

CASE REPORT

Regenerative Endodontic Treatment of Permanent Teeth with Open Apex: Case Series

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Abstract

The purpose of these case report was to present the follow-up of root development of teeth treated with different regenerative protocols. In the first case, double antibiotic paste was used for 3 weeks to ensure disinfection, and in the second case, triple antibiotic paste was used. Regeneration treatment was applied with apical bleeding method in the first case and with PRF in the second case. After the blood clots were formed, MTA was chosen as the coronal plug. It was observed that the lesion area healed completely at the end of 1 year. In the second case, it was observed that the radiolucent area in the apical region was improved during the 6th month follow-up. These case series show that the regenerative endodontic technique results in favorable healing of periradicular tissue in necrotic immature teeth.

Key words: apical bleeding; open apex; platelet-rich fibrin; platelet-rich plasma; regenerative endodontics

Introduction

Pulp tissue may become necrotic and root development may discontinue due to trauma or dentin caries in immature permanent teeth. Arrest of root development would leave teeth with thin dentin walls and open apex, and therefore an increased risk of root fracture.¹ In addition, to apply the traditional treatment protocols for treatment of these teeth represent a challenge to clinicians during root canal instrumentation and disinfection procedures.² Apexification is defined as a method that allows the development of an apical barrier in teeth with open apex and necrotic pulp. Traditionally, these immature teeth have been treated with a long-term calcium hydroxide dressing that creates a calcific barrier at the apex before filling the root canals.³ However, the apexification technique with calcium hydroxide has a long treatment period, and multiple sessions lead to inevitably high costs, poor patient cooperation, and re-infection risks resulting from the difficulty of creating long-term sealing with temporary restorations.⁴ Although single visit apexification is a method preferred by clinicians in recent years due to its short treatment time with newly developed biomaterials, it can not provide the continuation of root development.⁴

Regenerative endodontic treatment (RET) is an alternative treatment that would achieve root formation in immature teeth with necrotic pulp. It ensures the proliferation and differentiation of

stem cells from the apical papilla and also continuity of residual pulp cells in the apical third of the root canal.^{5,6} The primary purpose of regenerative endodontics is to control the infection, restore the vitality of the dental pulp and increase the resistance of the tooth by ensuring the continuity of root development.⁷ The purpose of these case reports is to present the follow-up of root development of teeth treated and lesions in the apical with different regenerative protocols.

Case Reports

Case 1

A 17-year-old male patient applied to our clinic with pain in the lower left posterior tooth and reported that the swelling did not resolve despite taking oral antibiotics. As a result of the clinical examination, an extra oral hard swelling was observed in the left mandibular area (Figure 1), and intraoral examination revealed a deep decay in the left mandibular second molar (Tooth #37). The tooth was sensitive to percussion, but there was no mobility. Radiographic examination revealed immature roots with a wide periapical radiolucency in Tooth #37 (Figure 2). In the first visit, after local anesthesia, the access cavity of the relevant tooth was prepared

under rubber dam isolation and the canal length was determined with hand files and an apex locator. Due to the canals were very wide, the distal canal walls were minimally prepared with a size #80 H-file, and the mesial canal walls prepared with a size #45 H-file by avoiding excess preparation. 1% NaOCl and 2% CHX irrigation solutions were used during preparation. After the canals were dried with paper points, access cavity sealed with a temporary filling without any medicament, and the patient was called 3 days later. Since the swelling on the face of the patient did not decrease sufficiently, the canals were irrigated with irrigants used in previous visit and dried with paper points. This procedure was performed twice a week for one month. After one month, it was observed that the swelling decreased (Figure 3). After the irrigation process, the canals were dried with paper points and triple antibiotic paste (metranidazole, minocycline and ciprofloxacin in a ratio of 1: 1: 1) was placed in the canals by mixing with distilled water. After 3 weeks, antibiotics medicament was removed from the canals with 1% NaOCl irrigation, the canals were dried with paper points. The canals were filled with blood by gently exiting out of apex with a sterile K file. It was waited about 10 minutes for the blood to clot in the canal. Afterwards, coronal third of the canals were filled with MTA Plus (Avalon Biomed Inc. Bradenton, FL, USA). The tooth was restored with glass ionomer cement (R&D Series Nova Glass F, Imicryl) and composite restoration (Filtek Ultimate Universal Restorative, 3M ESPE, St. Paul, USA). As a result of 1-year follow-up, it was observed that the radiolucency in the lesion area completely disappeared and lamina dura could be observed in the apical region of the tooth (Figure 4). The tooth was asymptomatic and there was no percussion sensitivity. The relevant tooth responded positively to cold (Endo Ice, Coltene Whaledent, Ohio, USA) and Electric Pulp Tester (EPT). The follow-ups are continuing.

