Diagnosis and treatment of dens invaginatus with open apex in a young adult patient by using cone-beam computed tomography and operative microscope

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Abstract

Background Dens invaginatus is a developmental anomaly that can affect both deciduous and permanent dentition. The anomaly is caused by the invagination of the enamel organ into the dental papilla prior to the calcification of the dental tissues. The treatment option changes according to the classification, from the simple filling of the invaginated enamel area to root canal treatment with or without retrograde surgery, intentional re-implantation, or the extraction of the affected tooth.

Case report In this study we report a case of a maxillary lateral incisor invaginatus in a young adult patient. The periapical endoral X-ray showed the presence of a periapical radiolucency in tooth 22, that had a structure similar to a tooth inside it and an immature apex. Cold thermal testing showed that it was not a vital tooth. CBCT confirmed the diagnosis of Oehler Class II dens invaginatus. The treatment plan involved root canal treatment of both the "true" and the "invaginated" canal using calcium hydroxide-based intermediate medication. Then, after removing the hard internal structure with the aid of an operative microscope, MTA was used to close the immature apex. Finally, the large endodontic space was filled with self-etching, self-adhesive, dual curing resin cement. The patient was included in a follow-up programme to monitor and verify the complete healing of the periapical bone of the affected tooth.

Conclusion The use of technology and of special materials allowed an adequate management and resolution of the case reported.

KEYWORDS Dens invaginatus; Developmental anomaly; Enamel.

Introduction

Dens invaginatus, also known as *dens in dente* is a developmental anomaly that can affect both deciduous and permanent dentition in both maxillary and mandibular teeth, with a greater prevalence in maxillary lateral incisors [Hülsmann, 1997]. The anomaly is caused by the invagination of the enamel organ into the dental papilla prior to the calcification of the dental tissues; later, as the hard tissues are forming, the invaginated enamel organ produces a small denticle within the future pulp chamber [Fayazi et al., 2013]. The prevalence of permanent teeth affected by this anomaly, as reported in several studies in literature, varies from 0.3% to 10%; the percentage of affected individuals varies from 0.25% to 26.5% [Thakur et al., 2014].

Although several classifications have been described, the Oehler classification is still the most valid and complete one, describing three classes of dens invaginatus based on the extent and on the coronal or radicular location of the invagination [Oehlers, 1957] as follows.

- Class I: The invagination is minimal and enamel-lined, it is confined within the crown of the tooth and does not extend beyond the level of the external cementoenamel junction.
- Class II: The invagination is enamel-lined and extends into the pulp chamber but remains within the root canal with no communication with the periodontal ligament.
- Class III a: The invagination extends through the root and communicates laterally with the periodontal ligament space through a pseudo-foramen. There is usually no communication with the pulp, which lies compressed within the root.
- Class III b: The invagination extends through the root and communicates with the periodontal ligament at the apical foramen. There is usually no communication with the pulp.

The possible causes reported in the literature for determining the anomalous development of a dens invaginatus are genetic factors, pressure caused by contiguous dental germs, focal failure of growth of internal enamel epithelium, distortion of the enamel organ, fusion of tooth germs, infection and trauma [Hülsmann, 1957; Hosey and Bedi, 1996; Alani and Bishop, 2008].

The treatment options change according to the classification, from the simple filling of the invaginated enamel area to root canal treatment with or without retrograde surgery, intentional re-implantation or extraction of the affected tooth.

The aim of this work is to report a case that involved conservative treatment of a dens invaginatus, where the invagination had given rise to a structure that was radiographically similar to a tooth contained in the endodontium of an upper lateral incisor that had gone into necrosis before the complete radicular apex formation. New technologies such as the operative microscope and CBCT,

FIG. 1 Vestibular fistula caused by the left lateral incisor.

FIG. 2 Periapical intraoral X-ray showing periapical radiolucency in tooth 22.

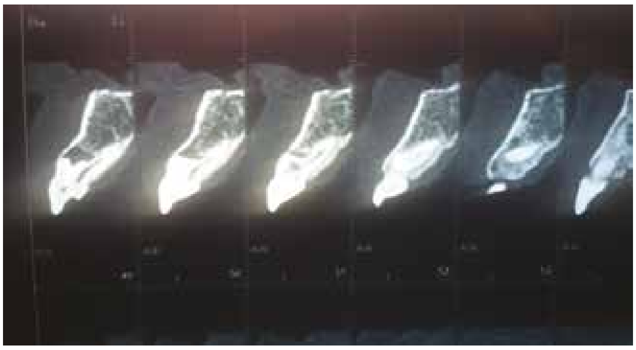


FIG. 3, 4 CBCT confirmed the diagnosis of Class II dens invaginatus.

which allowed a better understanding of the anomalous tooth anatomy, were used to support treatment.

