Revitalization of Open Apex Teeth with Apical Periodontitis Using a Collagen-Hydroxyapatite Scaffold

Alan J. Nevins, DDS, and Jerome J. Cymerman, DMD†*

Abstract

An enhanced revision of the revitalization endodontic technique for immature teeth with apical periodontitis has been described. It includes the addition of collagen-hydroxyapatite scaffold to the currently practiced revascularization technique. Four cases treated in series are presented in this report, 1 case involving 2 teeth. Periapical diagnoses of immature teeth included "asymptomatic apical periodontitis," "symptomatic apical periodontitis," and "acute apical abscess." Additionally, 1 fully developed tooth that had undergone root canal treatment that failed had a periapical diagnosis of acute apical abscess. An established revascularization protocol was used for all teeth. In addition to stimulating blood clots, all teeth were filled with collagen-hydroxyapatite scaffolds. Periapical radiolucencies healed in all teeth, and diffuse radiopacity developed within the coronal portions of canal spaces. Root development with root lengthening occurred in the immature nonvital maxillary premolar that had not undergone prior treatment. The technique of adding a collagen-hydroxyapatite scaffold to the existing revitalization protocol has been described in which substantial hard tissue repair has occurred. This may leave teeth more fully developed and less likely to fracture. *(J Endod 2015;41:966–973)*

Key Words

Collagen-hydroxyapatite scaffold, enhanced revascularization technique, regenerative endodontics, root development and thickening

From *Private Practice, Southampton; and †Private Practice, Stony Brook, New York.

Address requests for reprints to Dr Alan J. Nevins, 339 Meeting House Lane, Southampton, NY 11968. E-mail address: AlanJNevins@aol.com

0099-2399/$ - see front matter

http://dx.doi.org/10.1016/j.joen.2014.12.010

If the pulp tissue of a young tooth is damaged by trauma or caries to the extent that irreversible pulpitis with significant pulp necrosis is present, the physiological development of the root is compromised, and advanced endodontic therapy must be initiated. Traditionally, routine treatment requires that the diseased pulp tissue be removed and calcium hydroxide paste or mineral trioxide aggregate (MTA) cement be placed, which allows a thin hard tissue bridge to form and close off the apical portion of the root canal. These various techniques that use calcium hydroxide or MTA cement were performed for many years with variable results (1–3). These procedures were time-consuming and not fully predictable, mainly because of the difficulties in controlling root canal infection and the lack of a stable scaffold. They were performed to enhance the placement of the final root canal filling and prevent extrusion of the filling material into the periapical tissues. Little tissue growth occurs in the paste or cement within the root canal. Because there is no further root development, the treatment leaves the root thin in structure and susceptible to future fracture. Furthermore, for the retreatment of fully developed teeth that leave the apical foramen enlarged, it can be difficult to obturate without overextending the filling material into periapical tissue.

In recent years, there has been a shift in the treatment philosophy of necrotic immature teeth. This inherent potential of tissue to proliferate into the necrotic pulp space of an immature tooth is often referred to as *revascularization* (4). Disinfection techniques have been used in combination with less mechanical debridement, a protocol that has been effective and has resulted in a high frequency (84%) of negative cultures (5). A triple antibiotic paste consisting of ciprofloxacin, metronidazole, and minocycline (6, 7) placed for a period of 1 to several weeks further enhances the process of creating a bacteria-free pulp space that allows for tissue repair. A hand file overextended into periapical tissue creates a blood clot, which serves as a scaffold for the ingrowth of periodontal tissue (8–10). The induction of bleeding has been shown to result in a significant accumulation of undifferentiated mesenchymal stem cells into the canal space (11). These cells may contribute to the regeneration of calcified tissues observed after antibiotic paste therapy of immature teeth with pulpal necrosis. In animal studies, histopathological evaluations have shown that treating infected undeveloped teeth with triple antibiotic paste and the blood clot technique often results in cementum and bone formation within the canal space (12, 13). A retrospective study comparing radiographic and survival outcomes of immature teeth treated with either regenerative endodontic or apexification methods found the survival rate of the revascularization-treated teeth to be the highest (14). However, other studies concluded that the success rate and predictability of the revascularization technique have been only fair because the root structure remains weak in a significant number of cases (15). Kahler et al (16) recently published the results of 16 consecutive clinical cases in which these types of disinfection and regenerative blood clot induction procedures were performed. In a quantitative analysis of radiographs, it was found that only 2 cases resulted in continued root maturogenesis. Additionally, a recent retrospective cohort study that compared 19 teeth treated with revascularization with 12 teeth treated with apexification concluded that revascularization was not superior to apexification. Clinical and radiographic outcomes led to the same conclusion (17). Gomes-Filho et al (18) found that the addition of platelet-rich plasma and bone marrow aspirate to blood clots did not improve tissue ingrowth into debrided root canals of previously infected, fully developed, and overinstrumented teeth. Also, the use of an artificial hydrogel scaffold combined with basic fibroblast growth factor did not enhance the results of the revascularization technique in humans (19).

