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Non-surgical endodontic treatment of a type III dens invaginatus with large perirradicular radiolucency using bioceramic materials: Case report

Tratamento endodôntico não cirúrgico de dens invaginatus tipo III com grande radiolucência perirradicular utilizando materiais biocerâmicos: Relato de caso

Tratamiento endodôntico no quirúrgico de un dens invaginatus tipo III con radiolucidez perirradicular de gran tamaño mediante materiales biocerámicos: Reporte de un caso

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Bárbara de Assis Marra
ORCID: https://orcid.org/0000-0002-5726-3616
Universidade Federal de Uberlândia, Brazil
E-mail: barbaradeassismarra@hotmail.com
Alexia Mata Galvão
ORCID: https://orcid.org/0000-0001-6693-4963
Faculdade Anhanguera, Brazil.
E-mail: alexiamgalvao@gmail.com
Ana Clara Alves Araújo
ORCID: https://orcid.org/0009-0005-2579-3566
Universidade Federal de Uberlândia, Brazil.
E-mail: anac15araujo@ufu.br
Cristiane Melo Caram
ORCID: https://orcid.org/0009-0002-5059-6407
Prática Privada, Brazil
E-mail: cristiane@endomais.com
Jessica Monteiro Mendes
ORCID: https://orcid.org/0009-0000-2516-4616
Prática Privada, Brazil.
E-mail: jesmonteirom@gmail.com
Maria Antonieta Veloso Carvalho de Oliveira
ORCID: https://orcid.org/0000-0002-0762-8656
Universidade Federal de Uberlândia, Brazil
E-mail: mariaoliveira@ufu.br

Abstract
Dens invaginatus (DI), also known as dens in dente, is an uncommon dental anomaly in humans, characterized by irregular morphological development during odontogenesis, which can manifest in various coronal and radicular anatomies. Endodontic treatment of teeth with this variation demands anatomical knowledge, detailed planning, and the use of specialized techniques and materials. The objective of this research is to detail, through a case report, the non-surgical endodontic treatment of type III dens invaginatus in the upper lateral incisor with extensive periapical lesion, using bioceramic materials. An 18-year-old female patient was referred to the referral center by an orthodontist after radiographic examination revealed an extensive periapical lesion on tooth 12. Consequently, cone beam computed tomography was requested to assess the lesion and internal/external anatomy. The endodontic treatment was performed entirely under operative microscopy, utilizing mechanized instrumentation and thermoplasticized obturation. Disinfection was enhanced through activated irrigation technique and intracanal placement of bioceramic medication, with periapical repair achieved using bioceramic sealer cement. Long-term follow-up demonstrated that conservative endodontic treatment, employing modern techniques alongside bioceramic materials, proved effective in resolving complex cases.
Keywords: Biocompatible materials; Case report; Cone-beam computed tomography; Dens in dente; Dens invaginatus.

Resumo
Dens invaginatus (DI), conhecido também por dens in dente, é uma anomalia dentária incomum no ser humano, caracterizado pelo desenvolvimento morfológico irregular durante o processo de odontogênese, podendo assumir diferentes anatomias, tanto coronárias quanto radiculares. A endodontia de dentes com tal variação exige conhecimento anatômico, planejamento detalhado e utilização de técnicas e materiais especializados. O objetivo deste trabalho é, por meio de um relato de caso, detalhar o tratamento endodôntico não cirúrgico de dens invaginatus tipo III

em incisivo lateral superior com lesão periapical extensa, utilizando materiais biocerâmicos. Paciente sexo feminino, 18 anos, foi encaminhada ao centro de referência por um ortodontista após notar em exame radiográfico a presença de extensa lesão periapical no dente 12. Dessa forma, solicitou-se exame de tomografia computadorizada cone beam para avaliação da lesão e da anatomia interna e externa. O tratamento endodôntico foi inteiramente realizado por meio de microscopia operatória, instrumentação mecanizada e obturação termoativada. A descontaminação foi potencializada por meio da utilização da técnica de irrigação ativada e colocação de medicação intracanal biocerâmica, e o reparo periapical pelo cimento obturador biocerâmico. A proservação a longo prazo demonstrou que o tratamento endodôntico conservador, utilizando técnicas modernas, juntamente com a ação do material biocerâmico mostraram-se eficazes na resolução de casos complexos.
Palavras-chave: Dens in dente; Dens invaginatus; Materiais biocompatíveis; Relato de caso; Tomografia computadorizada de feixe cônico.