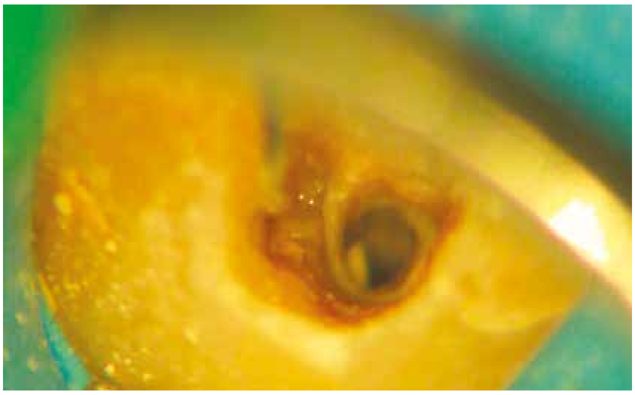
Case report

The patient, AS, aged 34, with a history of repeated vestibular abscesses at tooth 22 since childood, and with an ongoing vestibular fistula was sent to our private practice in Palermo by a colleague who had not been able to probe the root canal of tooth 22 (Fig. 1). After examination, the crown of the upper left lateral incisor was found to be larger than its contralateral one. The periapical intraoral X-ray showed a periapical radiolucency in tooth 22 with an immature apex that had a structure similar to a tooth inside it (Fig. 2). Cold thermal testing showed that the tooth was not vital. CBCT confirmed the diagnosis of Class II dens invaginatus, clearly showing the extent and area of invagination (Fig. 3, 4). Furthermore, CBCT highlighted the "C" shape of the broad "true" canal and a small area of hard tissue, a sort of dentinal bridge, between the walls of the canal and the inner formation.

The treatment plan involved root canal treatment of both the "true" canal and the "invaginated" canal using calcium hydroxide-based intermediate medication in order to try to fill the whole endodontium and form a calcific barrier on the open apex using the classic apexification technique.

Root canal treatment was carried out with the aid of a microscope so as to disinfect, bore and shape not only the invaginated part, but above all, also the endodontium around the invagination, which had a "C" shape (Fig. 5).

After placement of the dam, the pulp chamber was opened



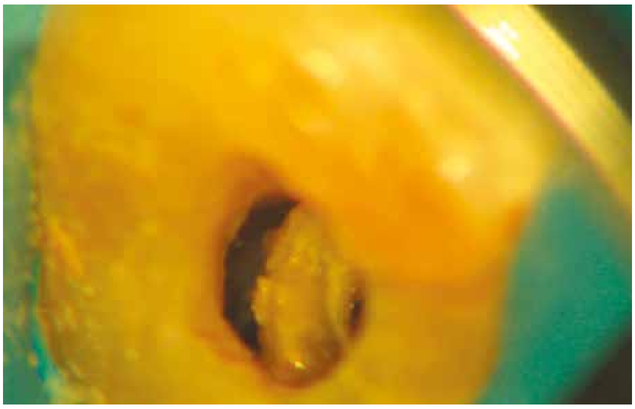


FIG. 5, 6 The root canal seemed to have a "C" shape, with a "true" and an "invaginated" canal.

FIG. 7 The hard internal structure was mobilised and removed through the access cavity.

FIG. 8 The immature apex was closed with MTA and the large endodontic space was filled with self-etching, self-adhesive, dual-curing resin cement.

and a root canal probe was carried out using a No. 10 manual file, which crossed the invaginated canal and reached the immature apex at a working length of 24.5 mm, as measured with a Root Zx apex locator (Morita, Irvine, CA, USA). Mechanical instruments were used to enlarge the canal, going up to the Protaper Gold F2 instrument (Dentsply-Maillefer, Ballaigues, Switzerland), with repeated and alternated rinsing with 5.25% sodium hypochlorite. Thanks to the operative microscope, it was possible to identify the access to the "true" endodontic space, around the hard tissues of the invagination; this was carried out using mechanical instruments, following and respecting the "C" shape that had already been highlighted by CBCT (Fig. 6). At first, the whole endodontic space, both the "true" one and the "invaginated" one, was filled with abundant calcium hydroxide paste (Stomidros, Stomygen, Bologna, Italy).

The remission of symptoms and healing of the fistula showed that the bacteria responsible for the lesion had been removed.

The medication was left in place for 3 months without replacing the calcium hydroxide to avoid the risk of chemically or mechanically damaging the tissues that were forming at the apical level. After 3 months, intraoral radiographic examination was performed. This showed that the hard internal structure was almost completely detached from the walls of the "true" canal. As suggested by Girsch and McClammy [2002] and Silberman et al. [2006], the canal was accessed again, the hard internal structure was mobilised and removed through the access cavity (Fig. 7). At this point, it was possible to fill the large canal with MTA.

Once the closure of the immature apex had been achieved, we proceeded to fill the large endodontic space with self-etching, self-adhesive, dual-curing resin cement for 60 seconds (Fig. 8), as proposed by Borkar et al. [2017]. The patient was included in a follow-up programme to monitor and verify the complete healing of the periapical bone of the affected tooth.

