

Histologic Findings of a Human Immature Revascularized/Regenerated Tooth with Symptomatic Irreversible Pulpitis

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Abstract

Introduction: Pulp revascularization/regeneration in immature permanent teeth with necrotic pulp and/or apical periodontitis is an effective approach for inducing root maturation. Previous histologic studies showed cementoid/osteoid tissue and/or periodontal ligament–like tissue formed within the root canals. This case report describes the histologic findings of a human symptomatic irreversible pulpitis immature permanent tooth with most of the pulp removed after a revascularization/regeneration procedure. **Methods:** A human immature permanent mandibular premolar (tooth #29) was diagnosed as symptomatic irreversible pulpitis with symptomatic apical periodontitis at the emergency department. Most of the pulp was removed. The tooth was treated with revascularization/regeneration.

Results: At the 12-month recall, the radiographic examination revealed thickening of the root canal wall, narrowing of the root apex, and lengthening of the root. The tooth was extracted at 12 months for orthodontic treatment. The specimens were processed for histologic examination. Histologically, the apical third of the root canal was filled with newly formed dentinlike and pulplike tissue. There was a layer of flattened odontoblastlike cells lining the dentinal wall. In the mid-portion of the root canal, the newly formed dentinlike tissue gradually changed to cementumlike tissue. In the upper third of the root canal, there was a presence of cementocytelike cells housed in the lacunae of cementumlike tissue around the loose connective tissue.

Conclusions: In the present case, regeneration of the pulplike tissue and the periodontium existed after a revascularization/regeneration procedure in an immature permanent tooth clinically diagnosed as symptomatic irreversible pulpitis. (*J Endod* 2017; ■:1–5)

Key Words

Immature permanent teeth, irreversible pulpitis, regeneration, revascularization

The management of immature permanent teeth with necrotic pulp is a challenging task for dental professionals. The young pulpless tooth with an open apex frequently has thin, fragile walls, which make it difficult to debride adequately and obtain the necessary apical seal using conventional endodontic treatment methods. Calcium hydroxide–based apexification and mineral trioxide aggregate apexification are usually used for these cases. However, neither treatment can solve the problem of the cessation of root development and the subsequent thin and fragile root canal wall (1, 2).

A novel treatment of revascularization/regeneration of immature nonvital teeth was introduced by Iwaya et al (3) and Banchs and Trope (4). They showed that a human necrotic immature permanent tooth after a revascularization/regeneration procedure could achieve increased thickening of the canal walls and continued root development. Since then, many successful cases have been reported (5–8). Radiographically, revascularized human immature permanent teeth had apical closure, root length increasing, and canal wall thickening and gave the impression that a normal, functional pulp had regenerated. However, animal histologic studies of revascularized teeth showed that the new tissue growing in the pulp space was cementoid/osteoid tissue and/or periodontal ligament–like tissue (9–14) regardless of the presence or absence of apical lesion, with or without the introduction of stem cells and scaffold. Almost all human studies of immature teeth with pulp necrosis and apical periodontitis after a revascularization/regeneration procedure showed that the tissues formed in the canal space were similar to the animal studies (15–18), except Torabinejad and Faras (19) in which pulplike tissue was observed in a revitalized tooth.

In an irreversible pulpitis tooth with normal periapical tissues, which was treated with revascularization/regeneration after a deep pulpotomy or a partial pulpectomy, the canal was filled with loose connective tissue similar to the pulp tissue (20). Based on the histologic findings in the case, regeneration of pulplike tissue is possible after a revascularization/regeneration procedure.

This case report describes the histologic observation of a human immature permanent tooth clinically diagnosed as symptomatic irreversible pulpitis after a revascularization/regeneration procedure.

Significance

This case report presents histologic findings of an immature permanent tooth with irreversible pulpitis after pulp revascularization, which is valuable to help clinicians understand the results of pulp revascularization and optimize the revascularization procedure accordingly.

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Case Report/Clinical Techniques

Materials and Methods

An 11-year-old girl was referred from the emergency department to the pediatric department at Peking University School and Hospital of Stomatology, Beijing, China, for the treatment of the lower right second premolar (tooth #29). The child had spontaneous and mastication-evoked pain in the lower right second premolar for 1 month. According to the case records, tooth #29 had a fracture of dens evaginatus. Pain could be induced by the thermal test. The tooth was diagnosed as symptomatic irreversible pulpitis with symptomatic apical periodontitis. The dentist at the emergency department removed most of the pulp and placed a cotton pellet in the pulp cavity of tooth #29 to relieve the pain. The patient went to the department of pediatric dentistry 2 days later. Tooth #29 was sensitive to percussion but negative to palpation. It showed no response to thermal or an electric pulp tester (Vitality Scanner; SybonEndo, Glendora, CA). Radiographic examination revealed an open apex of tooth #29 without noticeable periradicular radiolucency (Fig. 1A). A cotton pellet was found in the access cavity of tooth #29. Bleeding was noted when the root canal was irrigated with 5.25% sodium hypochlorite under rubber dam isolation without administration of a local anesthetic. The patient felt pain at the apical third of the root canals, which was 3–4 mm to the apex when exploring using a file, indicating vital pulp tissue in the apical portion of the root canal. It appeared that a partial pulpectomy might have been previously performed on tooth #29. Indications, procedures, advantages, and disadvantages of apexification and the revascularization/regeneration procedure were explained to the patient and her parents. They chose the revascularization/regeneration procedure, and informed consent was obtained.