We sought to assess if the addition of the implantation of a cross-linked collagen-hydroxyapatite scaffold to blood clot stimulation would provide more extensive support for advanced tissue repair. The purpose of this report was to evaluate the effect of using a type 1 cross-linked collagen-hydroxyapatite scaffold on tissue repair in root canal systems of open apex nonvital teeth.

Case 1

A 48-year-old woman was evaluated for a chief complaint of pain and moderate swelling on the right side of her mandible related to an acute abscess of tooth #29. Moderate swelling of the buccal mucosa was evident. A large composite filling was in place. Clinical examination revealed the tooth to be sensitive to percussion and to palpation of the buccal mucosa. Periodontal probing was within normal limits, and the tooth had no mobility. Radiographs and cone-beam computed tomographic (CBCT) imaging showed a periapical radiolucency to be present that was approximately 7 mm in diameter (Fig. 1*A*). The pulpal diagnosis was "previous treatment," and the periapical diagnosis was "acute apical abscess." Root canal treatment had been performed several years before this examination. Retreatment with revitalization endodontic treatment was selected by the patient after various options were reviewed with her. Informed consent in this and cases 2, 3, and 4 included the following options:

1. No treatment
2. Apexification using MTA as a barrier followed by standard root canal filling
3. Regenerative endodontic procedure as outlined on the American Association of Endodontists website updated February 4, 2013
4. Addition of SynOss (Collagen Matrix Inc, Oakland, NJ) collagen-hydroxyapatite scaffold to #3
5. Extraction of the tooth

The patients were advised that SynOss is Food and Drug Administration approved for use in intrabony and periodontal defects, and its use in root canals is off-label. Consent was obtained for 2 CBCT scans. Informed consent was reviewed and signed.

Endodontic access preparation using rubber dam isolation was performed after local anesthetic was given, which consisted of an inferior alveolar nerve block using 1.7 mL Xylocaine 2% with epinephrine 1:100,000 (Dentsply, Cambridge, Ontario) and a buccal infiltration using 1.7 mL Septocaine 4% with epinephrine 1:100,000 (Septodent, Louisville, CO). The existing gutta-percha root canal filling was removed, and the working length was determined radiographically with a size 60 K-file (Fig. 1*B*). The canal was instrumented, irrigated with 6% sodium hypochlorite 10 mL (Coltene/Whaledent, Cuyahoga Falls, OH), 17% EDTA 10 mL (Coltene/Whaledent), and dried with paper points. A creamlike consistency of ciprofloxacin and metronidazole mixed in equal amounts was placed into the canal. Cavit (3M ESPE, St Paul, MN) filling was placed into the access opening.

