Endodontic treatment of dens invaginatus: A 5-year follow-up

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Dens invaginatus is an anomaly of the tooth formation of embryonic origin that presents itself in several morphologic types. The complex anatomy of these teeth makes nonsurgical endodontic treatment complex and more so when its apex is immature. The 2 cases reported illustrate the nonsurgical endodontic management of a dens invaginatus type II and type III with an immature apex and periapical lesions, in which mineral trioxide aggregate (MTA) in one case, and calcium hydroxide in the other one, were the materials used. A 5-year follow-up of both cases shows a complete periapical healing with bone formation at the site of the lesions. **(Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2006;101:E15-21)**

Dens invaginatus has been defined as a defect in tooth development, characterized by invagination of the enamel organ before the calcification phase.[1] Other names for this type of malformation are dens in dente, invaginated odontoma, dilated gestant odontoma, dilated composite odontoma, tooth inclusion, and dentoid in dente.[2]

It was described for the first time in 1794 by Ploquet[3] who found this malformation in a whale's tooth.[4] A dentist by the name of Socrates in 1856 was the first to report a dens in dente in human teeth.[5] Several theories have illustrated the etiology of dens invaginatus, however at the present time they remain unclear. Kronfeld[6] speculated that dens invaginatus is caused by a failure in growth of the internal dental epithelium while at the same time there is also a proliferation of the surrounding normal epithelium, producing a static area of engulfing. Oehlers[7] considered that the distortion of the enamel organ during tooth development and the subsequent protrusion of a part of this can lead to a formation of a lineal enamel canal that ends at the cingulum and in some cases at the incisal border, producing an irregular crown shape.

The incidence of dens invaginatus has been reported to be in a range of 0.04% and 10%,[8,9] with the upper lateral incisors the teeth most commonly involved. Isolated cases have been reported in the mandibular region and in the deciduous dentition.

Dens invaginatus has been classified into the following 3 types according to the depth of the invagination and the degree of communication with the periodontal ligament or the periradicular tissue.[7]

Fig. 1. Case #1. Initial radiograph of tooth #10 with a Dens Invaginatus type II and immature apex. There is a large periradicular radiolucency associated with the tooth.

- Type I: invagination confined inside the crown, not extending beyond the cementum enamel junction (CEJ).
- Type II: invagination extending beyond the CEJ, it may or may not communicate with the pulp and not reach the periradicular tissue.

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Fig. 2. Case #1. Radiograph showing the removal of parts of the invagination using a K-Flex file #70.

Fig. 3. Case #1. Eight-week postoperative radiograph. Orthodontic treatment has started and an open coil spring can be observed. The root canal of tooth #10 is filled with calcium hydroxide. There are signs of healing of periradicular tissues.

- Type III: invagination extending beyond the CEJ penetrating the root and exhibiting a second foramina in the apical third within the periradicular tissue.

Most cases of dens invaginatus are detected after a routine radiographic evaluation with a panoramic x-ray and confirmed with a periapical film. Clinically, a morphologic alteration of the crown or a deep foramen coecum can serve as an indication for the diagnosis of dens invaginatus. On the other hand, the main reasons for consultation are acute pain and inflammation. Histological, fragile hypomineralized enamel is frequently seen at the site of the invagination; this condition facilitates the formation of dental caries and the penetration of microorganisms from the saliva directly into the pulp, leading to pulp necrosis and the development of a periradicular inflammatory process.[2]

Several treatment modalities have been described for these teeth, all of them related to the degree of complexity of its anatomy. They include nonsurgical endodontic treatment,[10] endodontic surgery,[11] intentional replantation,[11] and finally extraction.[12] In cases in which there is an immature apex, the use of calcium hydroxide inside the root canal has been proposed to stimulate apexification.[13]

Witherspoon and Ham[14] have described an apical closure technique in a single appointment using mineral trioxide aggregate (MTA) in teeth with pulp necrosis and immature apex, reporting it as an alternative to the traditional apexification technique with calcium hydroxide. Other authors also have reported clinical success with the apical closure technique with MTA.[15-17]

This article presents 2 successful cases of treatment of dens invaginatus. The first one using MTA (Dentsply, Tulsa Dental Company, Tulsa, Okla) in a dens invaginatus type II and the second one using calcium hydroxide (Calcifar P, EUFAR, Bogotá, Colombia) in a dens invaginatus type III, both cases with a diagnosis of pulp necrosis and chronic periradicular abscess.

