Pulp Revascularization of Immature Dens Invaginatus with Periapical Periodontitis

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Abstract

Introduction: Dens invaginatus is a rare developmental malformation of a tooth caused by the invagination of the tooth crown before biological mineralization occurs. The complex anatomy of these teeth makes nonsurgical endodontic treatment difficult and more so when there is presence of periapical periodontitis with open apex. The endodontic treatment of dens invaginatus is a challenge, especially in the case of periapical periodontitis with open apex. Pulp revascularization is a conservative endodontic treatment that has been introduced in recent years. Presented here is a variant approach for the treatment of immature dens invaginatus type II with periapical periodontitis, which combines filling of the invagination and pulp revascularization. **Methods:** After accessing the pulp chamber, the main canal and the invagination were explored. The root was thoroughly disinfected by irrigating and medication, invagination was filled, and the main canal was revascularized. Then the coronal sealing was made by glass ionomer cement and composite resin. Radiograph taken regularly and computed tomography scan were used to investigate the healing of the periapical lesion and development of the root. **Results:** In the subsequent follow-up, the periapical lesion was completely eliminated, the open apex was closed, and the wall of the root was thickened. **Conclusions:** For type II immature dens invaginatus with large periapical lesion, conservative endodontic treatment should be considered before periapical surgery. With sufficient infection control, pulp revascularization can be an effective alternative method. *(J Endod 2013;39:288–292)*

Key Words

Conservative endodontic treatment, dens invaginatus, immature permanent tooth, periapical periodontitis, pulp revascularization

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Dens invaginatus is a rare malformation of a tooth caused by the invagination of the tooth crown before biological mineralization occurs. Other names for this type of malformation are dens in dente, invaginated odontoma, dilated composite odontoma, tooth inclusion, and dentoid in dente (1). In the published literature, controversy exists regarding the terminology of this anatomic defect because of lack of consensus on the etiology of the anomaly.

Currently, there are several theories giving different hypotheses on the etiology of dens invaginatus; however, no agreement has been reached, and it remains unclear (1, 2). Hülsmann (1) presented a number of theories that have been proposed to explain the mechanisms of dental coronal invagination, including growth pressure of the dental arch, focal failure of growth of the internal enamel epithelium, rapid and aggressive proliferation of a part of the internal enamel epithelium, distortion of the enamel organ, fusion of 2 tooth germs, infection, and trauma.

The incidence of dens invaginatus has been reported to be in the range of 0.04%–10% (3, 4), with the upper lateral incisors most commonly involved. Isolated cases have been reported in the mandibular region and in the deciduous dentition (5–7).

The most popular and commonly used classification of invaginated teeth has been proposed by Oehlers (2): type I, invagination confined within the crown; type II, invagination as a blind sac extending beyond the cementoenamel junction but not reaching the periodontal ligament; and type III, invagination extending beyond the cementoenamel junction, with the second foramen extending into the periapical tissues or into the periapical area.

In most cases, the thin or incomplete enamel lining of the invagination cannot prevent the entry of bacteria into the pulp, which leads to pulp necrosis and eventually develops into periapical inflammation. The complex anatomy of dens invaginatus may compromise instrumentation, disinfection, and obturation of the root canals. Moreover, the infected invaginations may also lead to the early necrosis of pulp tissue before the completion of root development, leaving the tooth with an open apical foramen.

The treatment options for an invaginated tooth include preventive sealing or filling of the invagination, root canal treatment, endodontic periapical surgery, intentional replantation, and extraction. Treatment of an invaginated tooth can be combined with periapical surgery after insufficient root canal treatment or intentional replantation after failed periapical surgery (8, 9). In certain cases, endodontic treatment techniques may involve removal of the dens invaginatus from the root canal, apexification, obturation of the invagination alone while maintaining pulp vitality, and surgical treatment of the invagination alone (10–14).

The treatment of immature permanent tooth with periapical periodontitis is a challenge in pediatric dentistry, especially in the anatomic abnormal tooth such as dens invaginatus. The traditional treatment of immature permanent tooth with periapical periodontitis is apexification because there is little to no expectation of continued root development, and because of the likelihood of root fracture and reinfection, the prognosis of this method is not ideal.

In recent years, several clinical case reports proved that for immature permanent tooth with pulp necrosis or periapical periodontitis, continued root development can be accomplished by conservative treatment after disinfection of the root canal system, evoked bleeding into the root canal, and adequate coronal seal. Those procedures are called pulp revascularization of immature permanent tooth (15–18). Increasing

Figure 1. The crown of maxillary right lateral incisor was cone-shaped without caries.

numbers of clinicians have used pulp revascularization for the treatment of immature permanent tooth with periapical periodontitis and had ideal results; they believe that this conservative approach may substitute for the traditional apexification as the preferred treatment method for the immature tooth with periapical periodontitis and sinus tract (19).