Case 2

A 22-year-old male patient applied to our clinic with the complaint of pain in the right lower 2nd premolar. In the clinical examination, the patient had deep caries in the Tooth#46 and Tooth#45, and there was sensitivity to percussion in both teeth. In the radiographs, it was determined that Tooth#45 had an open apex and a wide periapical radiolucency (Figure 5). It was planned to apply revascularization treatment with PRF (Platelet-rich fibrin). After the patient accepted the treatment, local anesthesia was applied to the patient, the decay was cleaned under rubber dam isolation. An access cavity was prepared and suppuration was observed from the canal. The canal length was then determined with a hand file by an apex locator. Due to the canal was very wide, the canal was

prepared at minimum level with a size #80 H-file. Afterwards, the canal was irrigated first with distilled water, then 1% NaOCl and 17% EDTA. After the canals were dried with paper points, the tooth was sealed with a temporary restoration without any medicament and 3 days later the patient was recalled. The tooth was completely asymptomatic at the second visit. The canal was irrigated with 1% NaOCl, 17% EDTA, and then dried with paper points. Triple antibiotic paste (metranidazole, minocycline and ciprofloxacin in a ratio of 1: 1: 1) was mixed with distilled water and placed into the canal. At the end of the third week, the antibiotic paste was removed from the canal with 1% NaOCl and 17% EDTA. 10 ml blood was drawn from the patient in the same visit and centrifuged at 2700 rpm for 12 minutes to obtain the PRF in the centrifugal device (Elektromag, Istanbul, Turkey)(Figure 6). The PRF was placed into the canal until the cemento enamel junction with pluggers(Figure 7). After that, a 3-4 mm MTA Plus (Avalon Biomed Inc. Bradenton, FL, ABD) was placed on it. The tooth was restored with glass ionomer cement (R&D Series Nova Glass F, Imicryl) and composite resin (Filtek Ultimate Universal Restorative, 3M ESPE, St. Paul, USA) (Figure 8). After 6 months follow-up, it was observed that the radiolucency was healed in the apical of the relevant tooth (Figure 9). The relevant tooth responded positively to cold (Endo Ice,



Figure 2. A wide periapical radiolucency in tooth #37



Figure 1. Extra oral hard swelling in the left mandibular area



Figure 3. Reduced swelling after one month



Figure 4. Follow up after one year



Figure 5. A wide periapical radiolucency in tooth #45

Coltene Whaledent, Ohio, USA) and Electric Pulp Tester (EPT). The follow-ups are continuing.

Discussion

According to the American Society of Endodontists, the main purpose of RET is to eliminate symptoms and promote bone healing, as well as increase root wall thickness and/or root length and achieve a positive response to the vitality test.⁸ Revascularization procedures may be considered a better treatment option than traditional apexification procedures, due to the thickening of the lateral canal walls and increased root length with new dentin deposition.⁹

EDTA and various concentrations of NaOCl have been recommended as an irrigation solution during regenerative clinical procedures.¹⁰ Especially, EDTA was recommended for use as final irrigation, as it induces odontoblast differentiation by releasing growth factors from the dentin matrix. It is also recommended for reversing the negative effects of NaOCl on the viability and attachment of cells.^{11,12}

Martin et al.¹³ recommended the use of low concentration of sodium hypochlorite (1.5% NaOCl) to provide root canal disinfection without compromising the cellular activity of stem cells during regenerative endodontic treatment. Mishra et al.¹⁴ also preferred to use a lower concentration of 2.5% NaOCl in their case report. In accordance with these studies, we preferred to use low concentration

