Regenerative Endodontic Treatment of an Immature Necrotic Molar with Arrested Root Development by Using Recombinant Human Platelet-derived Growth Factor: A Case Report

Annie Zhujiang, DMD, and Sahng G. Kim, DDS, MS

Abstract

Regenerative endodontic treatment has provided a treatment option that aims to allow root maturation. The present report describes the regenerative endodontic treatment of a necrotic, immature molar by using recombinant human platelet-derived growth factor (rhPDGF-BB) and shows the continued root maturation in the tooth with arrested root development. A regenerative endodontic procedure that used a growth factor was performed for a necrotic molar with arrested root formation in a 20-year-old patient. Thorough disinfection by using mechanical instrumentation and copious irrigation of antimicrobial agents as well as intracanal medication with calcium hydroxide was performed throughout the first 2 appointments. At the third appointment, the root canals were irrigated with an antimicrobial solution and 17% EDTA, and bleeding was evoked by passing sterile paper points beyond the apex in each canal. Small pieces of a collagen membrane saturated with rhPDGF-BB solution from GEM 21S were packed into each canal. Mineral trioxide aggregate was placed, and Cavit and composite resin were used to restore the tooth. Complete root maturation and resolution of a periapical radiolucency were observed at the 15-month follow-up. The present report presents a regenerative endodontic procedure that uses rhPDGF-BB for a necrotic molar with arrested root development. The finding of continued root development in the present case suggests that regenerative endodontic treatment may be able to resume the root maturation process in teeth with arrested root formation. Further clinical studies are required to investigate the efficacy of rhPDGF-BB in regenerative endodontic treatment. *(J Endod 2016;42:72–75)*

Key Words

GEM-21S, pulp regeneration, pulp revascularization, pulp revitalization, regenerative endodontics, rhPDGF-BB, root maturation

Treatment of necrotic teeth with immature apices presents a clinical challenge. Common treatment options such as apexification fail to allow continued root development and leave the tooth predisposed to fracture because of its thin root walls (1). Achieving an adequate apical seal is difficult in a tooth with a large apex and can be managed by long-term calcium hydroxide treatment or placement of a mineral trioxide aggregate (MTA) plug (2). Regenerative endodontic treatment has provided an additional treatment option that aims to allow both continued root formation and apical closure, while restoring immune and sensory functions within the pulpal space (3).

The advancement of pulp regeneration in endodontics has been made possible through progress in tissue engineering. Tissue engineering "integrates the fields of biology and engineering into a discipline that is focused on tissue regeneration instead of tissue repair" (3) and requires a triad of stem cells, growth factors, and scaffolds (4). The protocol for regenerative endodontic treatment has been modified continuously to achieve the optimal environment for the regeneration of the pulp-dentin complex (5). The potential to refine and improve this clinical procedure involves the ability to control the growth factors present in the pulpal space. Growth factors can modify the environment of the stem cells, thus ultimately allowing control of cell fate (6). In a prospective study Nagy et al (7) demonstrated a significant increase in root width and length by using a hydrogel containing basic fibroblast growth factor. Iohara et al (8, 9) showed *de novo* regeneration of the pulp-dentin complex by transplanting autologous stem/progenitor cells and signaling molecules such as granulocyte colony-stimulating factor or stromal derived factor-1 in the root canals of pulpectomized dog teeth.

Recombinant human platelet-derived growth factor (rhPDGF-BB) has already demonstrated its effectiveness in periodontal regeneration (10–13). Platelet-derived growth factor (PDGF) is reported to have chemotactic and mitogenic effects on mesenchymal cells and possesses angiogenic ability (6, 10). PDGF has 4 isoform homodimers (AA, BB, CC, and DD) and 1 heterodimer (AB) (6). PDGF-BB is 1 of 4 homodimers and can bind to cell receptor dimers PDGFR α/α, α/β, and β/β (6). The most effective group within the PDGF family, PDGF-BB (6), comes in the commercially available GEM 21S (Osteohealth, Shirley, NY) and is composed of highly purified rhPDGF-BB and beta-tricalcium phosphate. Using growth factors that promote chemotaxis and proliferation/differentiation of mesenchymal stem/progenitor cells can potentially provide more control of the tissue formed in pulp regeneration and may provide higher and

From the Division of Endodontics, College of Dental Medicine, Columbia University, New York, New York.