To test the effectiveness of pulp revascularization in the treatment of immature dens invaginatus with periapical periodontitis, this article presents a clinical case applying pulp revascularization as a conservative method to successfully treat a maxillary lateral incisor with necrotic pulp, type II dens invaginatus, and large periapical lesion.

Case Report

An 11-year-old male patient without a history of systemic compromise was referred to the Department of Pediatric Dentistry, School of Stomatology, Peking University for endodontic treatment of a maxillary left lateral incisor. The patient complained of pain during mastication for the previous 2 days.

Clinically, the crown of the maxillary right lateral incisor was cone-shaped without caries (Fig. 1). The tooth was sensitive to percussion as well as palpation, with grade 2 mobility, and the palatal gingiva was swelling with periodontal probing depths less than 3 mm, which indicates the swelling more likely results from apical lesion rather than periodontal lesion. The tooth showed a negative response to pulp sensibility testing with ice. A periapical radiograph and cone-beam computed tomography (CT) scan revealed a type II invagination extending from the crown to the middle root, with no apparent communication to the main canal, and the presence of extended radiolucent area around the open apex (Fig. 2). The left lateral incisor was normal clinically and radiographically. There was no history of orofacial trauma.

After written informed consent was obtained from the patient's parents, the tooth was isolated with a rubber dam. Under no local anesthesia, endodontic access was made without any exudation but was accompanied by foul odor. The extirpated pulp appeared gray-black in color; thus, the necrotic nature of the pulp was confirmed.

By exploration, the position of the main canal and a second canal, the invagination, was determined; the main canal was located distal to the invagination. Without any instrumentation, the 2 canals were irrigated with 30 mL 5.25% NaOCl, followed by sterile normal saline, and then gently dried with paper points. After that, triple antibiotic paste (a creamy paste made of equal proportions of metronidazole, ciprofloxacin, and minocycline that was mixed with normal saline by a compounding pharmacist of Peking University School of Stomatology) was delivered into the 2 canals with lentulo spiral instrument, and then the tooth was temporized with Cavit G (3M ESPE, St Paul, MN) for a week.

At the following appointment, the patient's symptoms were partially relieved. After 4 weeks of consecutive irrigation and medication, the patient was asymptomatic; the tooth was not sensitive to percussion or palpation, and the localized swelling was resolved. The invagination was obturated with GuttaFlow (Coltène/Whaledent, Langenau, Germany), and the following radiograph revealed the invagination

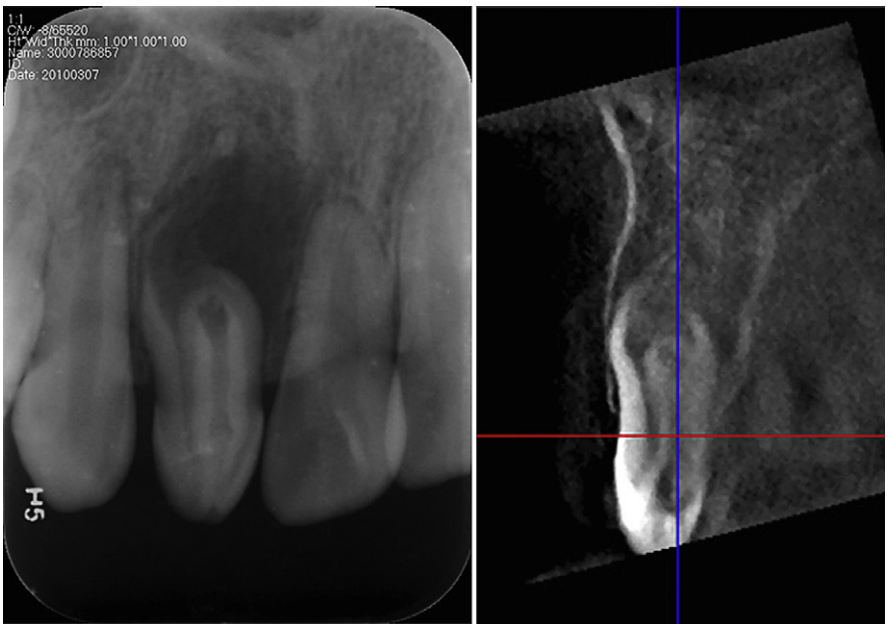

Figure 2. Radiographic examination and cone-beam CT scan revealed a type II invagination extending from the crown to the middle of the root, with no apparent communication to the main canal, and the presence of extended radiolucent area around the open apex.

