Management of Teeth with Persistent Apical Periodontitis after Root Canal Treatment Using Regenerative Endodontic Therapy

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Abstract

Regenerative endodontic therapy (RET) is currently used to treat immature teeth with necrotic pulp and/or apical periodontitis. However, recently RET has been used to treat mature teeth with necrotic pulp and/or apical periodontitis and resulted in regression of clinical signs and/or symptoms and resolution of apical periodontitis. The purpose of this case report was to describe the potential of using RET to treat 2 mature teeth with persistent apical periodontitis after root canal therapy using RET. Two male patients, one 26-year old and another 12-year old, presented for retreatment of persistent apical periodontitis after root canal treatment of 2 mature teeth (#9 and #19). The gutta-percha fillings in the canals of teeth #9 and #19 were removed with Carvene gutta-percha solvent (Prevest DenPro, Jammu, India) and ProTaper Universal rotary retreatment files (Dentsply Maillefer, Ballaigues, Switzerland). The canals of both teeth were further chemomechanically debrided with rotary retreatment files and copious amounts of sodium hypochlorite irrigation and dressed with Metapaste (Meta Biomed, Chungbuk, Korea). RET was performed on teeth #9 and #19. Periapical bleeding was provoked into the disinfected root canals. The blood clots were covered with mineral trioxide aggregate plugs, and the access cavities were restored with intermediate restorative material. Teeth #9 and #19 showed regression of clinical signs and/or symptoms and healing of apical periodontitis after 13-month and 14-month follow-ups, respectively. Tooth #9 revealed narrowing of the canal space and apical closure by deposition of hard tissue. RET has the potential to be used to retreat teeth with persistent apical periodontitis after root canal therapy. (J Endod 2015;41:1743–1748)

Key Words

Apical periodontitis, immune defense, regenerative endodontic therapy, retreatment, vital tissue

Regenerative endodontics (RET) is defined as biologically based procedures designed to physiologically replace a damaged tooth structure, including dentin and root structures, as well as the pulp-dentin complex. RET includes irrigation with copious amounts of 1.5% sodium hypochlorite, intracanal medication with calcium hydroxide and triple antibiotic paste (ciprofloxacin, metronidazole, and minocycline), and 17% EDTA rinse of the canal without mechanical debridement before induction of intracanal bleeding. RET is currently used to treat immature permanent teeth with infected or noninfected necrotic pulps. The treatment can result in regression of clinical signs/symptoms as well as resolution of apical periodontitis. In addition, thickening of the canal walls and/or continued root development may occur in some cases. According to the American Association of Endodontists guidelines, the primary goals of RET are resolution of apical periodontitis and elimination of clinical signs/symptoms. Increased thickening of the canal walls and/or continued root development as well as regaining a positive response to pulp testing are desirable but not essential to determine the clinical success of RET. The primary goals of RET are similar to those of nonsurgical root canal therapy. Therefore, RET might have the potential to be used to treat mature teeth with infected or noninfected necrotic pulps and teeth with persistent apical periodontitis after root canal therapy.

Histologically, normal-looking pulp tissue has not been reported to regenerate in the canals of human immature permanent teeth with infected or noninfected necrotic pulps after RET. However, cementumlike, bonelike, and periodontal ligament–like tissue and neurovascular supply have been observed regenerated in the canals of human immature permanent teeth with infected or noninfected necrotic pulps. Although these tissues are not pulp tissue, they are vital tissues, which are inherited with immune defense mechanisms. Therefore, RET can restore the vitality and defense capability of the tissue damaged in the canals of human immature permanent teeth with infected necrotic pulps.

Recently, mature permanent teeth with necrotic pulps and apical periodontitis have been successfully treated using RET. The treatment eliminates clinical signs/symptoms and resolves apical periodontitis. The tissues regenerated in the canals of human mature permanent teeth with infected necrotic pulps are not known because there are no histologic studies available. However, cementumlike, bonelike,
and periodontal ligament–like tissues and vasculature were shown regenerated in the canals of mature teeth with necrotic pulps and apical periodontitits in an animal model (15). These tissues are similar to those tissues regenerated in the canals of human immature permanent teeth with infected necrotic pulps and apical periodontitis (8–11).