Address requests for reprints to Dr Sahng G. Kim, Division of Endodontics, Columbia University College of Dental Medicine, 630 West 168 Street, PH7Stem #128, New York, NY 10032. E-mail address: sgk2114@columbia.edu

0099-2399/$ - see front matter

http://dx.doi.org/10.1016/j.joen.2015.08.026

faster likelihood of clinical success. There are currently no other reported clinical cases that use intracanal rhPDGF in regenerative endodontic therapy. The present report describes the regenerative endodontic treatment of a necrotic, immature molar by using rhPDGF-BB and shows the continued root maturation in the tooth with arrested root development.

Case Report

A 20-year-old man presented to the postgraduate endodontic clinic on September 26, 2012; he was referred by his dentist for evaluation of tooth #18 because of a large periapical radiolucency. The patient had never been symptomatic and had no significant medical history or known drug allergies. Extraoral and intraoral examinations were within normal limits, with no signs of swelling or lymphadenopathy. Tooth #18 had no response to Endo-Ice (Coltene/Whaledent Inc, Cuyahoga, OH), electric pulp test (EPT) (SybronEndo, Orange, CA), percussion, and palpation. The tooth had probing depths of 2–3 mm with normal physiological mobility. Radiographic examination revealed that tooth #18 had a large periapical radiolucency encompassing both the mesial and distal roots, which had open apices (Fig. 1*A*). Adjacent teeth #19 and #20 were unremarkable on clinical and radiographic examination, except for a noted taurodont anatomy. Tooth #18 was therefore diagnosed with pulp necrosis and asymptomatic apical periodontitis.

Because of the presence of open apices on tooth #18, treatment options of apexification or pulp revascularization by using a growth factor, rhPDGF-BB, were discussed. The patient elected to have pulp revascularization. Informed consent was reviewed and signed. The pulp revascularization therapy for tooth #18 was performed under a surgical microscope (Carl Zeiss Meditac Inc, Dublin, CA). One hundred two milligrams lidocaine with 0.051 mg epinephrine (Lidocaine HCl 2%; Henry Schein, Melville, NY) was given via inferior alveolar nerve block and infiltration. Rubber dam isolation (clamp 13A) was achieved, and endodontic access was made. Mesiobuccal, mesiolingual, and distal canals were located. Working lengths were determined by a radiograph (mesiobuccal: 16 mm, #45; mesiolingual: 16 mm, #45; distal: 17 mm, #120) (Fig. 1*B*). The mesial canals were instrumented to size 45 K-file, and the distal canal was instrumented to size 120 K-file. The tooth was copiously irrigated with 60 mL 6% sodium hypochlorite (Clorox Germicidal Bleach; Clorox Company, Oakland, CA) throughout the procedure, and the final rinse was with saline and 20 mL 2% chlorhexidine gluconate (Essential Dental System, Hackensack, NJ). The canals were dried, and calcium hydroxide paste (Dental Therapeutics AB, Nacka, Sweden) was placed with a lentulo spiral (size 40). The tooth was then temporized with cotton and Cavit (3M ESPE, St Paul, MN).

At the following appointment a month later, the patient was asymptomatic. Cleaning and shaping were completed at this appointment. Thirty-four milligrams lidocaine with 0.017 mg epinephrine was given via inferior alveolar nerve block. The rubber dam was placed, and the temporary restoration was removed. Calcium hydroxide was removed by using K-files and 60 mL 6% sodium hypochlorite. Step-back preparation was performed with K-files, forming a 0.05 taper in each canal. The canals were dried with paper points, and calcium hydroxide paste was placed with the lentulo spiral. Tooth #18 was again temporized with Cavit.

