Outcome of Revascularization Procedure: A Retrospective Case Series

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Abstract

Introduction: The purpose of this retrospective case series was to investigate the outcome of the revascularization procedure in necrotic immature teeth. **Methods:** The residents and faculty members at the University of Pennsylvania endodontic department were invited to submit consecutive revascularization cases treated by them, irrespective of the outcome, during the time period of 2009 to 2012. Twenty-eight of 35 submitted necrotic immature teeth met the inclusion criteria. The treatment protocol included minimal instrumentation and irrigation with 3% sodium hypochlorite and 17% EDTA. Triple antibiotic paste was placed for a minimum of 21 days. After blood clot induction, either EndoSequence Bioceramic Putty (Brasseler, Savannah, GA) or mineral trioxide aggregate was placed below the cementoenamel junction, and composite was used as a final restoration. The follow-up period ranged from 7 to 72 months. The outcome was assessed as complete healing (the absence of clinical signs and symptoms, complete resolution of periradicular radiolucency, increase in the root dentin thickness/length, and apical closure), incomplete healing (the absence of clinical signs and symptoms, the periapical lesion completely healed without any signs of root maturation or thickening, the periapical lesion either reduced in size or unchanged with/without radiographic signs of increasing root dentin thickness/length, or apical closure), and failure (persistent clinical signs and symptoms and/or increased size of the periradicular lesion). **Results:** Twenty-one of 28 cases (75%) healed completely, 3 cases (10.7%) failed during the observation period and needed further treatment, and 4 cases (14%) presented with incomplete healing. **Conclusions:** Within the limitation of this study, the outcome of revascularization, wherein healing of periapical periodontitis and maturation of roots occurs, is fairly high, making it a viable treatment option in comparison with apexification. *(J Endod 2016;■:1–8)*

Key Words

Apical periodontitis, BioCeramic, mineral trioxide aggregate, outcome, revascularization, success

Significance

Revascularization outcome analysis should include both the radiographic healing of apical periodontitis and the radiographic signs of further root development. The outcome of revascularization wherein healing of periapical periodontitis and maturation of roots occur is high.

Conventional endodontic treatment of necrotic immature teeth with apical periodontitis presents a certain set of challenges. Open apices make achieving an adequate seal during endodontic therapy difficult (1). Disinfection of necrotic immature teeth with traditional mechanical instrumentation and irrigation with sodium hypochlorite have been reported to be not as effective (2), necessitating placement of an intracanal medicament. Although this treatment protocol of apexification has reported high endodontic clinical success, these teeth are prone to post-treatment fracture because of thin fragile root canal walls (3).

Calcium hydroxide apexification has traditionally been the treatment of choice for necrotic immature teeth (4). The goal of this treatment is to induce a hard tissue barrier apically to facilitate root canal filling. However, the treatment protocol calls for multiple visits and hence a compliant patient. Prolonged contact with calcium hydroxide weakens root dentin resistance to mechanical forces, thereby rendering the tooth further susceptible to fracture (5, 6).

To reduce the time for treatment execution, a 1-step apexification technique with mineral trioxide aggregate (MTA) was proposed (7). Nevertheless, this treatment modality does not not promote root canal wall thickening or apical closure. This necessitates the need for an alternative treatment protocol conducive to continued root maturation with deposition of hard tissue, thereby strengthening the tooth and protecting against future loss to root fracture.

Revascularization is a regenerative treatment that is biologically based to allow for root maturation by continued deposition of dentin and a cementumlike structure along the root walls. The foundation of revascularization was laid down in the early 60s by Nygaard-Østby and Hjortdal (8, 9), but the concept behind the contemporary revascularization procedure comes from the trauma literature. It was observed that when an avulsed immature tooth was reimplanted within a certain set of circumstances, revascularization occurred. The main requirements being absence of bacterial challenge, thereby having a necrotic/ischemic but uninfected pulp tissue in the root canal system acting as a scaffold into which new tissue can grow through the large open apical foramina (10). It was postulated that creating a similar

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environment when treating necrotic immature teeth with apical periodontitis should result in revascularization and subsequent root development.

The first case treated with this approach was published in 2001 with promising results (11). An overwhelming number of case reports have been published since. However, the literature lacks outcome studies evaluating the probability of long-term success. Case reports are generally an accumulation of cases that present a successful outcome of the intended procedure. There are very few studies that describe success and failure rates for revascularization. The objective of this retrospective case series was to report the outcome of consecutive revascularization procedures in necrotic immature teeth treated in the endodontic department at the University of Pennsylvania from 2009 to 2012 by faculty and residents regardless of outcome. A set of outcome criteria was established to describe clinical and radiographic success and failure.

