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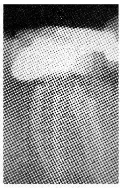

CASE REPORT

Calcium hydroxide barrier over the apical root-end of a type III *dens invaginatus* after endodontic and surgical treatment

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Abstract

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Aim To report the simultaneous endodontic and surgical treatment of a tooth associated with Oehlers type III ***dens invaginatus*** and a persistent periapical lesion, which comprised root-end resection, root-end filling and application of a calcium hydroxide barrier placed on the resected dentine surface.

Summary Three root canals were identified in a tooth with a type III ***dens invaginatus***, which presented with a necrotic pulp, wide foraminal opening and extensive periapical lesion, and with a previous history of acute abscess, intracanal exudate and fistula. After root canal preparation followed by intracanal application of calcium hydroxide pastes, the clinical–pathological status persisted. After periapical curettage and root-end resection, the root canals were filled, followed by root-end filling with Sealer 26 mixed with zinc oxide powder to a clay-like consistency. Calcium hydroxide paste was then applied over the exposed dentinal surface forming a covering over the root apex. At the 20-month follow-up examination the patient had no symptoms and no fistula; advanced periapical bone repair was obvious on the radiograph.

Key learning points

- Because of the variable morphology and extent of invagination, type III ***dens invaginatus*** represents a challenge for conventional treatment, often leading to the need for a surgical approach.
- Sealer 26 thickened with zinc oxide powder provided satisfactory clinical properties for use as a root-end filling material.
- Application of a calcium hydroxide barrier over the resected root-end is a potential treatment option to encourage tissue repair.

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Introduction

The *dens invaginatus* also called *dens in dente*, dilated composed odontoma or gestant odontoma, is a developmental disturbance resulting from invagination of the enamel organ toward the dental papilla before mineralization; it may be limited to the tooth crown or invade the root to affect the periapical region (Shafer *et al.* 1987). According to Pindborg (1970), the aetiology of this malformation is unknown, yet the following explanations have been proposed: (i) delayed focal growth, (ii) stimulation in the area of the tooth bud and (iii) abnormal pressure on tissues surrounding the dental organ. The incidence ranges from 0.04% to 10% and primarily affects the permanent dentition, especially the maxillary lateral incisors, although primary teeth may also be affected (Hovland 1977, Gotoh *et al.* 1979).

Clinically, the crown of an affected tooth may appear normal or have size and shape alterations. Thus, there may be greater buccolingual diameter, peg-shaped or barrel-shaped teeth or a talon cusp. Mild invaginations exhibit only a lingual pit, which is often clinically unnoticed. However, when the crown is large and has a prominent cusp with a palatogingival groove, the occurrence of *dens invaginatus* is assumed (Takeda *et al.* 1991, Girsch & McClammy 2002, Tsurumachi *et al.* 2002, Tsurumachi 2004). According to the extent of the invagination into the tooth structure, Oehlers (1957) proposed the following classification: type I, characterized by a small invagination limited to the crown not extending beyond the cementoenamel junction; type II, the line delineating enamel invagination invades the root, yet is limited to it as a 'cul-de-sac' configuration, without reaching the periodontal ligament, yet it may communicate with the tooth pulp and type III, a severe form of invagination extending through the root and ending at the apical region without direct communication with the tooth pulp. According to Bhatt & Dholakia (1975), this root variability of *dens invaginatus* is usually related to folding of the Hertwig's epithelial sheath.

Radiographically, the roots present smaller dimensions with presence of a radiopaque formation with density similar to that of enamel, which is invaginated from the cusp through variable extents into the root. This invagination varies in shape and size, and may present a loop-like or pear-shaped configuration or a slightly radiolucent structure, to more extensive and bizarre shapes, simulating a 'tooth within a tooth' (Gotoh *et al.* 1979, Gound & Maixner 2004, Jung 2004, Tsurumachi 2004). Hygiene around the area of invagination is difficult or impossible, which reveals the importance of early diagnosis, which may be completed from radiographs even before tooth eruption (Vajrabhaya 1989, Jung 2004).

Histologically, the structure of a *dens invaginatus* is composed of internal enamel, dentine, connective tissue nucleus and blood supply. The internal enamel is remarkably hypomineralized and the dentine is uniformly mineralized (Beynon 1982). Gotoh *et al.* (1979) highlighted that the thin canals or fissures connecting the invagination to the pulp cavity act as pathways through which microorganisms and irritating agents from the oral cavity may lead to pulp alterations before the development of caries.

