be submitted.

### Ethical policy and institutional review board statement

All the procedures have been performed as per the ethical guidelines laid down by Declaration of Helsinki (2013).

### Patient declaration of consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

### Data availability statement

Not applicable.

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