Resumen
El dens invaginatus (DI), también conocido como dens in dente, es una anomalía dental poco común en los seres humanos, caracterizada por un desarrollo morfológico irregular durante el proceso de odontogénesis, pudiendo presentar diversas anatomías tanto coronales como radiculares. El tratamiento endodóntico de dientes con esta variación requiere conocimiento anatómico, planificación detallada y el uso de técnicas y materiales especializados. El objetivo de este trabajo es detallar, a través de un informe de caso, el tratamiento endodóntico no quirúrgico de dens invaginatus tipo III en el incisivo lateral superior con extensa lesión periapical, utilizando materiales biocerámicos. Una paciente de sexo femenino, de 18 años, fue remitida al centro de referencia por un ortodoncista luego de notar en una radiografía la presencia de una extensa lesión periapical en el diente 12. Como resultado, se solicitó una tomografía computarizada cone beam para evaluar la lesión y la anatomía interna y externa. El tratamiento endodóntico se realizó completamente mediante microscopía operatoria, instrumentación mecanizada y obturación termoplástica. La descontaminación se potenció mediante el uso de la técnica de irrigación activada y la aplicación de medicación intracanal biocerámica, y la reparación periapical se logró con cemento obturador biocerámico. El seguimiento a largo plazo demostró que el tratamiento endodóntico conservador, utilizando técnicas modernas junto con el uso del material biocerámico, resultó efectivo en la resolución de casos complejos.
Palabras clave: Dens in dente; Dens invaginatus; Informe de caso; Materiales biocompatibles; Tomografía computarizada de haz cónico.

1. Introduction

Dens Invaginatus (DI) is an anomaly that affects teeth during development, which can also be named as dens in dente, dilated composite odontome and gestant anomaly (Hulsmann, 1997). The upper lateral incisor is the permanent teeth most commonly affected by this morphological alteration (nearly 42% of the cases) and its reported incidence varies between 0.04% and 10% of the population (Rotstein et al., 1987).

DI develops due to invagination in the external crown surface of the tooth prior to its calcification. However, this etiology is still unclear, but seems to involve even genetic and environmental factors (Alani & Bishop, 2008, Siqueira et al., 2022). Among the external factors, those caused by adjacent teeth can be highlighted, such as traumas and infections (Alves dos Santos et al., 2023).

DI types were previously categorized by Oehlers, in 1957, into three major groups: type I, type II and type III. Type I are those teeth in which the invagination is limited to the enamel and does not extend beyond the cementoenamel junction. For type II, the invagination reaches the dental root, but remains as a dead space, whether there may be communication with the pulp. In type III, however, the invagination, in addition to penetrating the dental root, extends and expels apically or laterally, being able to form a second foramen at the root (Oehlers 1957a, Oehlers 1957b).

Teeth affected by DI are more likely to present carious lesions and pulpal diseases due to the facilitated bacterial contamination that may occur through invagination. Therefore, the early treatment and use of more efficient complementary exams may result in better prognosis for those teeth (Gonçalves *et al.* 2002). The treatment options range from conservative approaches, such as morphological defect restoration; or invasive techniques, such as surgical or non-surgical treatment of the root canal and, even, exodontia of the affected tooth (Brooks & Ribera, 2014).

It is difficult to establish the three-dimensional morphological structure of the invagination area in teeth presenting DI. Thus, the use of cone-beam computed tomography (CBCT) scanning is recommended, preferably associated with dental operative microscopy (Kaneko et al., 2011). These technologies allow complicated cases to be planned and successfully treated commonly using non-surgical treatment option (Kato, 2013).

