

Endodontic management of a complex Type IIIA dens invaginatus in a maxillary central incisor

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Abstract

Dens invaginatus is a developmental dental anomaly resulting from invagination of the enamel organ into the dental papilla during odontogenesis, often leading to complex root canal configurations and challenging clinical management. This report describes the nonsurgical endodontic treatment of a maxillary central incisor with Oehlers type IIIa dens invaginatus associated with asymptomatic apical periodontitis. Diagnosis was established through clinical examination, periapical radiographs, and cone-beam computed tomography. Treatment involved combined instrumentation with Reciproc Blue, Self Adjusting File, and XP-endo Shaper systems, passive ultrasonic irrigation with 2.5% sodium hypochlorite and 17% EDTA, and calcium hydroxide as intracanal medication. The root canal was obturated with gutta-percha and epoxy resin-based sealer using a thermoplastic technique. Six-month follow-up showed satisfactory periapical healing. This case highlights the importance of accurate diagnosis and individualized treatment planning for the successful endodontic management of teeth with dens invaginatus.

KEYWORDS: Tooth Abnormalities; Endodontics; Root Canal Therapy.



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Introduction

Dens invaginatus — also known as *dens in dente*, dilated composite odontoma, or invaginated odontoma — is a developmental dental anomaly resulting from the invagination of the enamel organ into the dental papilla before complete mineralization¹⁻³. This invagination may be limited to the pulp chamber, extend along the root, or reach the apical region. Reported prevalence rates vary widely (0.04%–10%) depending on diagnostic criteria, imaging methods, and classification systems, with bilateral occurrence being common and the maxillary lateral incisor the most frequently affected tooth, followed by central incisors, premolars, canines, and molars²⁻⁴. The most widely used classification is that of Oehlers⁵, which divides Dens invaginatus into three types according to the apical extension and radiographic characteristics: type I (confined to the crown), type II (extending beyond the enamel–dentin junction and potentially communicating with the pulp), and type III (an enamel-lined invagination penetrating through the root with a lateral or apical foramen — type IIIa or IIIb, respectively). Although practical, this classification relies on two-dimensional radiography, which may underestimate the actual extent and complexity of the malformation.

While several hypotheses have been proposed, the etiology of Dens invaginatus remains unclear. Embryological, genetic, molecular, traumatic, and infectious factors have been implicated in its development^{2,3}. Clinically, affected teeth may exhibit variable morphology, including barrel-, peg-, or claw-shaped crowns. However, many cases are present with normal crown morphology and are diagnosed incidentally on routine radiographs. The invaginated structure creates a favorable environment for biofilm retention and bacterial penetration, increasing the risk of caries, pulp pathology, and apical periodontitis^{2,3,6} and often complicating restorative and endodontic procedures⁷.

Accurate diagnosis and treatment planning relies on three-dimensional imaging, particularly cone-beam computed tomography (CBCT), which provides a detailed view of the root canal

system^{3,4,8,9}. Therapeutic options include conventional nonsurgical root canal treatment, with or without guided endodontics, as well as apical barrier techniques, intentional replantation, or extraction. Given the inherent anatomical complexity, endodontic management of dens invaginatus requires careful case selection, individualized planning, and a technically demanding approach. In this context, this report aims to describe the nonsurgical endodontic treatment of an Oehlers type IIIa dens invaginatus with apical healing observed after a six-month follow-up.

Case report

A 13-year-old male patient was referred for endodontic treatment of the left maxillary central incisor. Medical history revealed no systemic conditions, medication use, or known allergies. The patient was classified as ASA I, with no evidence of hereditary dental anomalies, history of dental trauma, sinus tract, or swelling. No pain or other symptoms were reported in association with the affected tooth.

Clinical examination revealed an alteration in crown morphology of tooth 21 and a negative response to the cold pulp sensitivity test using a refrigerant spray applied with a cotton pellet to the buccal surface. Both percussion and palpation tests were negative. Radiographic examination showed features consistent with dens invaginatus, associated with radiolucent area at the periapical and lateral region of tooth 21 (Figure 1).

Due to the complex root anatomy, CBCT was prescribed to aid in the planning of nonsurgical endodontic treatment (Figure 2). Three-dimensional imaging allowed a detailed assessment of the extent and morphology of the invagination as well as its relationship with the adjacent periapical tissues. Based on the medical and dental history, clinical examination, and radiographic findings, a diagnosis of Oehlers' s dens invaginatus type IIIa associated with asymptomatic apical periodontitis was established for tooth 21.