Fig. 4. Case #1. Radiograph showing apical plug of 4 mm mineral trioxide aggregate (MTA).

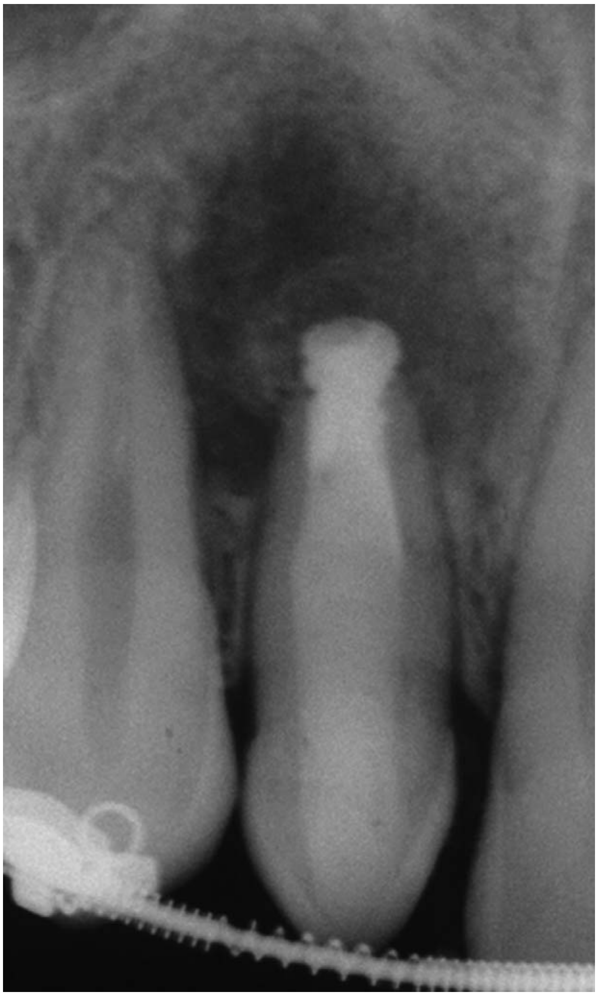

Fig. 5. Case #1. The root canal was finally filled with glass ionomer to reinforce the dentine walls.

CASE REPORT #1

A male patient of 15 years of age without a history of systemic compromise was referred by his dentist for evaluation and management of an upper left lateral incisor (tooth #10). The patient complained of acute pain during the previous 12 hours. The extraoral initial examination revealed edema on the left side of the face compromising the upper left canine and the infraorbitary space. Intraorally, tooth #10 showed a peg-shaped clinical crown, with a marked depression in the palatal aspect near the cingulum. It was sensitive to palpation as well as to horizontal and vertical percussion, with a grade 2 mobility. Periodontal probing showed a deep periodontal pocket that drained purulent material on the vestibular side.

A periapical radiograph revealed the presence of a dens invaginatus type II, with immature apex in tooth #10, associated with a large periapical radiolucency of approximately 25 mm $\times$ 30 mm partially involving the periradicular area of the upper left canine (#11) (Fig. 1). Sensitivity tests to cold and heat and electric pulp test confirmed vitality of tooth #11 and the final diagnosis for tooth #10 was pulp necrosis with chronic periradicular abscess.

As an emergency treatment the abscess was drained through the vestibular sulcus. Antibiotics (amoxicillin 500 mg every 8 hours for 7 days) and anti-inflammatory analgesics (ibuprofen 400 mg every 8 hours for 4 days) were prescribed. Six days later the patient was seen again and the edema had disappeared. Local anesthesia (Lidocaine 2% with epinephrine 1:80 000) was applied, and under complete isolation of the operative field with rubber dam and wedjets (Coltène Whaledent Inc, Mahwah, NJ) an adequate endodontic access cavity was performed with diamond and carbide burs #2. Then complete elimination of invagination was done with the aid of a K-Flex #70 file (Dentsply-Maillefer, Ballaigues, Switzerland) (Fig. 2).