Briefly, the root canal was gently irrigated with 20 mL 5.25% sodium hypochlorite solution with an irrigation syringe 2 mm above the residual pulp tissues and then dried with sterile paper points. A mixed antibiotics paste of ciprofloxacin, metronidazole, and minocycline based on the method Hoshino et al (21) previously described was placed in the root canal space, and the access cavity was sealed with Coltosol F (Coltene-Whaledent, Altstätten, Switzerland). A week later, the temporary filling was missing for 3 days. The root canal was disinfected using 20 mL 5.25% sodium hypochlorite irrigation and triple antibiotic paste intracanal medication 1 more time. At the third visit, the tooth showed mild sensitivity to percussion. Local infiltration with 2% lidocaine without vasoconstrictor was administered. After removing the remaining antibiotics paste under rubber dam isolation, the root canal was irrigated with 10 mL 5.25% sodium hypochlorite solution and 10 mL sterile saline and dried with sterile paper points. A size #30 K-file was then introduced into the root canal and pushed beyond the apex toward the periapical tissue to create bleeding into the canal. However, there was no bleeding noted in the root canal except on the file. After 10 minutes, no more bleeding was observed, and the accessed cavity was sealed with Fuji IX glass ionomer cement (Fuji Corporation,

Osaka, Japan) followed by Filtek Z250 composite resin restoration (3M ESPE, Irvine, CA).

Clinical examination of the patient at the 3-month recall showed the tooth was asymptomatic. The tooth was not sensitive to percussion or palpation and showed no response to ice, heat, or an electric pulp tester. The radiographic examination revealed minimal lengthening of the root without thickening of the canal wall (Fig. 1B).

At the 12-month recall, the tooth was asymptomatic. The tooth was still not sensitive to percussion or palpation and showed no response to thermal or electric stimuli. The radiographic examination revealed thickening of the root canal wall, narrowing of the root apex, and lengthening of the root, which showed the continual development of the root (Fig. 1C).

Twelve months later, the tooth was planned to be extracted because of orthodontic treatment. After an inferior alveolar block using 2% lidocaine with 1:100,000 epinephrine, bleeding was observed from the pulp cavity when the filling was removed. There was no calcified bridge formed when explored with a file. After extraction, the tooth was immediately fixed in 4% formaldehyde for 48 hours and decalcified in 10% EDTA (pH = 7.5) for 6 months at 4°C. Then, the specimen was dehydrated in ethanol, embedded in paraffin, and serially sectioned (to 5- μ m thickness) along the long axis of the tooth. The sections were stained with hematoxylin-eosin and examined under a light microscope.

Results

Histologically, the apical third of the root canal was filled with newly formed dentinlike and pulplike tissue (Fig. 2A and B). There was a clear line between the new dentinlike tissue and the previous dentin (Fig. 2C). There was a layer of flattened odontoblastlike cells lining the dentinal wall of the apical root canal. The newly formed dentinlike tissue contained dentinal tubules (Fig. 2D). The pulplike tissue with hypercellular and hypervascular connective tissue appeared to be an extension of periapical tissue. In the midportion of the root canal, there was amorphous tissue enveloped with fibers and phagocytes and inflammatory cells (Fig. 2E and F). The newly formed dentinlike tissue gradually changed to cementumlike tissue (Fig. 2G), which was not well connected with the dentinal wall and extended into the root canal space. In the upper third of the root canal, there was a presence of cementocytelike cells housed in the lacunae of cementumlike tissue. The loose connective tissue was around the cementumlike tissue (Fig. 2H). The increased root length and thickness were caused by apical deposition of newly formed dentinlike and cementumlike tissue.

Discussion

The present study showed that there were 4 types of tissues formed in the root canal after the pulp revascularization/regeneration procedure: dentinlike tissue, pulplike tissue, cementumlike tissue, and loose

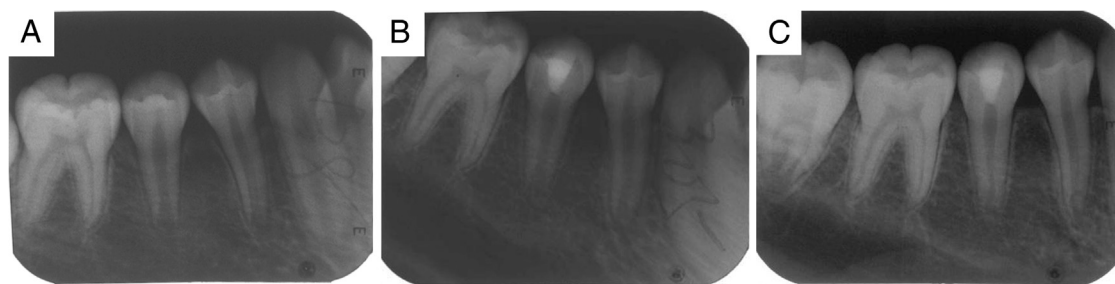


Figure 1. (A) The preoperative radiograph of tooth #29. (B) The postoperative radiograph at the 3-month recall. (C) The postoperative radiograph at the 12-month recall.

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