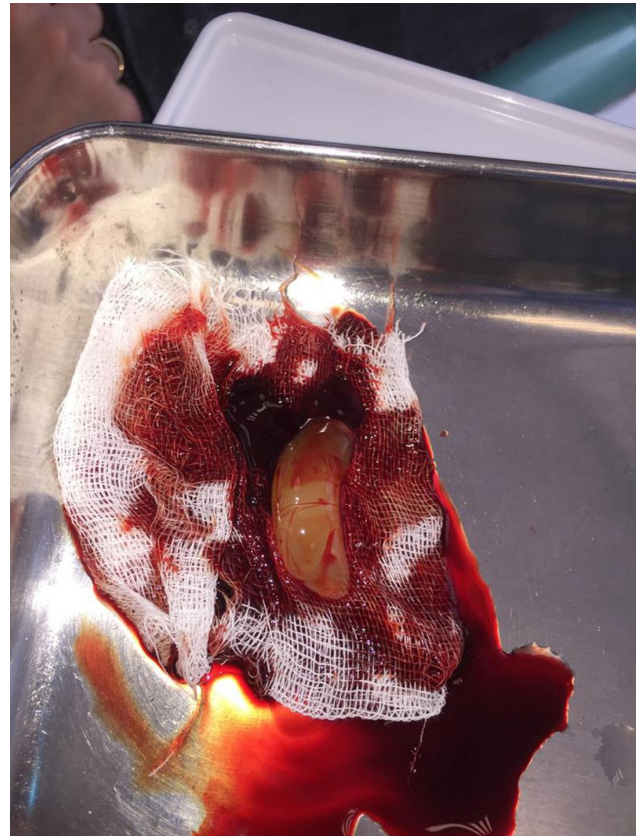


Figure 6. The PRF

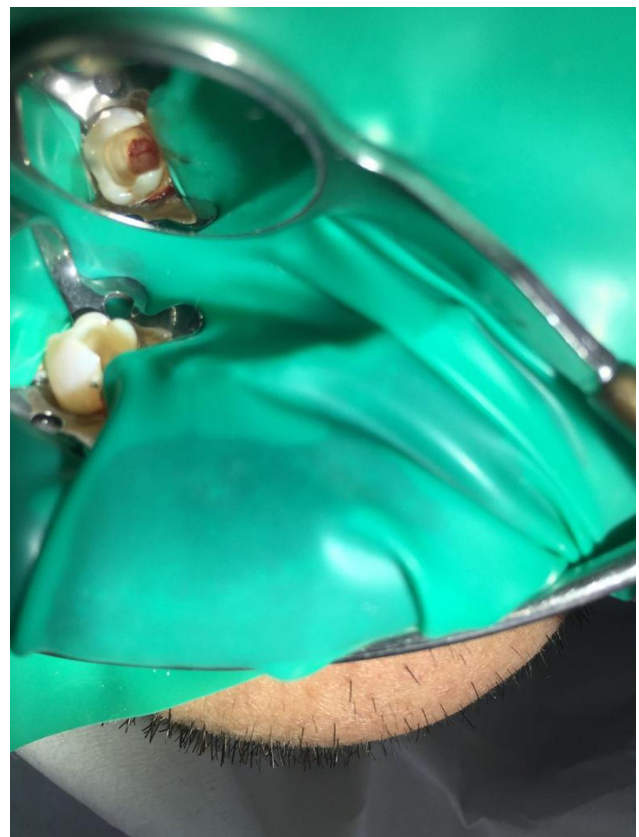


Figure 7. Placing into the root canal



Figure 8. Covering with MTA



Figure 9. Follow up after six months

NaOCl (1%).