After establishing optimal length work in the radiograph, the canal was disinfected with 5.25% sodium hypochlorite, then dried with absorbent paper points. Calcium hydroxide was placed as medication inside the canal; this was changed every 2 weeks for a period of 2 months. During this time the

Fig. 6. Case #1. Follow-up radiograph of tooth #10 5 years after the treatment was completed. There is complete healing of the periradicular tissues.

Fig. 7. Case #2. Initial clinical aspect of tooth #7. The presence of a sinus tract on the bucally of #7 on the alveolar process.

Fig. 8. Case #2. Initial radiogram of tooth #7. There is a Dens Invaginatus type III and a periradicular lesion.

orthodontist increased the mesial distal space between teeth #9 and #11 using an open coil spring (Fig. 3). The endodontic access cavity was always sealed temporarily with Coltosol (Colténe Whaledent Inc) cement.

An apical barrier of 4 mm in thickness was created with Pro Root MTA (Dentsply, Tulsa Dental Company) (Fig. 4) and it was left with a cotton pellet moistened with distilled water for 48 hours. At the following appointment the cotton pellet was removed and after verifying the setting of MTA, the rest of the canal was filled with Vitremer glass ionomer (3M ESPE Dental Products, St. Paul, MN, USA) (Fig. 5).

Finally, the peg-shaped tooth #10 was corrected by means of a small incisal reduction and reconstruction with composite resin. A radiograph after 5 years of treatment shows complete healing of the periradicular tissue (Fig. 6).

CASE REPORT #2

A male patient of 14 years of age without a history of compromising systemic diseases was referred by an orthodontist for evaluation and management of an emergency situation. The patient reported acute pain for the previous 24 hours, localized in the upper right lateral incisor (tooth #7). Extraoral

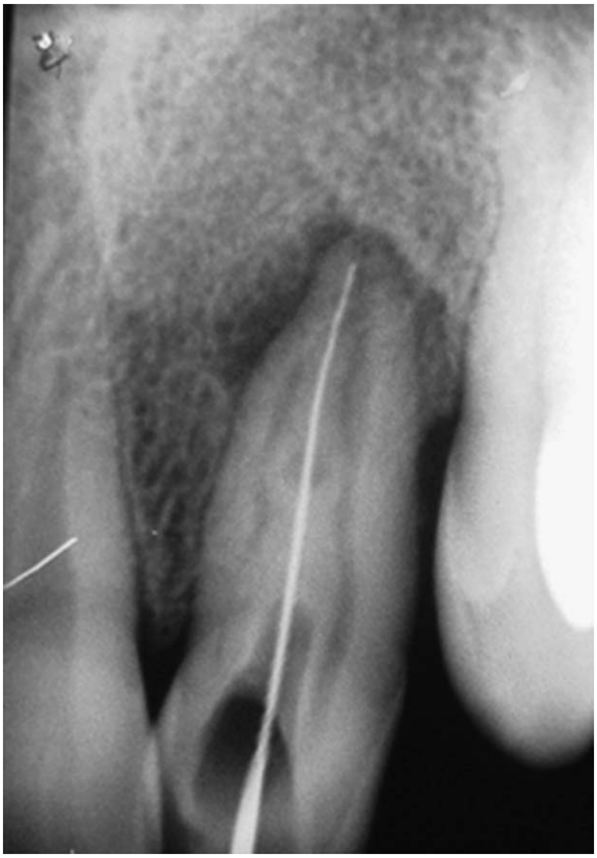

Fig. 9. Case #2. Initial exploration of the main canal with a K-Flex #15 file.