The application of bioceramics technology in endodontics has shifted both surgical and non-surgical treatments, providing a promising direction to the preservation of teeth (Wang et al., 2023). These materials have the ability to release hydroxyapatite during the setting process, providing a chemical bond between dentin and the filling material. Besides, it has properties, such as: biocompatibility, biomineralization, adhesion, radiopacity, solubility, adequate flow, antimicrobial properties and good setting time (AL-Haddad & Aziz, 2016).

Thus, the aim of this case report was to describe procedures for clinical management of a type III DI affecting a maxillary lateral incisor with large perirradicular radiolucency using cone-beam computerized tomographic images associated to dental operating microscope and bioceramic materials, including a novel bioceramic intracanal medication.

2. Methodology

This study reports a case of a patient treated at a reference clinic in Endodontics who, after being informed and providing authorization through the free and informed consent, underwent endodontic treatment of the upper right lateral incisor with dens invaginatus and extensive periapical lesion. This study was approved by the Ethics and Research Committee under number 69413423.9.0000.5152 (#6,087,320). It was written following the purposes and techniques described by the academic community (Estrela, 2018).

3. Case Report

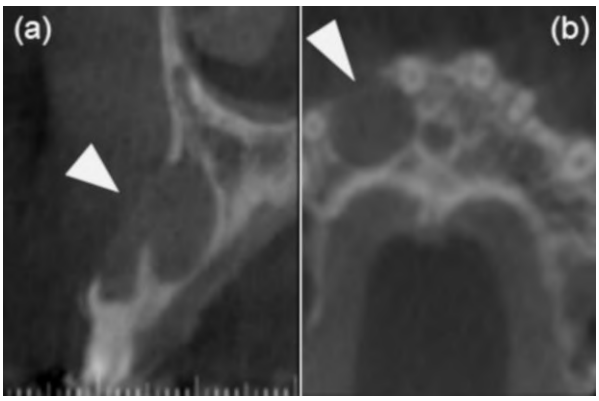
The case reported here involved an 18-year-old female patient with dens invaginatus affecting the upper right lateral incisor (tooth 12) referred by an orthodontist to an endodontic specialty center due to a perirradicular radiolucency. During the anamnesis, the patient has not reported any type of pain or other complaints. Clinical examination showed absence of tenderness to percussion or pain on palpation and normality to the sensitivity test. Besides, the palatal region of the tooth was more swollen than its analogous tooth. Still during the clinical examination, the pulp chamber was closed and without any restoration. Local radiographic examination revealed the presence of type III DI associated with a large perirradicular radiolucency (Figure 1).

Figure 1 – Radiographic image of a dens invaginatus Type III with extensive periradicular lesion in tooth 12.

Source: Authors.

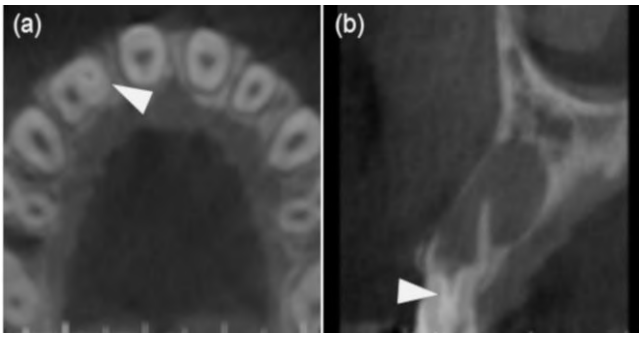
A CBCT scanning (Carestream K9000 3D, HULBERT Dental ICT, Worcester, Massachusetts, USA) with exposure parameters of 74 kV, 10.0 mA, and 10.80 seconds was performed in the area of interest. The CBCT images revealed the presence of a periapical radiolucency larger than the one that has been seen radiographically (Figures 2a and 2b). The CBCT images (Figures 3a and 3b) also showed that the invagination was separated from the main root canal. Based on the anamnesis, clinical data, radiographic images and tomography (CBCT), a chronic apical periodontitis was the hypothetical diagnosis, and root canal treatment was indicated.