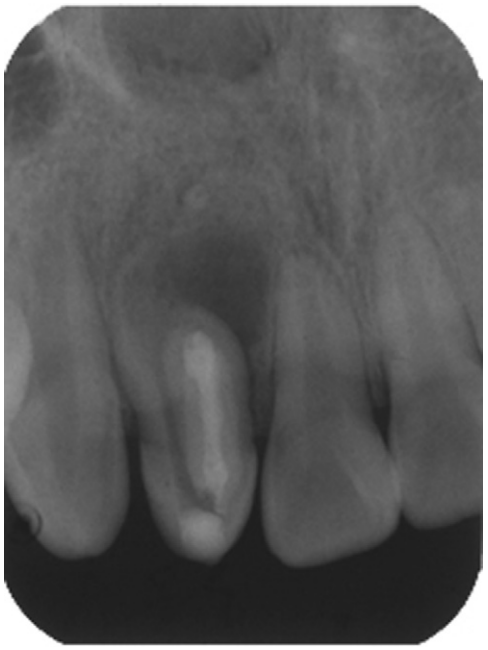

Figure 3. After 4 weeks of consecutive irrigation and medication, the patient was asymptomatic. The invagination was fully obturated by GuttaFlow, which is radiopaque.

was thoroughly radiopaque (Fig. 3). After irrigating the main root canal with 2.5% NaOCl and normal saline and drying the canal with paper point, periapical tissues of the main canal were irritated by #30 K-file, but bleeding was not evoked; there was no blood found in the root canal orifice except on the tip of 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 adhesive composite resin (Filtek Z250; 3M ESPE).

After placement of Fuji IX glass ionomer cement and composite resin, radiographs taken once a month showed that the range of the periapical radiolucency gradually reduced.

At the 24-month follow-up, the patient continued to be asymptomatic. In clinical examinations, the tooth was functional with normal periodontal condition and insensitive to percussion and palpation, and there was no presence of swelling. However, the tooth was not responsive to cold testing. A periapical radiograph and cone-beam CT scan revealed that periapical radiolucent lesion was eliminated completely, open root apex was closed, and the wall of the root canal was thickened (Fig. 4). This conservative treatment of immature dens invaginatus with periapical periodontitis has reached ideal result. Then the tooth was restored to normal shape with adhesive nanocomposite resin (Filtek Z350; 3M ESPE). Because the crown of the dens invaginatus had been discolored by minocycline, which is a component of the triple antibiotic paste used in the treatment, the treated tooth was darker in color than the adjacent ones (Fig. 5).

Discussion

The case presented here was diagnosed as an Oehlers type II invaginatus that invaded into the root beyond the level of cementoenamel junction, ending as a blind sac and never reaching the periapical tissues. Although there was no detectable coronal caries or retrograde infection, the maxillary right lateral incisor had pulp necrosis and periapical periodontitis. The infection may have come from a small pit on the lingual aspect of the invaginated tooth crown that allowed the penetration of bacteria into the invagination and further into the pulp chamber because of weak enamel and dentin, leading to pulp necrosis, periapical inflammation, and cessation of root formation.

Dens invaginatus is a critical developmental abnormality of teeth resulting from an invagination of the enamel organ. Dental treatment is often required because the invagination may allow irritants into the pulp space that cause inflammation of the pulp or even the periodontal tissue.

Because of the complex anatomy of dens invaginatus, it is difficult to carry out endodontic treatment, especially with pulp necrosis and