Teeth with persistent apical periodontitis after root canal therapy are primarily caused by persistent root canal infection or root canal reinfection (16, 17). Therefore, more complete root canal infection control of unsuccessfully treated teeth is important in retreatment. The unsuccessfully treated teeth are usually managed with nonsurgical or surgical retreatment to eliminate root canal infection and apical periodontitis (18, 19). Surgical retreatment is recommended when nonsurgical retreatment is not feasible. The outcome of nonsurgical or surgical retreatments is predictable (18, 19).

Most recently, Nevins and Cymerman (20) reported the successful retreatment of 2 teeth with persistent apical periodontitis after nonsurgical root canal therapy using a revitalization procedure or RET. Based on the results of mature teeth with infected necrotic pulps and apical periodontitis successfully treated using RET (12–14), it was believed that teeth with persistent apical periodontitis after root canal therapy might also be able to be managed using RET because the objectives and goals of primary and secondary root canal treatment are the same. The purpose of this case report was to describe the potential of using RET to treat 2 teeth with persistent apical periodontitis after root canal therapy.

Case Reports

Case 1

A 26-year-old man presented to the dental clinic of the faculty of dentistry with pain and labial swelling associated with his maxillary anterior teeth. The patient’s medical history was noncontributory. The dental history revealed that the patient had a traumatic injury to his maxillary anterior teeth more than 10 years ago. Subsequently to the trauma, a general dentist performed conventional root canal therapy on teeth #8 and #9. Tooth #9 was restored with porcelain fused to metal full crown coverage. The crown of tooth #8 was partially restored with composite resin. At some point, the crown of tooth #9 fell off, likely because of poor fit.

Extraoral examination revealed slight labial swelling of the maxilla. There were no palpable lymph nodes in the head and neck. Intraoral examination showed that hard bony swelling was localized labially in the periapical region of tooth #9. The full crown coverage on tooth #8 was missing, and the tooth was tender to percussion and palpation. Tooth #8 was asymptomatic and not tender to percussion and palpation. Conventional periapical radiography showed that tooth #9 had a large canal space, which was poorly obturated with root filling, and a periapical radiolucency (Fig. 1A). Tooth #8 also had a root canal filling but no periapical lesion (Fig. 1A). Both teeth had completely formed roots. The periodontal pocket probing of both teeth #9 and #8 were within normal limits (3–4 mm).

Based on the dental history and clinical radiographic findings, tooth #9 was diagnosed as previously treated acute apical abscess. Treatment options including nonsurgical root canal retreatment, RET, and extraction were presented to the patient. The outcome of secondary root canal treatment was discussed with the patient. The patient was informed that the outcome of RET for teeth with persistent apical periodontitis after root canal therapy was not known. The patient opted for RET.

The intraoral swelling was hard and localized and not very painful to palpation. Therefore, an incision and drainage were not performed. The patient was advised to take ibuprofen as needed for pain and scheduled for endodontic retreatment in a week.

Treatment Procedures

First Treatment Visit. At the time of the treatment visit, localized intraoral swelling was still present. Tooth #9 was asymptomatic. Local anesthesia with 2% lidocaine containing 1:100,000 epinephrine was administered. Tooth #9 was isolated with a rubber dam. The canal was accessed, and the root canal filling was identified. The poorly fitted gutta-percha cones were removed with a Hedstrom file #20 (Dentsply Maillefer, Ballaigues, Switzerland). The working length (WL) 0.5 mm short of the radiographic apex was determined with an electronic apex locator and periapical radiography. The canal was prepared using ProTaper Universal rotary retreatment files D1 (tip size #30/09), D2 (tip size #25/08), and D3 (tip size #20/07) (Dentsply Maillefer) to the WL with copious amounts of 2.5% sodium hypochlorite irrigation (Household Cleaning Products Company of Egypt, Cairo, Egypt). Because tooth #9 had a large canal space and an open apex, it was sequentially debrided to hand #60 K-files to the WL. The canal was irrigated, dried, and dressed with Metapaste (calcium hydroxide with barium sulfate; Meta Biomed, Korea). The access cavity was closed with a sterile cotton pellet and intermediate restorative material (IRM) (Dentsply DeTrey, Konstanz, Germany).