Figure 2 – Tomographic image shows the real extent of the lesion through the white arrows. It is possible to observe the bone loss caused by the lesion, sagittal section (a) and axial section (b).



Source: Authors.

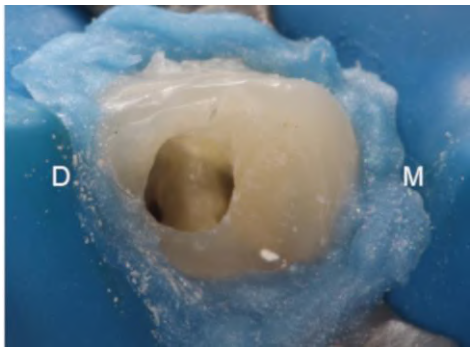
Figure 3 – Tomographic sections show the location and anatomy of the invaginated canal. (a) Axial section, with the white arrow indicating the location of the canal invagination. (b) Shows the anatomy of the invaginated canal as indicated by the white arrow.



Source: Authors.

With the aid of a dental operating microscope (ZEISS OPMI pico, Zeiss, Jena, German), the access to the pulp chamber was performed with high-speed handpiece using long spherical carbide drill (#2, Jota do Brasil, Florianópolis, SC, Brazil), aiming to find just the invagination (mesial canal), which was the cause of the problem. But during the access, the root canal (distal canal) was found first (Figure 4).

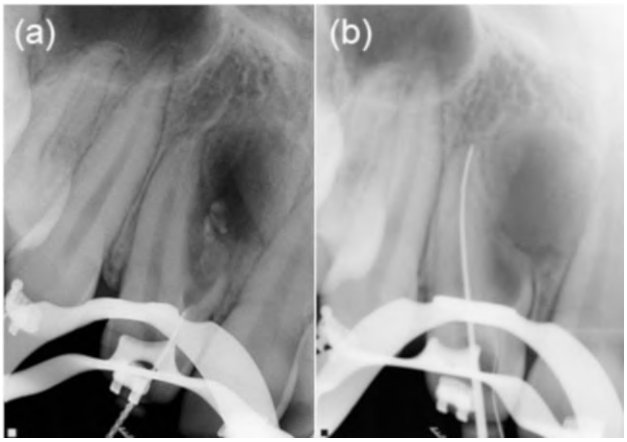
Figure 4 – Clinical appearance after coronal access, with the main canal indicated by the letter D in the figure, and the invaginated canal indicated by the letter M.



Source: Authors.

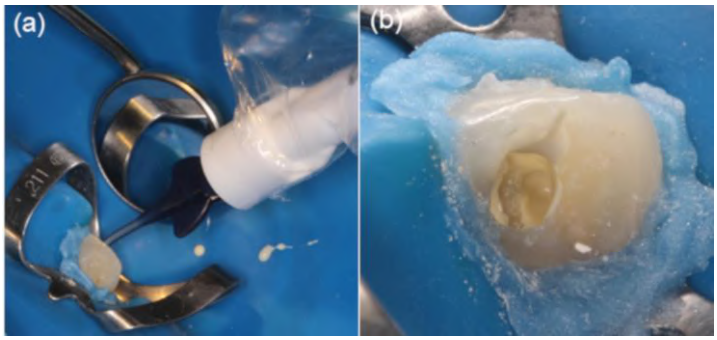
During the exploration of the mesial canal, it was not possible to fully access it and the instrumentation was performed only in the initial 3.0 mm (Figure 5a). The chemomechanical preparation of the mesial canal was performed with K-files (Dentsply, Pirassununga, SP, Brazil) and 2.5% sodium hypochlorite solution with the Oregon technique (crown-down). The chemomechanical preparation of distal canal (21.5 mm) (Figure 5b) was performed with rotatory instrumentation, using endodontic files (Easy ProDesign Logic, Easy, Belo Horizonte, MG, Brazil) and completed with K-files (Dentsply) until #55 file, also irrigated with 2.5% sodium hypochlorite solution. The final irrigation was performed with 0.9% saline solution for the both canals. Subsequently, the canals were dried with sterile paper points and filled with a bioceramic intracanal medication "ready to use" (BIO-C TEMP, Angelus, Londrina, PR, Brazil) (Figures 6a and 6b). In the subsequent session, 2 weeks later, the chemomechanical preparation was completed and the root canals were again dried with sterile paper points and intracanal medication ready for use (BIO-C TEMP, Angelus) was placed inside the root canal and maintained for 3 months. After, it was newly changed and, then, maintained for additional 3 months (Figure 7). For removing the intracanal medication, K-files (Dentsply) were used with 2.5% sodium hypochlorite alternately with ethylenediamine tetraacetic acid (EDTA), solutions under sonication using ultrasonic tip (Irrisonic, Helse Dental Technology, Santa Rosa de Viterbo, SP, Brazil).