Ca(OH)₂ or antibiotic pastes are used for the disinfection of the canal in regeneration treatments.¹⁵ However, studies have reported that the proteolytic effect of Ca(OH)₂ causes a decrease in the organic support of dentin by disrupting the connection between collagen fibers and hydroxyapatite crystals.^{16,17} Ca(OH)₂ causes a decrease in dentin microhardness and an increase in root fracture.¹⁶ Triple antibiotic sealer is widely used in revascularization treatments from 1996.¹⁸ Sato et al.¹⁹ reported that this drug combination exerts a bactericidal effect in the deep dentin layers of the root canal. However, the triple antibiotic paste cause color change in the crown.²⁰ Therefore; double antibiotic sealer is produced by removing minocycline from TAP. But it has been reported that there is no difference in success between double and triple antibiotic pastes in the studies performed.²¹ In our study, we used triple antibiotic paste to ensure disinfection because we treated molar and premolar teeth that are not in the smile line.^{21,22}

The regenerative endodontic treatment protocol covers usage

the blood clot, PRP, or PRF as a scaffold.²³ The clot formed into the root canal acts as a scaffold for the migration of stem cells, fibroblasts and macrophages.⁷ Interlocking cells in the scaffold can further release signaling molecules that are essential for wound healing.⁷ Previous animal studies have shown that roots containing blood clots after disinfection have better treatment results than those without blood clots.²³

PRP is the first generation thrombocyte concentrate obtained from the patient's whole blood.²⁴ Platelet aggregates contain, on average, about 4 times higher growth factors and cytokines than whole blood.²⁵ In regeneration studies with PRP, it has been shown that the teeth respond positively to both the cold test and the electric pulp test over time, the periapical opening is closed and the lesion heals.²⁴ PRF, is a second-generation thrombocyte concentrate obtained from the patient's own blood and contains cytokines that provide recovery with thrombocyte, growth factors.^{26,27} The most important advantage of this technique is that it does not involve bovine thrombin or calcium sulfate activation compared to PRP, so it is obtained more easily and in a shorter time.²⁸ However, while PRP causes sudden release of growth factors in about 7-14 hours²⁹, PRF is in a fibrin network structure that acts as a reservoir for the slow and continuous release of growth factors over a period of 7-14 days.³⁰ Positive responses to EPT and cold tests were also obtained in teeth treated with PRF, lengthening of the root length with apical closure and thickening of dentin walls were reported.³¹

PRF is a potential scaffold in pulp revascularization procedures, as it is rich in growth factors, enhances cellular proliferation and differentiation, increases angiogenesis, acts as a matrix for tissue growth, regulates inflammatory reactions and has anti-infective properties. Additionally, it acts as an excellent matrix to support MTA placement.³⁰ In a revitalization case report performed by Subash et al. using PRF on a 13-year-old patient's tooth number 37 with an immature, apical lesion, the lesion completely healed after 9 months of follow-up, the tooth responded positively to EPT and cold tests, and the root length was extended with apical closure.³¹ In a study, PRP, PRF and apical bleed groups were compared to respond to viability tests, and the PRP and PRF groups gave a faster response. This may be due to the higher platelet level of these biological scaffolds, which can stimulate the regeneration process of sensory fibers.³² The advantage of apical bleeding is the practicality of the procedure, while the disadvantage is that sufficient bleeding cannot always be achieved and sufficient growth factors cannot reach the area.^{33,34} In present report, the blood clot and PRF were used.

In a study comparing the effect of PRF and apical bleeding on root length, it was reported that the results of PRF group were significantly longer in millimeters and percentage.⁹ However, root dentin thickness increased did not differ.⁹ In the second case, we have achieved successful results with the PRF. Although the purpose of regeneration therapy is observed in some cases that the lesion area in the periapical region heals while the root length increases and apical closure does not occur. Clinical studies using RE'T have shown successful clinical results radiographically and clinically for teeth with complete periapical healing but without further root development.³⁵

Conclusion

These case series show that the regenerative endodontic technique is applicable for the treatment of necrotic permanent teeth with open apex. It shows that the treatment can be successfully performed by using different disinfection protocols.

Author Contributions

Case planning and Methodology: Ş.N.G., H.E., T.D Writing – Original Draft Preparation: H.M.B., E.B., Creation and/or presentation of the published work: Ş.N.G., H.E., T.D., Writing – Review & Editing: H.M.B., E.B.

Conflict of Interest

The authors deny any conflict of interest related to this study.

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