Second Treatment Visit. Two weeks after the first treatment visit, the localized swelling had subsided, and the tooth remained asymptomatic. Local anesthesia with 2% mepivacaine without a vasoconstrictor was administered. The tooth was isolated with a rubber dam. The IRM and cotton pellet were removed from the access cavity. Metapaste in the canal was removed with copious amounts of sodium hypochlorite irrigation, and the canal was gently debrided with a hand #60 K-file, irrigated, and dried. The canal was rinsed with saline solution and dried and then irrigated with 17% EDTA and dried with paper points. A #25 K-file was used to penetrate the periapical tissue and provoke periapical bleeding into the canal under the observation of magnifying surgical loupes. After the bleeding became semicoagulated, a mineral trioxide aggregate (MTA) plug (Dentsply Tulsa Dental, Tulsa, OK) of approximately 3-mm thickness was placed over the semicoagulated blood clot. A moist cotton pellet was placed over the MTA plug, and the access cavity was closed with IRM (Fig. 1B).

Third Treatment Visit. Three days after the second treatment visit, the IRM and cotton pellet were removed from the access cavity. It was determined that the MTA plug had completely set after examination with an endodontic explorer. The access cavity was restored with luting-curing composite resin, and the patient was advised to have the tooth permanently restored with a crown by his dentist.

Follow-up Examinations

At the 7-month follow-up, the periapical lesion had slightly decreased in size (Fig. 1C). At the 13-month follow-up, the periapical lesion showed further radiographic evidence of healing. The canal space appeared slightly decreased in size because of thickening of the canal walls relative to the postoperative radiograph, and the apex appeared to have closed (Fig. 1D). The tooth was restored with a temporary crown. The tooth did not respond to pulp tests with cold, heat, and electric pulp test at the 7-month and the 13-month follow-ups.

Case 2

A 12-year-old boy accompanied by his mother presented to the endodontic clinic with a referral from the pediatric dentistry department of the faculty of dentistry for the evaluation of tooth #19. The patient’s medical history was not contributory. The dental history indicated that because of a deep carious lesion, the general dentist performed root canal therapy on tooth #19 17 months ago. Extraoral...
examination showed that the submandibular lymph node was slightly enlarged. Intraoral examination revealed that there was localized swelling on the lingual aspect of the left mandibular molar area, which was tender to palpation. The tooth was also sensitive to percussion. A healing draining sinus tract was present on the buccal aspect of tooth #19 near the periapical area, which was not traced. There was no coronal restoration, and recurrent caries was observed in the access cavity of tooth #19. The root canal fillings in the mesiobuccal and mesiolingual canals and the distal canals were exposed to the oral environment. Conventional radiography showed poorly obturated root canals and a large periapical radiolucent lesion involving both the mesial and distal roots (Fig. 2A). Both the mesial and distal roots were completely formed. The periodontal pocket probing was within normal limits (3–4 mm).

Based on the dental history and clinical and radiographic findings, the diagnosis for tooth #19 was previously treated chronic apical abscess. Treatment options including nonsurgical root canal retreatment, RET, and extraction were presented to the patient and the patient’s mother. They were also informed of the prognosis for each treatment option. The patient’s mother and the patient decided to try RET of tooth #19. The patient was scheduled for endodontic retreatment in a week.

**Treatment Procedures**

**First Treatment Visit.** The local swelling was still present, and tooth #19 was asymptomatic. Local anesthesia with 2% lidocaine containing 1:100,000 epinephrine was administered as a block of the left inferior alveolar nerve. The tooth was isolated with a rubber dam. Caries was completely removed. The access cavity was irrigated with 2.5% sodium hypochlorite solution and dried. Carvene gutta-percha solvent (Prevest DenPro, Jammu, India) was dripped onto the cavity floor via an irrigation syringe. The gutta-percha cones in the mesiobuccal and mesiolingual canals and the distal canals were carefully removed with #15 H-files (Dentsply Maillefer) and ProTaper Universal rotary retreatment file D1. The WL 0.5 mm short of the radiographic apex was determined with an electronic apex locator and periapical radiography. The mesiobuccal and mesiolingual canals were subsequently prepared with rotary retreatment file D3 and the distal canal with D2. The canals were copiously irrigated with 2.5% sodium hypochlorite solution, dried with paper points, and dressed with Metapaste. The access cavity was closed with a sterile cotton pellet and IRM.

**Second Treatment Visit.** A week after the first treatment visit, the local swelling had subsided. An inferior alveolar block with 2% lidocaine containing 1:100,000 epinephrine was given. Tooth #19 was
isolated with a rubber dam. The cotton pellet and IRM were removed from the access cavity. The mesiobuccal and mesiolingual canals were mechanically instrumented with rotary retreatment files D3 and the distal canal with a hand #35 K-file along with abundant sodium hypochlorite irrigation. The canals were dried with paper points and dressed with Metapaste. The access cavity was temporized with a sterile cotton pellet and IRM.

