Clinical and Radiographic Outcomes in Immature Permanent Necrotic Evaginated Teeth Treated with Regenerative Endodontic Procedures

Ling Li, DDS, MSc, Yihuai Pan, DDS, PhD,† Liqin Mei, DDS, PhD,* and Jun Li, DDS, MSc†*

Abstract

Introduction: Regenerative endodontics is a promising alternative treatment for immature permanent teeth with necrotic dental pulp. The present study assessed the time to resolution of clinical symptoms and radiographic changes in root dimensions in immature permanent necrotic teeth with dens evaginatus. **Methods:** In this prospective study, clinical and radiographic data were collected for 20 teeth with dens evaginatus treated with a revascularization protocol for 1 year. Tooth survival and success rate were analyzed, and radiographic changes in the radiographic root area, apical diameter, and root length were quantified. **Results:** All 20 treated teeth (100%) survived and met the clinical criteria for success throughout the study period. The within-case percent change in radiographic root area was 28.14% at 3 months and had increased to 97.58% at 12 months. The within-case percent change in apical diameter after 3 months was 21.40% and had increased to 72.90% by 12 months, with 40% (8 of 20) showing complete apical closure at 12 months. The within-case percent change in root length was 2.65% at 3 months and had increased to 23.37% at 12 months. **Conclusions:** In this study, revascularization allowed the continued development of roots in teeth with necrotic pulp as well as excellent overall survival and success rates. *(J Endod 2016;■:1–6)*

Key Words

Clinical research, dens evaginatus, immature teeth, radiographic outcomes, regenerative endodontics

Significance

Knowledge of the clinical and radiographic outcomes in immature evaginated premolars over time in our study will help clinicians to know when they might expect to observe these outcomes in their patients.

Treatment of immature permanent teeth with necrotic pulp status and open apex poses several clinical challenges to the dentist. Because of the presence of thin dentinal root walls, these teeth may be susceptible to root fracture during or after treatment (1). Moreover, gutta-percha would be extended into the periapical tissue because of the open apex. Traditionally, a long-term calcium hydroxide–based apexification procedure has been advocated for inducing formation of a calcific barrier at the apex. However, long-term use of calcium hydroxide can weaken dentin (2). More recently, mineral trioxide aggregate (MTA) has been used in 1-step or 2-step apexification procedures to create an artificial apical barrier (3); however, it still cannot stimulate the development of radicular dentin (4).

Regenerative endodontic treatment (RET), which has been recently recognized by the American Association of Endodontics as a legitimate endodontic procedure for immature permanent teeth with pulpal necrosis, has the potential to allow for continuation of root development and might therefore offer another choice in the management of these teeth (5–10). Although several studies have attempted to predict the timing of continued root lengthening and the decrease in diameter of the apical apex after RET (11–18), the expected rates for the above-mentioned outcomes are still not clear, and the expected rate of increased root area remains unknown.

The etiology of pulp necrosis in immature permanent teeth can include caries, trauma, or dental anomalies such as dens invaginatus and dens evaginatus. Dens evaginatus usually occurs in Asian people and is also referred to as central cusp in premolars (19). A central cusp fracture in the premolars can cause pulpal necrosis and arrested root development, and it is not yet clear how central cusp fracture in premolars as an etiology for pulpal necrosis influences the outcomes of RET. The purpose of this prospective study was to evaluate the timing of clinical and radiographic changes in patients receiving RET in teeth with dens evaginatus.

Materials and Methods

Subjects

Twenty patients (aged 8–12 years) were referred to the pediatric dentistry clinic for treatment of non-vital immature premolars with dens evaginatus. The teeth included 8 mandibular first premolars and 12 mandibular second premolars. Patient-informed consent and approval of the institutional review board had been obtained (WYKQ2014005). The initial diagnosis of these teeth was pulp necrosis with or without apical periodontitis.

From the Departments of *Oral Prophylaxis and Hygiene and †Endodontics, School and Hospital of Stomatology, Wenzhou Medical University, Wenzhou, China.

Address requests for reprints to Dr Jun Li, Department of Endodontics, School and Hospital of Stomatology, Wenzhou Medical University, 373 West Xueyuan Road, Wenzhou 325000, China. E-mail address: endo_lijun@aliyun.com

0099-2399/$ - see front matter

http://dx.doi.org/10.1016/j.joen.2016.10.015

A detailed medical and dental history was collected from each patient's guardians. The study inclusion criteria were non-vital pulp and immature root of premolars with dens evaginatus (stages 7–9 according to the criteria of Nolla (20)). The exclusion criteria were teeth with radiographic signs of internal or external resorption, teeth with periodontal involvement, and subjects with chronic systemic illness. No subjects dropped out during this 1-year prospective study.