Discussion and conclusion

Since the current trend is to prefer conservative treatment, surgical treatment should only be considered after failure of Non-Surgical Root Canal Therapy (NSRCT), as suggested by Shadmehr et al. [2015]. On the other hand, in recent years, there have been a few cases of dens invaginatus treated through surgical procedures, thanks also to the use of the microscope and computed tomography [Schmitz et al., 2010].

In the present case, the diagnosis of the anomaly, detected with an intraoral X-ray and above all CBTC, was of Oehler's Class II dens invaginatus, with an invagination confined to and connected with the main root canal. It was treated successfully with NSRCT.

Cases of dens invaginatus with vital pulp have been described; in these cases, the suggested treatment was to treat and fill only the invaginated portion and leave the dental pulp vital. This is especially true for Oehler's Class III, where the pronounced invagination gives rise to a pseudo-canal that does not communicate with the pulp. Instead, it communicates directly with the periodontium [Hülsmann, 1997; Akers et al., 2014]. In our case, however, probably the pulp was already necrotic at the time of root formation, thus not allowing the physiological closure of the apex, which was still open when we observed it. It is not clear why the pulp of dens invaginatus becomes necrotic. Probably the deeper the invagination, the greater the risk of bacterial colonisation and therefore the possibility of an inflammatory and degenerative response of the dental pulp [Schmitz et al., 2010].

In these cases, both the invagination and the main canal should be treated if pulpal involvement occurs [Ridell et al., 2001; Keles and Cakici, 2010; Falcao Lde et al., 2012]. In open apex cases, apexification with CH or mineral trioxide aggregate (MTA) usually has a successful outcome [Heydari and Rahmani, 2015].

Apexification is described in literature as a technique that leads to the formation of a calcific barrier in immature apexes thanks to medication with calcium hydroxide. In most cases, it is performed at a young age, when the tooth of a child or an adolescent, following a trauma or a carious process, goes into necrosis and remains with an immature apex. Currently, a material that is frequently used in open apexes, together with calcium hydroxide medication, is MTA, which provides an effective apical plug when placed at the working length

[Fayazi et al., 2013; Silberman et al., 2006; Jaramillo et al.,2006; Paula-Silva et al., 2011; Bogen and Kuttler, 2009; Kristoffersen et al., 2008; Sathorn and Parashos, 2007]. Compared to calcium hydroxide, MTA has the advantage of hardening rapidly, thus providing an apical barrier in a short time, reducing the time necessary for concluding the treatment. However, we initially preferred to use calcium hydroxide, as suggested by several authors [Fayazi et al., 2013; Paula-Silva et al., 2011; Morfis and Lentzari, 1989; Holtzman and Lezion, 1996; Tarján and Rózsa, 1999; Jung, 2004; Sübay and Kayatas, 2006; Jung et al., 2008], because MTA requires a large root canal space for the pluggers. Instead, in our case, the main canal was occupied by the invaginated hard tissue. When we subsequently succeeded in removing the invaginated dental tissue and the canal was much larger, we used MTA.

Furthermore, calcium hydroxide has an antibacterial effect and is able to dissolve the residual pulp tissue; it contributes to the healing of the periradicular lesion thanks to the increase in the periapical pH, providing calcium ions for the repair process and for the denaturation of pro-inflammatory mediators such as interleukine-1 and tumour necrosis factor [Shadmehr et al., 2015; Sathorn et al., 2007; Farhad and Mohammadi, 2005; Khan et al., 2008].

CBCT was crucial for the diagnosis. Thanks to its three-dimensional analysis, it was seen that invagination did not relate to the periodontium, but was confined within the root canal; furthermore, it was possible to highlight that the main canal's anatomy had a "C" shaped.

In the case report presented, it was found that when the invaginated tract and the main canal are separate entities, the surgical microscope guarantees the clinician better access and allows a complete removal of the tissue and the subsequent filling of the canal, as suggested by Girsch and McClammy [2002] and Silberman et al. [2006].

Finally, some authors have used the lateral condensation of gutta-percha [Steffen and Splieth, 2005; Shadmehr and Farhad, 2011] or vertical [Fayazi et al., 2013], or have used MTA for filling the canal [Demartis al., 2009]; Rotstein et al. [1987] and Nallapati [2004], instead, recommended the injectable thermoplastic method. In the case described in this article, we followed the suggestion of Borkar et al. [2017]: In the presence of very wide canals and very thin root walls, it is advisable to fill the canal with adhesive materials to reinforce the radicular walls and prevent their fracture. This is achieved thanks to materials with a modulus of elasticity similar to that of dentin, which dissipate stress, reducing the likelihood of root fracture and preventing crack propagation.

In conclusion, the use of technology and of special materials allowed an adequate management and resolution of the case reported.

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