Case report

Previous dental history

A female patient aged 16 years was referred by a general practitioner to the Endodontic clinic at the Federal University of Vales do Jequitinhonha e Mucuri-MG, Diamantina, Brazil, for evaluation and treatment of a maxillary right central incisor. The previous dental history identified a cause of treatment for an acute dentoalveolar abscess in a public health centre, but the treatment was not completed as a result of the complexity of the case. Clinical examination of the teeth compared with their antimeres revealed the larger crown of the maxillary right central incisor in both mesiodistal and buccolingual directions and an enamel projection on the palatal aspect associated with a well-defined fissure. There was no caries or periodontal pocketing. Sensitivity tests by cold (Endo-Ice; The Hygienic Corporation, Akron, OH, USA), electric (Vitapulp; Pelton & Crane Company, Charlotte, NC, USA) and hot stimulus (by application of a heated gutta-percha point) were negative for both maxillary right central and lateral incisors, whereas the adjacent teeth responded within normal limits. Initial radiographic examination (Fig. 1), revealed a temporary restoration in the crown of the maxillary right central incisor associated with abnormal root morphology and a periapical radiolucent area on the maxillary right central and lateral incisors. The previous dentist had proposed root canal treatment of these teeth, however, only the treatment for the maxillary right lateral incisor could be completed, because of the complex root anatomy of the maxillary right central incisor, which had two root canals (Fig. 2). The previous dentist also reported that calcium hydroxide paste had been placed in the maxillary right lateral incisor for approximately 2 months before filling. However, after 1 month, a buccal fistula had appeared between the maxillary right central and lateral incisors.

Clinical and radiographical examination, diagnosis and treatment planning

Clinical examination of the patient revealed a fistula, the large crown of the maxillary right central incisor, moderate sensitivity to vertical percussion and upon palpation of the buccal mucosa. Radiographically, the root length of the maxillary right central incisor was shortened and the complicated root morphology was observed, as well as an extensive periapical lesion of 18 mm in the largest diameter. The pathway of the fistula traced with a fine-medium gutta-percha point (Fig. 3) revealed its origin between the two teeth (Fig. 4). Consequently, a diagnosis of pulp necrosis associated with the chronic periapical lesion between the maxillary right central and lateral incisors was established, with occurrence

Figure 1 Diagnostic radiograph reveals root canal with bizarre morphology and extensive periapical inflammation tooth 11.

Figure 2 Initial probing of the maxillary right central incisor revealed a wide palatal root canal with a single buccal root canal.

Figure 3 Pathway of the fistula traced with a fine-medium gutta-percha point.

of Oehlers type III *dens invaginatus* in the maxillary right central incisor. The patient was informed of the problem and its negative influence on conservative endodontic treatment, as well as the likely need for a surgical approach.

Root canal treatment

At the first session, access to the pulp chamber of the maxillary right central incisor was followed by spontaneous drainage of purulent exudate. After cleaning the pulp chamber, a mass of invaginated hard tissue was observed in a mesiodistal direction, which established a limit between a large palatal root canal and a narrow buccal fissure. The palatal canal had several irregularities on its walls and a wide foramen with a funnel-shape, which was accessed to the working length with a size 80 file. Another root canal was observed at the distal angle of the buccal fissure, suggesting the presence of three root canals with two foraminal openings (Fig. 5). The 'septum' was nearly removed during instrumentation with files and Gates-Glidden burs, especially at the coronal and mid-root levels. After biomechanical preparation complemented by irrigation with 5.25% sodium

Figure 4 Radiographical appearance of the gutta-percha point following the fistulous pathway.

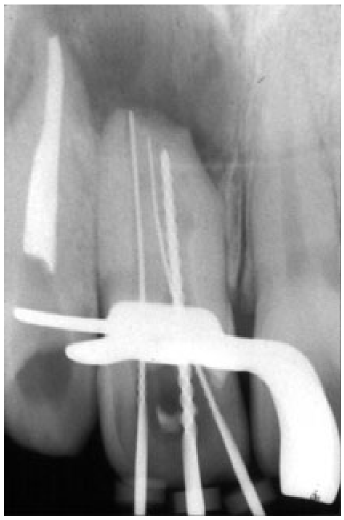

Figure 5 Radiographical observation of the three root canals in *dens invaginatus*.