Figure 5 – Odontometry radiography, (a) of the invaginated canal, with a length of only 3.00 mm. In (b) of the main canal.



Source: Authors.

Figure 6 – Clinical aspect of the intracanal medication stage: (a) the operator performs the insertion of the ready-to-use bioceramic material, (b) clinical appearance after the material has been inserted.



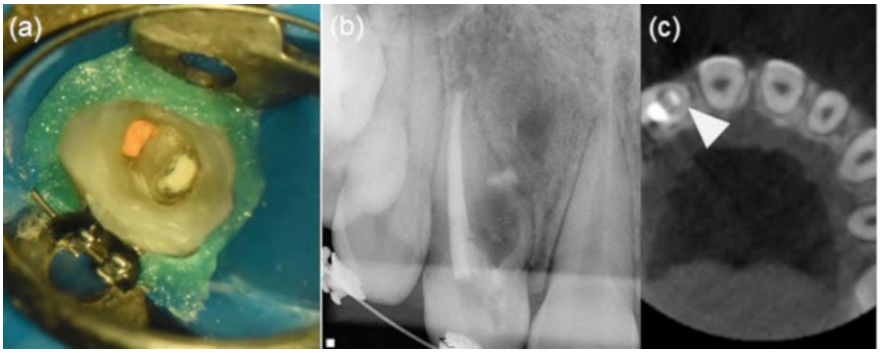
Source: Authors.

Figure 7 – Radiographic appearance after the insertion of the bioceramic intracanal medication, showing efficient filling of the canal.

Source: Authors.

In the last session of the endodontic treatment, the endodontic filling of the distal canal was made using a bioceramic root canal sealer ready to use (BIO-C SEALER, Angelus) using the Schilder's Plus technique, with a termal press (Friendo, Lions Dental Supply, Riverside, CA, USA) and a thermoplastifiable gutta-percha injector (Gutta Easy, Lions Dental Supply). The mesial canal (invagination) was filled with BIO-C REPAIR (Figures 8a and 8b). Coronal temporary restoration was completed with glass ionomer cement (FGM, Joinville, SC, Brazil) and the final composite resin restoration was placed after 15 days. The patient has not reported painful symptoms at any time of treatment.

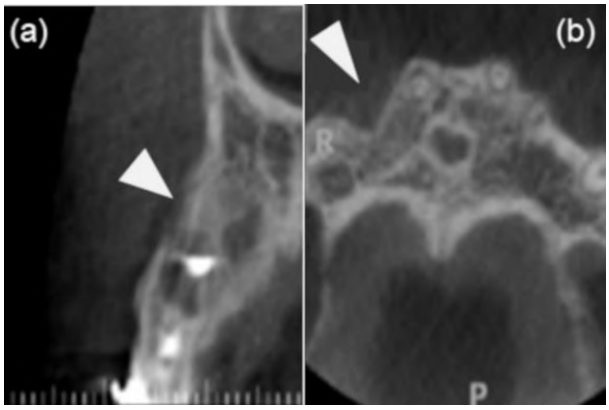
Figure 8 – Clinical, radiographic, and tomographic appearance of endodontic filling. (a) Coronal image after the filling of the main canal and the invagination. (b) Final radiograph after the filling, showing a satisfactory fill. Additionally, (c) is a tomographic image showing the three-dimensional filling of both canals.