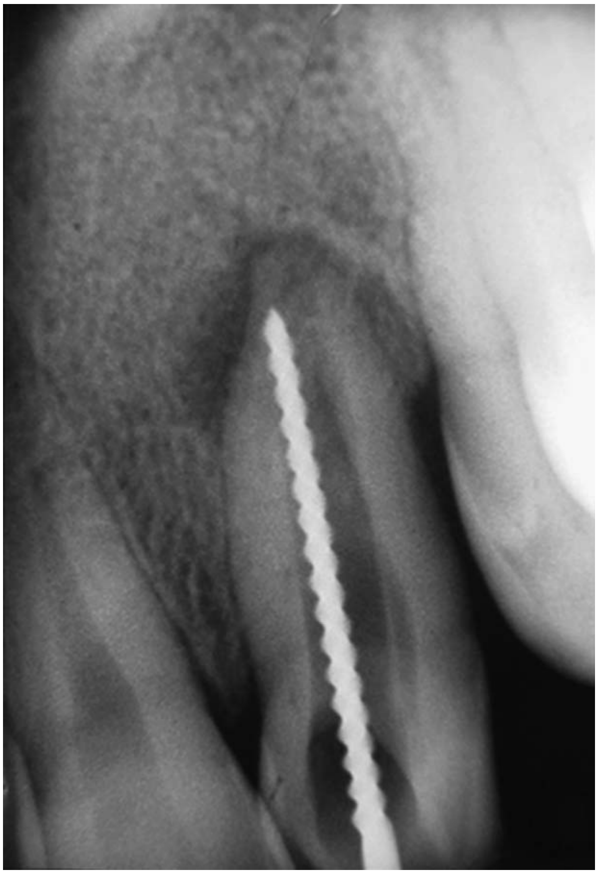

Fig. 10. Case #2. Complete elimination of the invagination and the rudimentary canals. There is one wide root canal. K file #110.

clinical examination revealed no facial asymmetry. Intraorally the tooth showed mesial inclination of the crown, no change in color when compared to the adjacent teeth, and in the palatal aspect small resin restoration near the cingulum was present.

The evaluation of soft tissues showed a sinus tract in the vestibular gingival adjacent to tooth #7 (Fig. 7). Horizontal and vertical percussion tests revealed a highly sensitive tooth and the absence of vitality was confirmed with thermal stimulation with cold, heat, and electric pulp tester. A periapical radiograph revealed the presence of a dens invaginatus type III extending from the pulp chamber to the apical foramina, and a periapical radiolucency associated with this tooth (Fig. 8). Based on this evaluation, the diagnosis for tooth #7 was pulp necrosis and chronic periradicular abscess.

Local anesthesia (Lidocaine 2% with epinephrine 1:80 000) was applied and under rubber dam isolation with wedjets (Coltène Whaledent Inc) an adequate endodontic access cavity was performed with diamond and carbide burs #2. It was initially instrumented with a K-Flex #15 file (Dentsply-Maillefer, Ballaigues, Switzerland) and an adequate working length was determined based on the radiograph. The absence of apical closure was also established (Fig. 9). The disinfection was carried out with 5.25% sodium hypochlorite and with the use of manual K-Flex files sequentially from sizes #40, 80, and 110 (Dentsply-Maillefer, Ballaigues, Switzerland), the invagination and rudimentary canals were eliminated until a wide canal was obtained (Fig. 10).

The canal was initially filled with calcium hydroxide (Calcifar-P, EUFAR, Bogotá, Colombia) for a period of 2 weeks (Fig. 11). Then, monthly changes were made during a 14-month period during which the tooth was under orthodontic treatment. The access cavity was closed with IRM cement (Caulk/Dentsply, Milford, DE, USA). A periapical radiograph at this time (Fig. 12) revealed an advanced healing in the periradicular tissue and evidence of apical closure, which was clinically corroborated as successful. The rest of the canal was filled using vertical condensation technique with thermoplastic gutta-percha (Ultra Fill System, Hygienic Corporation, Akron, Ohio) and a zinc oxide eugenol-based cement (Grossfar, EUFAR, Bogotá, Colombia). The restoration of the crown was done at a later appointment with a composite resin. Five-year follow-up revealed a complete healing of the inflammatory process associated with the tooth #7 (Fig. 13).

DISCUSSION

Nonsurgical endodontic treatment in teeth with dens invaginatus should be the first treatment alternative

Fig. 11. Case #2. Radiograph of tooth #7 after 15 days with calcium hydroxide.