Third Treatment Visit. Because of scheduling difficulty, the patient returned 1 ½ months later for the continuation of treatment. Tooth #19 remained asymptomatic. Radiographically, the periapical lesion appeared to be decreased in size. Local anesthesia with 2% lidocaine containing 1:100,000 epinephrine was administered. The tooth was isolated with a rubber dam, and IRM and the cotton pellet were removed from the access cavity. Metapaste was removed from the canals with copious amounts of sodium hypochlorite irrigation. The mesiobuccal and mesiolingual canals were hand instrumented to #30 K-files and the distal canal to a #40 K-file to the WL with copious amounts of sodium hypochlorite irrigation. The canals were irrigated with sodium hypochlorite, dried with paper points, and dressed with Metapaste. The access cavity was sealed with a cotton pellet and IRM.

Fourth Treatment Visit. Tooth #19 was asymptomatic. Local anesthetic of 3% mepivacaine without a vasoconstrictor was given. The tooth was isolated with a rubber dam. IRM and the cotton pellet were removed from the access cavity. Metapaste in the canal was removed with copious amounts of sodium hypochlorite irrigation. The mesiobuccal and mesiolingual canals were gently debrided with a #30 K-file and the distal canal with a #40 K-file with sodium hypochlorite irrigation. The canals were dried with paper points, rinsed with saline solution and dried with paper points, and then irrigated with 17% EDTA and dried with paper points. A hand #25 K-file was used to penetrate into the periapical tissue from each canal to provoke periapical bleeding into all canals observed with magnifying surgical loupes. After the bleeding became semicoagulated, MTA plugs of approximately 3-mm thickness were placed over the semicoagulated blood clot in all canals. A moist cotton pellet was placed over the MTA plugs, and the access cavity was closed with IRM (Fig. 2B).

Fifth Treatment Visit. A week after the third treatment visit, the IRM and cotton pellet were removed from the access cavity. It was determined that the MTA plug had completely set after examination with an endodontic explorer. The access cavity was temporarily restored with IRM, and the patient’s mother and the patient were advised to have the tooth permanently restored by his dentist.

Follow-up Examinations

The tooth was asymptomatic at the 8-month follow-ups, radiographic evidence of healing of the periapical lesion was observed (Fig. 2C). At the 14-month follow-up, there was complete periapical healing of the distal root and slight thickening of the periodontal ligament space of the mesial root (Fig. 2D). The tooth was not permanently restored. The tooth did not respond to pulp tests with cold, heat, and electric pulp test at the 8-month and 14-month follow-ups.

Discussion

Teeth with persistent apical periodontitis after root canal therapy are primarily caused by persistent root canal infection or root canal reinfection (16, 17). Systematic reviews of primary and secondary root canal treatments indicate that the outcome of secondary treatment is poorer than the primary treatment (18, 21). Therefore,
secondary root canal treatment is more difficult than primary root canal treatment. The microbial flora in teeth undergoing secondary root canal treatment is single species of the predominantly gram-positive organism Enterococcus faecalis (22), which is resistant to intracanal medication (ie, calcium hydroxide) (23) but might not be resistant to immune defense mechanisms of regenerated vital tissue after RET.

Teeth with persistent apical periodontitis after root canal therapy are usually retreated with nonsurgical (18, 19) or surgical procedures (19). Surgical treatment is recommended when nonsurgical treatment is not feasible. The long-term outcome of both treatments is predictable (18, 19). In the present case report, we have described the potential of using RET to retreat teeth with persistent apical periodontitis after root canal therapy. In our previous publication, we have discussed the possible advantages of vital tissue regenerated in the canals of mature teeth with necrotic pulps and apical periodontitis using RET (14). Vital tissue is endowed with innate and adaptive immune defense mechanisms and neurovascular supply to detect and protect tissues from foreign invaders such as bacteria.

The size of the apical foramen was an issue in revascularization or regenerative endodontic therapy. However, studies appear to indicate that the size of the apical foramen is not critical to revascularization or regenerative endodontic therapy (15, 24–26). This has also been discussed in our previous publication (14).