At the first appointment, local anesthesia was administered, and individual endodontic access was performed to both the invagination and the main canal using high-speed burs and ultrasonic refinement, followed by rubber dam isolation. The working length was determined with an electronic apex locator and confirmed radiographically (Figure 3A). Based on CBCT planning and under operative microscopy, chemomechanical preparation was carried out in two sessions, with calcium hydroxide as intracanal medication during a 14-day interval. Instrumentation was performed using the Reciproc Blue (VDW, Munich, Germany), Self Adjusting File (ReDent Nova, Berlin, Germany), and XP-endo Shaper (FKG Dentaire, Le Crêt-du-Loche, Switzerland) systems, combining manual and mechanical techniques.

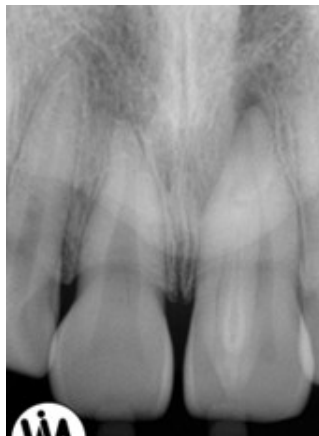


FIGURE 1 - Preoperative periapical radiograph of tooth 21 showing a periradicular radiolucency consistent with bone resorption in the periapical tissues.

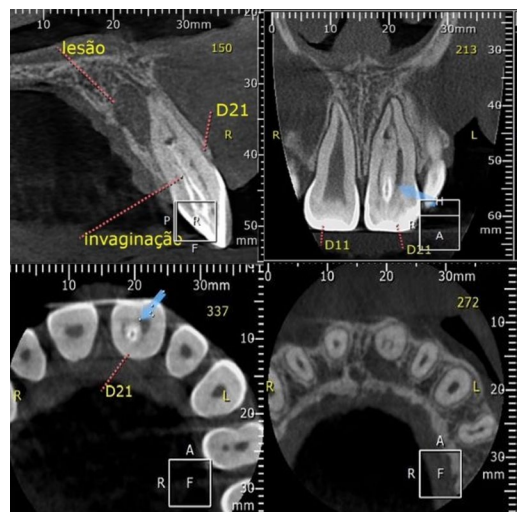


FIGURE 2 - Top left: sagittal CBCT reconstruction of tooth 21 showing dental invagination and an extensive periapical lesion. Top right: coronal reconstruction confirming the presence of two distinct canals. Bottom left and right: axial views at the coronal and apical thirds demonstrating two independent foramina, consistent with Oehlers type IIIa classification.

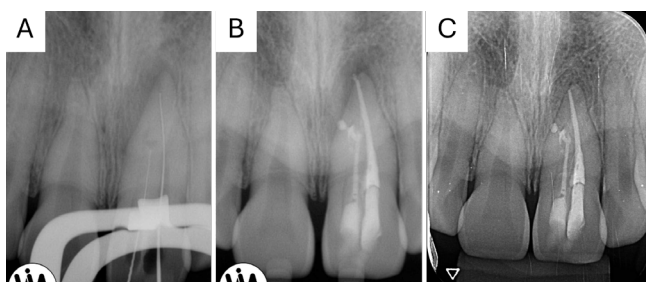


FIGURE 3 - (A) Working length determination radiograph. (B) Final radiograph after obturation and restorative procedure. (C) Six-month follow-up radiograph showing apical healing.

Irrigation was performed abundantly after every three pecking motions and instrument change. The irrigation protocol consisted of three phases—flow, resting, and agitation—to maximize irrigant penetration¹⁰. Passive ultrasonic activation of 2.5% sodium hypochlorite and 17% EDTA was used to enhance debris removal and minimize the compaction of residual tissue in areas of greater anatomical complexity. Apical patency was maintained with a #10 K-file up to working length.

At the second session, the intracanal medication was removed by copious irrigation with 2.5% sodium hypochlorite, followed by repetition of the irrigation activation protocol. The canals were dried with absorbent paper points and obturated using gutta-percha cones and an epoxy resin-based sealer (AH Plus; Dentsply-Sirona, Charlotte, USA) with a thermoplastic technique. The tooth was restored with composite resin, and a post-operative radiograph was obtained (Figure 3B). After six months, the patient remained asymptomatic, and radiographic follow-up demonstrated satisfactory periapical healing (Figure 3C).