Materials and Methods

The University of Pennsylvania endodontic department has a prescribed methodology for the revascularization procedure based on the recommendations of the American Association of Endodontics (AAE) (12). The residents and faculty were invited to participate in this study by submitting consecutive cases treated by them with this protocol during the time period of 2009 to 2012 regardless of the outcome. The resident dental charts for these cases were retrieved via an electronic search using Dentrix software (Henry Schein Inc, Melville, NY). The faculty members were asked to fill out a similar electronic chart with radiographic and other examination notes for submission. Patient's personal information was masked in accordance with the Health Insurance Portability and Accountability regulations.

Each case that fulfilled the following criteria was included in the outcome analysis:

1. An immature permanent tooth with clinical diagnosis of necrotic pulp with or without radiographic signs of apical pathology and the cause of necrosis clearly indicated
2. A tooth treated with the prescribed revascularization protocol
3. A preoperative, postoperative, and follow-up radiograph of at least 6 months after the treatment along with documented clinical signs and symptoms at each of the previous appointments

The preoperative radiographs were checked for immature apices, either blunderbuss canals or wide canals with parallel walls, and in a few cases a moderately developed root but with an open apex.

Patient age, sex, tooth number, dental history, presence or absence of periapical radiolucency, treatment and follow-up periods, and the details of the clinical procedure and any variation were also recorded.

Thirty-five cases were treated and submitted by the residents and faculty during the previously stated treatment duration. A total of 28 immature teeth out of 35 (in 23 patients) between the ages of 8 and 31 years met the inclusion criteria. Seven cases were excluded because of 1 or more of the following reasons: lack of a detailed description of the treatment protocol, less than a 6-month follow-up or no follow-up, and less than ideal radiographic documentation.

The revascularization protocol used was as follows. The treatment was completed in 3 visits; the first visit consisted of the administration of local anesthesia, rubber dam isolation, access preparation, copious irrigation with 3% sodium hypochlorite, minimal or no instrumentation, and placement of triple antibiotic paste (TAP) (metronidazole, ciprofloxacin, and ciprofloxacin [equal parts mixed in distilled water in a 3:1 powder:liquid ratio]; Skywalk Pharmacy, Milwaukee, WI) as an interappointment dressing. An open apex was also verified clinically with a size 100 K-file.

Minocycline was replaced with clindamycin in this composition to reduce the risk of tooth discoloration (12). The access opening was temporarily sealed for these cases for an average of 37 days with a temporary restoration material (Cavit; 3M ESPE, St Paul, MN). At the second appointment, 3% mepivacaine without a vasoconstrictor (Dentsply Pharmaceutical, York, PA) was the local anesthetic of choice. After removal of temporary filling under rubber dam isolation, TAP was flushed out by copious irrigation with 3% sodium hypochlorite and a final rinse with 17% EDTA. The blood clot was induced using a #10 K-file to lacerate the apical tissues. After the blood clot was formed, either EndoSequence Bioceramic Putty (Brasseler, Savannah, GA) or MTA (Dentsply, York PA) was placed below the cementoenamel junction and either over the blood clot directly or using a matrix barrier (Collaplug; Zimmer Dental, Carlsbad, CA) based on the clinician's judgment. The access opening was again temporarily sealed with Cavit. At the final appointment, the setting of bioceramic putty or the MTA was confirmed before placing the permanent composite restoration (3M Filtek P60; 3M ESPE, St Paul, MN). The majority of the follow-up period ranged between 7 and 31 months, with 2 cases being the longest at 4 and 6 years.

TABLE 1. A Summary of Patient Demographics and the Clinical Characteristics and Outcome of the Study Population

Variable	Teeth, *n* = 28 (%)	Complete healing, *n* = 21 (%)	Incomplete healing, *n* = 4 (%)	Failure, *n* = 3 (%)
Tooth type				
Anterior	21 (75)	17 (80.9)	2 (9.5)	2 (9.5)
Premolar	5 (18)	3 (60)	2 (40)	0
Molar	2 (7)	1 (50)	0	1 (50)
Location				
Maxilla	22 (79)	17 (77)	3 (14)	2 (9)
Mandible	6 (21)	4 (66.6)	1 (16.6)	1 (16.6)
Cause				
Caries	5 (18)	3 (60)	1 (20)	1 (20)
Anatomical/caries	3 (11)	2 (67)	1 (33)	0
Trauma	20 (71)	16 (80)	2 (10)	2 (10)
Signs and Symptoms				
Absent	18 (64)	15 (83)	2 (11)	1 (6)
Present	10 (36)	7 (70)	2 (20)	1 (10)
Radiolucency				
Absent	6 (21)	4 (66.6)	1 (16.6)	1 (16.6)
Present	22 (79)	17 (77)	3 (14)	2 (9)