The major concern in RET of mature or immature teeth with infected necrotic pulp and/or apical periodontitis is the residual bacteria in the canals and the root dentinal tubules because residual bacteria may grow in the unfilled canals. Contemporary root canal disinfection protocols including the use of antibiotics are not able to eliminate all bacteria in the infected root canal system because of its anatomic complexity (27). Therefore, root filling is necessary and expected to prevent coronal leakage, retard residual bacteria in the canal from penetrating into the periapical tissues, and hopefully entomb bacteria in the canal in nonsurgical root canal treatment. Root filling may be able to achieve some but not all 3 expectations. Otherwise, teeth with infected necrotic pulps and apical periodontitis after root canal therapy should be able to accomplish complete periapical healing. A systematic review of the outcome of primary root canal treatment does not support this notion (21). In RET, the possibility that the residual bacteria in the canals may be eliminated by immune defense mechanisms of regenerated vital tissue cannot be ruled out. This rationale is supported by the high success rate of immature permanent teeth with infected necrotic pulps after RET (2).

The fate of bacteria remaining in the root dentinal tubules after proper chemomechanical debridement is not known. In nonsurgical root canal therapy, residual bacteria in the root dentinal tubules do not appear to be the primary cause of post-treatment apical periodontitis (28). In fact, an inflammatory periapical lesion is able to heal even without root filling if root canal infection is properly controlled and the coronal seal is able to prevent root canal reinfection (29, 30). There are no convincing studies to show that bacteria in the root dentinal tubules are capable of sustaining or inducing apical periodontitis of endodontically involved teeth after proper root canal therapy. However, it must be emphasized that effective control of root canal infection is always pivotal to endodontic therapy including nonsurgical root canal treatment and RET (31, 32).

It is possible for wound healing to occur in the canals after RET if the load of residual bacteria in the disinfected canals is reduced to the subthreshold level (27), at which point the immune–competent cells of regenerated vital tissue can function effectively. It is known that bacteria are present in the periapical tissues of teeth with acute apical abscesses or chronic apical abscesses with a draining sinus tract (33, 34). Despite the presence of bacteria, the periapical tissues are able to heal once the root canal therapy successfully reduces the bacterial load to the subthreshold level in the canal, at which point the innate and adaptive immune defense mechanisms of the periapical tissues are capable of eliminating the bacteria (33, 34). The same principle may apply to RET of immature and mature teeth with necrotic pulps and apical periodontitis. The regenerated vital tissue in the canals after RET is also endowed with immune defense mechanisms. Therefore, wound healing could occur in the infected canals after RET depending on the numbers of bacteria and their virulence and the host’s immune defense (35, 36).

After the induction of bleeding into the canal, the host’s humoral (complement components and immunoglobulins) and cellular (phagocytes, lymphocytes) components of the immune system contained in the circulation are brought into the canal. For bacteria to survive in vital tissue, they have to be able to evade the host’s immune defense mechanisms, such as avoidance of opsonization by complement component C3b, binding by antibody (immunoglobulin), and recognition by Toll-like receptor of immune cells as well as resistance to phagocytosis by phagocytes and killing by phagolysosomes.

It is not known whether new tissue could be regenerated in the canals of teeth with persistent apical periodontitis after root canal therapy using RET. In the present case report, the canal space of tooth #9 decreased in size after RET, likely because of deposition of hard tissue on the canal walls. This finding was also observed in our previous case report of mature teeth with necrotic pulps and apical periodontitis after RET (14). The hard tissue can only be formed by mineralized tissue-forming cells, which must have migrated into the canal after RET. Therefore, thickening of the canal walls and apical closure can also occur in mature teeth with necrotic pulps and apical periodontitis after RET. It has been shown histologically that the tissues regenerated in the canals of mature teeth with necrotic pulps and apical periodontics after RET are cementumlike, bonelike, and periodontal ligament–like tissues in an animal model (15). Although these tissues are not pulp tissue, they are vital tissue. It is likely that such vital tissue might also be regenerated in the canals of teeth with persistent apical periodontitis after root canal therapy, which was retreated using RET in humans in the 2 cases presented here. However, currently, there are no histologic studies available in humans.

In conclusion, if mature teeth with necrotic pulp and apical periodontitis can be treated using RET (12–14), teeth with persistent apical periodontitis after root canal therapy may also be managed with RET after careful root canal infection control (20). The treatment objectives and goals of nonsurgical root canal therapy and RET are the same—elimination of clinical signs/symptoms and healing of apical periodontitis. It may be preferable to fill the disinfected root canals with the host’s own vital tissue rather than with nonvital foreign material. However, randomized, prospective clinical trials are needed to compare the treatment outcome of conventional root canal treatment and RET for teeth with persistent apical periodontitis after root canal therapy.

Acknowledgments

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

References