Discussion

Although dens invaginatus most frequently affects permanent maxillary lateral incisors, the present case involved a maxillary central incisor with a type IIIa invagination according to Oehlers classification. This is a less common and typically unilateral presentation. Type IIIa configurations are often associated with periapical lesions, as documented in the literature^{2,3,4,6}. Accurate classification is crucial because it guides the clinical decision-making process and enables appropriate treatment planning. Dental anomalies such as dens invaginatus significantly alter the internal anatomy, creating a “pseudocanal” formed by the invagination, which may communicate with the periodontal ligament through a “pseudo-foramen”. Although its etiology remains uncertain, no predisposing systemic, traumatic, or infectious factors were identified in this patient’s history.

Three-dimensional diagnosis through CBCT plays a decisive role in the management of dens invaginatus. CBCT provides a more accurate and comprehensive assessment of the extent and depth of the invagination, as well as its relationship with the pulp chamber and surrounding tissues, overcoming the limitations of conventional periapical radiographs^{4,8,11,12}. This detailed evaluation allows for more predictable treatment planning. In addition, optical magnification with an operating microscope improves visualization of the internal anatomy, enhancing clinical precision in challenging cases. Although cost and the learning curve are limiting factors, these technologies can be critical in managing anatomically complex cases.

The choice of instrumentation systems also plays a key role in the treatment outcome. The Reciproc Blue system, with its reciprocating motion and enhanced flexibility, provides safety against cyclic fatigue and facilitates initial enlargement^{13,14}. The XP-endo Shaper system combines a snake shaping motion with high flexibility, reducing dentinal stress and improving irrigant flow and agitation^{15,16}. Self Adjusting Files adapt three-dimensionally to canal morphology, maximizing wall contact and combining instrumentation with simultaneous irrigation. This characteristic improves cleaning of critical areas and enhances the removal of debris, tissue, and biofilm in complex root canal anatomies^{17,18}.

In this case, irrigant activation was also optimized through passive ultrasonic irrigation. This technique generates cavitation and acoustic streaming, enhancing irrigant distribution throughout the root canal system. This dynamic improves debridement of isthmuses and polar areas, reduces intracanal microbial load, and contributes to successful clinical outcomes, particularly in cases of irregular anatomy and deep invaginations¹⁹.

Overall, the management of dens invaginatus requires meticulous diagnosis, individualized treatment planning, and advanced endodontic techniques to overcome anatomical challenges.

When these principles are applied, even complex cases such as dens invaginatus can achieve favorable periapical healing and long-term clinical success^{7,9,20}.

Conclusions

Early recognition and accurate diagnosis of developmental anomalies are essential for successful endodontic outcomes. Despite the anatomical challenges of dens invaginatus, proper planning and precise technical execution can lead to predictable periradicular healing.

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Manejo endodôntico de um dens invaginatus Tipo IIIA complexo em um incisivo central superior

Resumo

O dens invaginatus é uma anomalia dentária de desenvolvimento resultante da invaginação do órgão do esmalte na papila dentária durante a odontogênese, podendo gerar configurações anatômicas complexas e de difícil manejo clínico. Este trabalho relata o tratamento endodôntico não cirúrgico de um incisivo central superior com dens invaginatus tipo IIIa de Oehlers, associado a periodontite apical assintomática. O diagnóstico foi estabelecido por meio de exame clínico, radiografias periapicais e tomografia computadorizada de feixe cônico. O tratamento envolveu instrumentação combinada com os sistemas Reciproc Blue, Self Adjusting File e XP-endo Shaper, irrigação ultrassônica passiva com hipoclorito de sódio a 2,5% e EDTA a 17%, além do uso de hidróxido de cálcio como medicação intracanal. A obturação foi realizada com cones de guta-percha e cimento à base de resina epóxi, empregando técnica termoplástica. Após seis meses, o controle radiográfico revelou reparo periapical satisfatório. O caso destaca a importância do diagnóstico preciso e do planejamento individualizado no manejo endodôntico de dentes com dens invaginatus.

PALAVRAS-CHAVE: Anormalidades Dentárias; Endodontia; Tratamento do Canal Radicular.

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