hypochlorite solution, calcium hydroxide paste (Calen/CPMC, SS White Artigos Dentários, Rio de Janeiro, Brazil) was applied and replaced monthly on two occasions. However, the intracanal exudate and fistula persisted during this period. The outcome of the root canal treatment of the maxillary right lateral incisor was not assured and its retreatment was proposed. Thus, after removal of the gutta-percha, from this tooth a wide foraminal opening corresponding to a size 55 file was noted. Based on a previous radiograph (Fig. 2) the presence of an apical perforation or 'zip' was assumed. After completion of biomechanical preparation a root canal dressing was applied, made up of calcium hydroxide and 2% chlorhexidine digluconate (FGM Produtos Odontológicos, Joinville, Brazil) to a toothpaste consistency. After 20 days, the fistula and intracanal exudate on the maxillary right central and lateral incisors remained. Periapical surgery with simultaneous root canal filling was therefore planned.

Periapical surgery with simultaneous root canal filling

After local anaesthesia, a sulcular rectangular flap with two vertical releasing incisions was performed, followed by dissection of the mucoperiosteal flap. After completion of bone removal, curettage of the periapical lesion was performed. After sectioning the apical 3 mm of the maxillary right central and lateral incisors (Fig. 6), access was obtained to the root apices with a size 80 file, by orthograde route. Repeat root canal instrumentation and saline flushing was therefore performed. The root apices were smoothed with fine-fine tapered diamond burs (KGSorensen, Barueri, São Paulo, Brazil), under irrigation with saline. Rolled gutta-percha points were fabricated, softened by heat and seated 3 mm short of the root apex. After irrigation and drying, canal filling was performed with Pulp Canal Sealer-EWT (Kerr Sybron Dental Specialties, Glendora, California, USA) and a thermomechanical gutta-percha condensation technique. After radiographical evaluation, the apical 2 mm were filled from the surgical approach. For that purpose, Sealer 26 (Dentsply Indústria e Comércio Ltda, Petrópolis, Brazil) was mixed with zinc oxide powder to achieve a claylike consistency (Fig. 7) and was then condensed into the root-end cavity, leaving approximately 1 mm of empty space, which was filled with a paste prepared with calcium hydroxide and saline solution. The dentine surface exposed by the root-end resection was covered with this paste, forming a 'calcium hydroxide apical barrier' with an approximate thickness of 1 mm (Fig. 8). After suture placement, the crown was restored with light cured composite resin. A periapical radiograph then was exposed (Fig. 9). Analgesics and anti-inflammatory drugs (Naproxen, Syntex, São Paulo, Brazil) were prescribed in the postoperative period, as well as a cold face compress. The 20-month follow-up period revealed substantial periapical bone repair (Fig. 10) and no signs or symptoms.

Discussion

Several treatment options for *dens invaginatus* have been reported, including preventive restorative treatment, root canal treatment, combined root canal and surgical treatment, intentional replantation and extraction (De Smith & Demaut 1982, Suchina *et al.* 1989, Vajrabhaya 1989, Tsurumachi *et al.* 2002). The Oehlers type III *dens invaginatus* is a challenge for root canal treatment, requiring knowledge and clinical experience (Tsurumachi *et al.* 2002, Gound & Maixner 2004). The difficulties of treatment are closely related

Figure 6 The pathological tissue was removed surgically, with subsequent root-end resection.

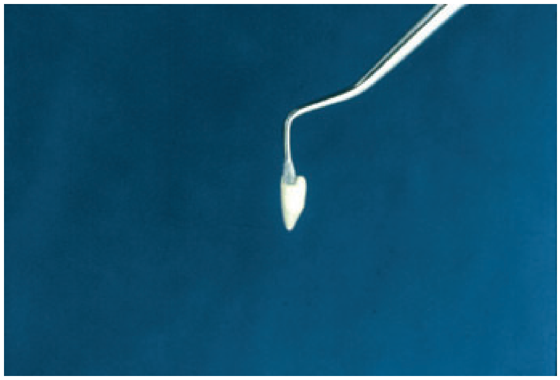

Figure 7 Claylike consistency of the retrograde obturation material composed of Sealer 26 + zinc oxide powder.

Figure 8 Calcium hydroxide apical cover applied on the dentine surface.

to the complexity, the type and extent of invagination. In these most complex cases, challenges are initiated by location of root canal openings. Utilization of a surgical microscope might be useful at this stage, because of the magnification and better lighting of the canal system (Girsch & McClammy 2002, Jung 2004).