At 1 month after the second appointment, the patient was asymptomatic. One hundred two milligrams Carbocaine (Mepivacaine HCl 3%; Septodont, Lancaster, PA) was given via inferior alveolar nerve block and infiltration around tooth #18. Rubber dam was placed, and the temporary restoration was removed. Calcium hydroxide was removed by using K-files and 60 mL 6% sodium hypochlorite. Canals were irrigated and soaked with 17% EDTA for about 1 minute. Canals were dried with sterile paper points, and bleeding was induced by passing sterile paper points (#40, .04) approximately 2 mm past the apex in each canal. The rhPDGF-BB solution from GEM 21S was flowed into each canal. Collatape (Zimmer Dental Inc, Carlsbad, CA) was cut into small pieces, which were saturated with rhPDGF-BB solution and tightly packed into each canal with hand pluggers. Collatape was also placed on the pulp chamber floor in the hope that regeneration might extend to the pulp chamber. MTA (Dentsply Tulsa Dental, Tulsa, OK) was packed against the Collatape. Approximately 2 mm Cavit was placed on top of the MTA. The tooth was restored with shade A2/A3 composite resin (Filtek Supreme XTE; 3M ESPE) (Fig. 1*C*).

At the 1-month follow-up, the patient was asymptomatic since the treatment. Tooth #18 responded negatively to Endo-Ice, EPT, percussion, and palpation. Radiographic examination revealed no remarkable

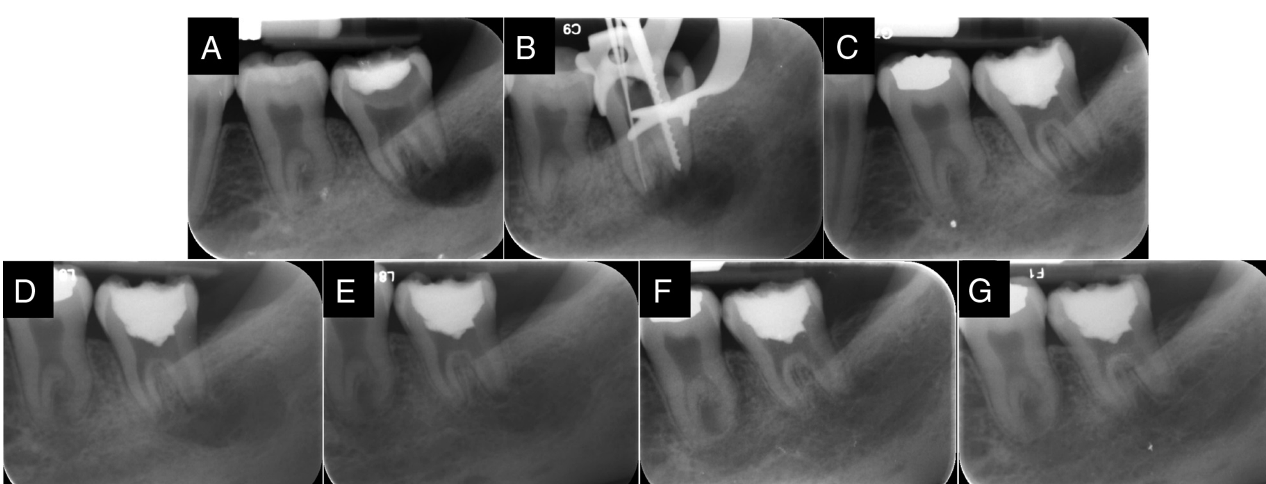

Figure 1. (*A*) Preoperative radiograph of tooth #18 with periapical radiolucency around root apices. (*B*) Working length radiograph. (*C*) Postoperative radiograph showing restoration above cementoenamel junction. (*D*) One-month follow-up radiograph. (*E*) Six-month follow-up radiograph showing decrease in size of radiolucency and complete root maturation. (*F*) Twelve-month follow-up radiograph revealing complete resolution of periapical radiolucency and appearance of lamina dura around the mesial root and further decrease in size of periapical radiolucency around distal root. (*G*) Fifteen-month follow-up radiograph demonstrating complete resolution of periapical radiolucency and appearance of lamina dura around the distal root.