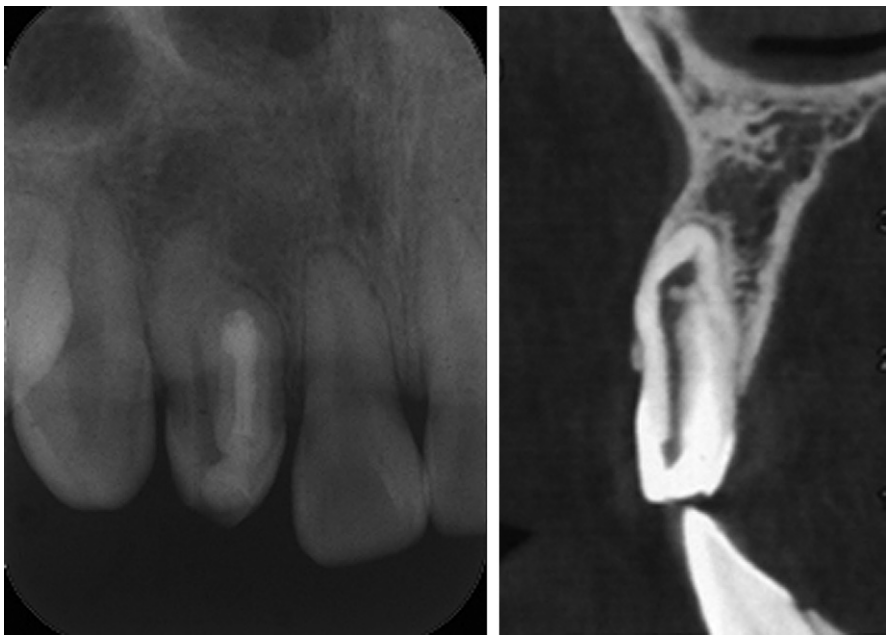

Figure 4. Radiographic examinations and cone-beam CT scan showed periapical radiolucent lesion was eliminated completely, open root apex was closed, and wall of the root was thickened.

Figure 5. After treatment reached ideal result, the tooth was restored to normal shape with adhesive nanocomposite resin. Because the crown of the dens invaginatus had been discolored by triple antibiotic paste, the treated tooth was darker in color than the adjacent ones.

periodontitis before the completion of root development or apical closure.

Regardless of the size of the periapical lesion, surgical treatment should be performed only when nonsurgical endodontic treatment has failed (20). Thus, conservative endodontic treatment was the top priority for this case.

Because there was a large periapical lesion in the immature type II invaginatus, simple preventive sealing or filling was not enough. To eliminate the periapical lesion and promote the root development, endodontic treatment should be performed. Apexification is the traditional treatment for the immature permanent tooth with nonvital pulp (21, 22). Canal irregularities between the main canal and the invagination may prevent the direct contact of antibiotics or medication such as calcium hydroxide (23), so traditional apexification was not suitable for the presented case. Moreover, the apexification can only induce a calcific barrier at the open apex but cannot thicken the wall of the root canal, and the prognosis is not ideal. Another nonsurgical endodontic treatment is to perform apexification after complete elimination of the invagination by #70 or larger K-file (24). After apexification, the strength of the root is usually weak, especially when invagination is eliminated, so the root is likely to fracture, which makes it difficult for future prosthetic treatment.

In 2001, pulp revascularization was first introduced by Iwaya et al (15) in treatments of immature permanent teeth with pulp necrosis or apical periodontitis. Since then, many other successful case reports of pulp revascularization have been published. Huang et al (25) determined that the open apex of immature permanent tooth provided a good communication from the pulp space to periapical tissue; therefore, it may be possible for periapical lesion to occur while the pulp is only partially necrotic and infected. Along the same line of reasoning, stem cells in pulp tissue and in apical papilla may also have survived the infection and allowed regeneration of pulp and root maturation to occur, and the infection could have spread through surviving pulp tissue, reaching the periapex.

Although pulp revascularization is not tissue regeneration but wound repair, as indicated by animal experiments (26), it can effectively heal the periapical lesion and thicken the wall of root canal; hence it can prevent the root from fracture and reach long-term retention. Therefore, pulp revascularization is still the ideal treatment for the presented case.

During the treatment, we followed the protocol of the published articles about pulp revascularization, including minimal or no instrumentation of canal while relying on gentle but thorough irrigation of the canal system with 5.25% NaOCl, disinfection with intracanal medication of triple antibiotic paste between appointments, evoked bleeding into the root canal, and finally adequate coronal sealing.

Despite the fact that invagination is not a real canal, root canal filling is still important, because the enamel and dentin of invagination are so weak that irritants can easily penetrate the main root canal and cause infection. For type I and II dens invaginatus, the invagination should be filled closely with or without the presence of pulp infection (1, 23).

In the presented case, the periapical tissue was irritated with #30 K-file, but there was little bleeding into the canal. Therefore, it is impossible to place mineral trioxide aggregate (MTA) over the blood clot as required by the protocol. On the other hand, the anatomic complexity of dens invaginatus increased the difficulty of MTA placement. After filling of the invagination and irritation of the periapical tissue, we sealed the accessed cavity with composite resin, after Fuji IX glass ionomer cement, a biocompatibility material, was placed onto the filled invagination instead of MTA.

Pulp revascularization is a new treatment protocol for immature permanent teeth with periapical periodontitis. In the presented case, which combined the filling invagination, we used this variant method as conservative endodontic treatment for type II immature dens invaginatus with large periapical lesion. Radiographic follow-up after 24 months showed that the periapical lesion had been eliminated completely, and the open apex had closed.

This case illustrates that even for type II immature dens invaginatus with large periapical lesion, conservative endodontic treatment should be considered at first instead of periapical surgery. With sufficient infection control, pulp revascularization can be an effective alternative method.

Acknowledgments

The authors deny any conflicts of interest related to this study.

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