The present case report represents the extreme form of *dens invaginatus* and similar to the reports of Gound & Maixner (2004) and Tsurumachi (2004), the root canal walls were lined with a tissue similar to enamel and resistant to instrumentation. As stated by Girsch & McClammy (2002), the aim was to widen these invaginations with files and Gates-Glidden burs, for complete removal of this mass of invaginated tissue, as it may be separate from the remaining tooth structure. However, it was not possible to remove it because of the presence of a fold of tissue connecting the invagination to the tooth structure. This bizarre root anatomy (with many branches, narrowing, irregular walls and wide and irregular foraminal openings) impaired adequate chemo-mechanical cleaning, shaping and antisepsis, which consequently contributed to the persistent exudate and fistula, i.e. the failure of conservative root canal treatment.

During root treatment in patients with pulp necrosis and periapical radiolucent areas, instrumentation, intracanal antiseptic medication followed by filling of the principal root canals and its branches are fundamental for a good clinical and radiographical outcome.

Figure 9 Radiographic appearance after endodontic and surgical treatment. Note the adequate obturation of the root canal system of the *dens invaginatus*.

Figure 10 Advanced periapical bone repair after 20 months.

Most cases of post-treatment failure are associated with the persistence of microorganisms in areas of the root canal systems not accessible to the mechanical action of files and the chemical effect of intracanal antiseptics (irrigants and intracanal medication), as well as the occurrence of extra-radicular infection – the microbial biofilms located on the cement resorptions surrounding the apical foramen and in the structure of granulomas and apical cysts (Leonardo *et al.* 2002, Soares 2003). Therefore, even after application of both calcium hydroxide formulations, it was not possible to eliminate or effectively neutralize the endodontic infection, with persistence of exudate and fistula. Tracking of the fistula pathway did not allow establishment of the specific tooth that was not responding to treatment; thus, retreatment was performed on the maxillary right lateral incisor, followed by surgical intervention on the maxillary right central and lateral incisors.

The type of surgery employed intends to provide the best outcomes considering the clinical–pathological conditions of the present case (Soares *et al.* 1999). Root-end filling was performed to achieve a better apical seal of the root canals with utilization of Sealer 26 which is a resin sealer derived from AH26 that has been shown to have a satisfactory performance for apical sealing (Soares *et al.* 2002). This cement was thickened with zinc oxide to improve its application in the apical 2 mm of the root canal and reduce its solubility in periapical fluids. The solubility of Sealer 26 is much reduced, by the addition of zinc oxide (Siqueira Jr *et al.* 2001). As it dissolves, it is likely to be progressively replaced by periapical connective tissue which grows into the retropreparation. This tissue is initially loose connective, with collagen fibrils, blood vessels and reparative cells (fibroblasts and cementoblasts), which develops into a rather fibrotic and dense tissue which may later become partial mineralized. Complete apical closure with hard-tissue formation would be the last step of this healing process, named biologic seal (Holland *et al.* 1979, Leonardo *et al.* 1993, 1993a, Soares & Santos 2003). The utilization of calcium hydroxide, to form a barrier on the sectioned root surface, in close contact with the periapical tissues, is based on the studies of Holland & Bernabé (1998). The reason of using the calcium hydroxide instead of another biomaterial, such as MTA (mineral trioxide agreggate), was based in the following factors: (i) both present a similar mechanism of action; (ii) calcium hydroxide can maintain a lasting alkalinity, as it does not set in the presence of moisture, unlike MTA; (iii) the continuous solubility of calcium hydroxide is very good for the tissues, as the calcium and hydroxide ions stimulate the periapical healing process and (iv) calcium hydroxide is far less expensive than MTA (Holland & Bernabé 1998, Soares 2003).

This type of treatment has provided satisfactory clinical and radiographical outcomes (Soares *et al.* 2002), and histologically it is associated with a lower incidence of root resorption on the sectioned dentine, combined with a higher frequency of partial or complete apical biological sealing by mineralized tissue (Holland & Bernabé 1998). The calcium hydroxide barrier may also be related to the limited periapical extrusion of these pastes, which have revealed excellent tissue response (Soares 2003). These microscopical findings corroborate the clinical observations; thus, at the 20-month follow up, the patient was asymptomatic and radiographical examination revealed substantial periapical bone regeneration associated with lack of apical root resorption.

Conclusions

The Oehlers type III *dens invaginatus* presents a complex root canal system that impairs proper cleaning, shaping and antisepsis. Considering the failure of conservative root canal treatment, periapical surgery with simultaneous root canal filling followed by application of a calcium hydroxide apical barrier represents an additional promising treatment option for teeth with anatomical variation and extensive periapical inflammation.

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