Fig. 12. Case #2. Radiograph of tooth #7 after 14 months with calcium hydroxide. The calcium hydroxide has allowed tissue healing with apical closure. The periradicular tissue has healed.

before recurring to endodontic surgery, intentional replantation, or extraction of the tooth. However, endodontic treatment of dens invaginatus type II and III can become complicated because of an unpredictable internal anatomy.[2] A complete disinfection of the canal is of great importance to promote healing of affected periradicular tissues. In this case, sodium hypochlorite as irrigation and calcium hydroxide as intracanal medication between appointments were used to obtain this result.[18]

One of the major problems in endodontic therapy in teeth with pulp necrosis and open apex is obtaining an adequate closure of the root canal. The clinical procedure required for these teeth is based on the principle of pulp space disinfection allowing the formation of a mineralized tissue barrier at the apex of the tooth[15]; calcium hydroxide is the most commonly used medication for this purpose.[19,20]

MTA has been proposed as a material for immediate closure of the apical opening without waiting for a natural healing process. This will create an apical barrier in the canal preventing the extrusion of root filling material into the periapical tissues.[21] It has been demonstrated that MTA induces the formation of a calcified matrix in the periapical tissue and regeneration of new cement, possibly associated with its high sealing capacity, biocompatibility, alkaline pH, and liberation of substances activating the cementoblasts, which in turn will deposit a matrix for the cementogenesis.[22,23]

The dens invaginatus types II and III reported here had a diagnosis of pulp necrosis and chronic periapical abscess with immature apex. For both cases the endodontic procedures were necessary and resulted in successful outcome with either of the 2 materials used.

The importance of adequate coronal seal in has been demonstrated.[24,25] During extended endodontic treatment it is important to prevent leakage through temporary intervisit restorations. For this reason, the apical

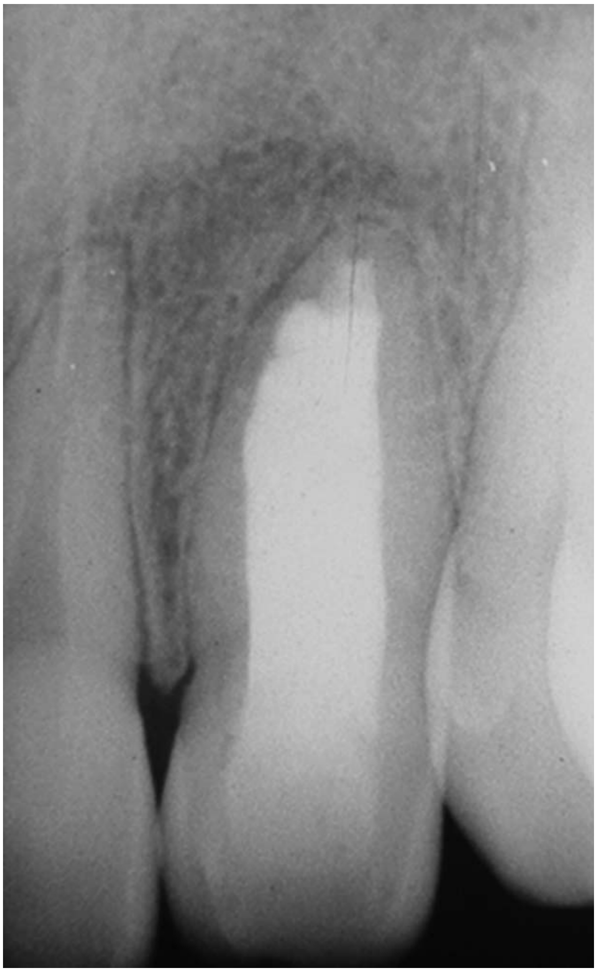

Fig. 13. Follow-up radiograph of tooth #7 5 years after completed treatment. There is complete healing of the periradicular tissues.

closure technique using MTA in one appointment has been suggested in order to avoid contamination of the canal between appointments. The treatment period when using calcium hydroxide to obtain a biological apical closure is long, introducing concerns about intervisit contamination of the pulp space.[19]

In case #1 the root canal was filled apically with an approximate thickness of 4 mm of MTA. At a later appointment the rest of the root canal was filled with glass ionomer. This was an attempt to reinforce the root, as there is a high incidence of root fracture after endodontic treatment in these types of teeth with large pulp spaces.[26]

Five-year follow up of the 2 cases of dens invaginatus showed clinical and radiographic success after orthograde endodontic treatment.

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