Clinical Protocol

A single operator completed all the study procedures at the Pediatric Dentistry Department, Hospital of Stomatology, Wenzhou Medical University, China. At the time of the clinical examination, preoperative signs and symptoms, clinical photographs, and radiographic imaging of the teeth were collected. All 20 teeth were treated according to a 3-appointment or 4-appointment protocol. At the first appointment, the protocol consisted of local anesthesia, rubber dam isolation, getting access to the pulp chamber, and irrigation with copious amount of 2.5% NaOCl without instrumentation. After irrigating, calcium hydroxide paste (Merck, Darmstadt, Germany) was placed in the coronal half of the root canal with a plastic carrier, and the access cavity was sealed with Cavit (3M ESPE, St Paul, MN). Two weeks later, if clinical symptoms persisted, the initial treatment procedures were repeated. Otherwise, the tooth was isolated with a rubber dam for the next treatment. After local anesthesia and removal of temporary restoration, the canal was irrigated with sterile saline solution and dried with sterile paper points. A blood clot was formed in the canal about 2–3 mm below the level of the cementoenamel junction (CEJ) by gentle irritation of the apical tissue with #15 K-file. Fifteen minutes later, MTA (Dentsply Tulsa Dental, Tulsa, OK) was placed over the blood clot and covered by a moist cotton pellet. After 1 week, conventional glass ionomer cement and resin composite were used to fill the access cavity. The patient was followed up at regular intervals of 3 months until 12 months after completion of RET. Follow-up included clinical assessment of pain or discomfort, swelling, sinus tract, mobility, pulp sensibility testing, and acquisition of a periapical radiograph.

Radiographic Outcomes and Analysis

Preoperative and postoperative radiographs were evaluated by the study investigators for the presence or absence of periapical radiolucency (PARL). For quantification of changes in radiographic root dimensions, the radiographic root area (RRA), width of the apical foramen, and length of the root were measured from both the preoperative and recall images, which were modified from the procedure described by Alobaid et al (18). After image standardization by using TurboReg (Biomedical Imaging Group, Swiss Federal Institute of Technology, Lausanne, VD, Switzerland), the RRA, apical diameter, and root length were measured by using NIH ImageJ (version 1.41; National Institutes of Health, Bethesda, MD). The RRA was measured according to Flake et al (21). Briefly, by using ImageJ to measure the total root area and the root canal space, the measurement for RRA was calculated as follows: RRA = total root area–root canal space. For the length of the root, the measurements were done as a straight line from the CEJ to the midpoint of the radiographic apex of the root from both mesial and distal, and the average of both measurements was calculated. The apical diameter was measured as a straight line across the radiographic apical foramen. According to Bose et al (11), we present the data as percentage change from preoperative values rather than the actual millimeter data to minimize one potential source of systematic errors in the overall analysis of treatment outcome. All measurements were collected by the same investigator and repeated after 1 week, and the mean of the 2 replicates was considered as the final value.

Clinical Findings

Clinical findings were evaluated on the basis of both survival and clinical success as used by Saoud et al (16) Survival was defined as the tooth remaining present in the arch throughout the study period. Clinical success was defined as a tooth that survived and did not require another endodontic intervention during the recall period (18).

Statistical Analysis

The data were collected, tabulated, and analyzed by using SPSS 13.0 statistical software (SPSS Inc, Chicago, IL). The McNemar test was used to compare the proportion of cases with and without PARL present and with or without closure of the apical foramen on follow-up at 3, 6, 9, and 12 months versus the baseline proportion of cases. $P < .05$ was considered to be statistically significant. Graphs were generated by using GraphPad Prism 5 (GraphPad Software, Inc, La Jolla, CA).

Results

Baseline Characteristics of the Study Population

The demographics and baseline clinical characteristics of the patients are summarized in Table 1. All treated teeth were premolars with dens evaginatus and with necrotic dental pulp preoperatively and showed radiographic periapical pathology and/or periapical symptomatology. All cases had periapical lesion symptoms, and 55% had radiographic periapical pathology present (Table 1).

Clinical Outcomes

All 20 revascularization cases were followed for 12 months, with review once every 3 months. All 20 teeth survived and met the study criteria for clinical success at 12 months. Five teeth regained responsiveness to the pulp sensibility test (cold, heat, and electrical) during the 1-year follow-up period, and representative cases are presented in Figure 1.

Radiographic Outcomes

The proportion of cases with radiographic evidence of PARL had significantly decreased by the 9-month follow-up visit (Fig. 2*A*). Ninety percent of cases (18 of 20) did not show periapical lesion at 12-month follow-up. The remaining 2 cases still had evidence of PARL but had signs of continued development of roots and no clinical symptoms, so they still met the clinical criteria for success in this study. Thirty

TABLE 1. Patient Demographics and Baseline Characteristics

	Revascularization (N = 20)	
Variable	Teeth	%
Sex		
Female	11	55.00
Male	9	45.00
Age (y)	10.6 ± 0.995	
Tooth type		
Premolar	20	100.00
Tooth location		
Mandible	20	100.00
Signs and symptoms		
Absent	0	0.00
Present	20	100.00
Apical periodontitis		
Absent	9	45.00
Present	11	55.00

Continuous and ordinal variables are presented as mean ± standard deviation. Frequency of all categorical variables is presented as number (N) and percentage (%).