Source: Authors.

At the end of the endodontic filling, a new CBCT scanning (Carestream K9000 3D, HULBERT Dental ICT), with the same exposure parameters of the first one, was taken. The CBCT showed the endodontic filling (Figure 8c) and the reduction of the perirradicular radiolucency, suggesting healing the affected region (Figures 9a and 9b).

Figure 9 – Tomographic image showing in sections (a) sagittal and (b) axial, where the white arrows indicate the reduction of the periradicular lesion and bone formation.



Source: Authors.

During the follow-up period (20 months), no signs and symptoms related to the treated region were reported or found, the radiolucent lesion regressed over time, indicating new bone formation in the lesion area and the patient was able to complete her orthodontic treatment (Figures 10).

Figure 10 – Radiographic image of follow-up after 20 months, showing a reduction in the lesion and bone formation.

Source: Authors.

4. Discussion

Root canals frequently present complex internal anatomy according to critical conditions, such as dens invaginatus (Schmitz et al., 2010). Even with many alternative treatments for these cases, non-surgical endodontic treatment should be the first option before surgical procedures (Wayama et al., 2014).

Detailed radiographic examination plays a key role in the identification of DI conditions. However, conventional or digital periapical radiographs may not reveal the details of the type and extent of the invagination, since plane images are obtained with these techniques (Mao & Neelakantan, 2014). CBCT imaging has been shown to be particularly useful in the diagnosis and management of teeth with unusual anatomy (Vier-Pelisser et al., 2012). In the case presented, the use of the CBCT scanning favored the final outcome, since it presented more details of the dental anatomy, essential for planning this type of treatment.

The use of dental operating microscope associated with CBCT is also of great importance for the endodontic treatment of complex cases, such as DI. By improving the vision, lighting and safety to the professional, it favors the prognosis and success of the treatment (Girsch & McClammy, 2002). The greatest difficulty that we observed in this case report occurred during the coronary access, supported by the use of the microscope, in which the professional aimed to find just the mesial canal (invagination). Instead, the distal canal was found first, so there was the necessity to carry out the treatment of both regions.

The appropriate diagnosis and treatment of chronic periodontitis with perirradicular lesions allows the repair of these large radiolucent periapical defects without surgical treatments, by using intracanal medications for the needed time (Broon, 2007). Considering the importance of bioceramic materials, already compared through studies with other endodontic sealers (Sokolonski et al., 2023, Dong & Xu, 2023), the novel bioceramic intracanal medication used in this case, BIO-C TEMP (Angelus), has resulted in successful outcome, with the regression of a periapical lesion and stimulation of new bone formation. This bioceramic intracanal medication is the first one available on market worldwide, and its main properties, besides the bioceramic feature, are the radiolucency, “ready to use” protocol, easy insertion into the root canal (by syringes with proper tips for the intraradicular filling), besides its adequate flow. Also, the use of bioceramic materials, as intracanal medication, sealer and repair, can predict a best outcome considering the biological interactions that may occur between these materials and the tooth tissues.

The long time needed for medication exchanges observed, in this case, where due to the radiographic follow-up of lesion regression taken by the specialist. The intracanal medication was only changed when its presence was no longer observed inside the root canal by the radiographic assessments. Also, the patient has not presented painful symptomatology during treatment, even when the medication overflowed in the apical region. At the end of the treatment, both the radiographic and tomographic images, showed reduced periapical lesion and bone formation in the affected region, allowing the completion of treatment by the root canal filling followed by final restoration.

5. Conclusion

It can be concluded that conservative endodontic treatment, when supported by modern techniques, such as the CBCT images, the dental operating microscope and bioceramic materials can be viable and predictable for long-term treatment of complex cases such as dens invaginatus, favoring tooth survival.

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