On a subsequent visit 1 month later, the patient returned and was given a mandibular block and buccal infiltration of 3.4 mL Mepivicane Plain (Septodont). The tooth was reopened, irrigated with 2% chlorhexidine gluconate 10 mL (Coltene/Whaledent), and dried with paper points, and bleeding into the canal was induced with an endodontic file. SynOss Putty implant material was soaked in normal saline solution, cut into several pieces, and placed into the canal. Some material was placed through the apical foramen into the periapical tissue, and the rest was used to fill the entire volume of the canal to the cervical region (Fig. 1*C*). MTA cement (Dentsply, Tulsa, OK) was used to cover the

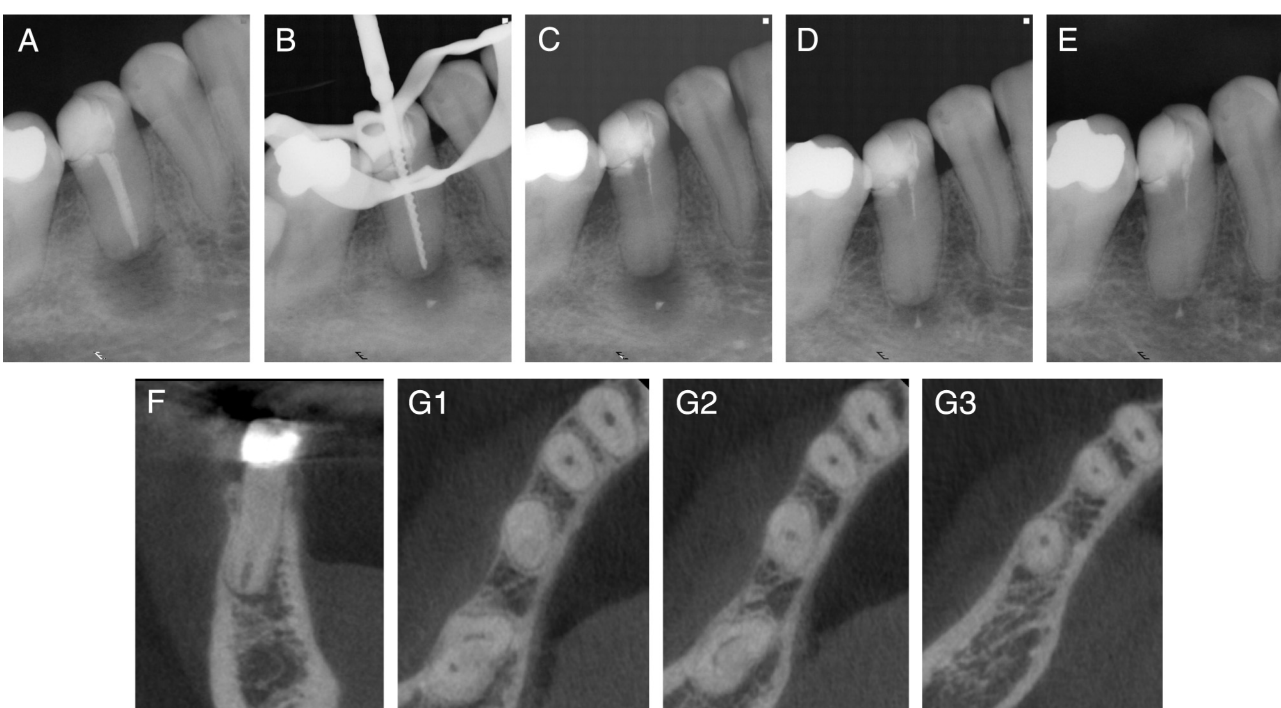

Figure 1. (*A*) A preoperative radiograph of tooth #29 showing a periapical radiolucency approximately 7 mm in diameter and a root canal filling in place. (*B*) A working length radiograph with a size 60 file in place. (*C*) A radiograph taken with SynOss placed into the canal. (*D*) A radiograph taken 6 months postoperatively. (*E*) A radiograph taken 1 year postoperatively. Cone-beam images of case 1 (1 year postoperative): (*F*) coronal view and (*G1–3*) axial views showing radiopacity developing within the canal space in the coronal portion.