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Nonsurgical Endodontic Management of Type II Dens Invaginatus Associated with Gemination in a Maxillary Lateral Incisor: A CBCT-Assisted Case Report

Maryam Dalaei Moghadam [a*]

[a] Department of Endodontics, Razi Herbal Medicines Research Center, Faculty of Dentistry, Lorestan University of Medical Science, Khorramabad, Iran

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****Corresponding author***: Maryam Dalaei Moghadam, Department of Endodontics, Razi Herbal Medicines Research Center, Faculty of Dentistry, Lorestan University of Medical Science, Khorramabad, Iran.

E-mail: maryam.dalaei@yahoo.com

Abstract

Dens invaginatus (DI) is a developmental dental anomaly characterized by the invagination of the enamel organ into the dental papilla during tooth development, often resulting in complex root canal anatomy and increased susceptibility to pulpal disease. Gemination is another uncommon developmental anomaly resulting from the incomplete division of a single tooth germ, which produces an enlarged or bifid crown. The simultaneous occurrence of these anomalies in a single tooth is extremely rare. This case report describes the diagnosis and nonsurgical endodontic management of a maxillary lateral incisor presenting with both gemination and Oehlers type II dens invaginatus. A 14-year-old female patient was referred for further endodontic management of the maxillary left lateral incisor. Normal apical tissues were diagnosed, and the referring practitioner previously initiated endodontic therapy. Clinical examination revealed a bifid crown morphology, while cone-beam computed tomography (CBCT) demonstrated type II dens invaginatus associated with gemination and a complex root canal system with apical bifurcation. Root canal treatment was performed under dental operating microscope magnification using nickel-titanium rotary instrumentation, passive ultrasonic irrigation, and calcium hydroxide intracanal medication. The root canal system was subsequently obturated using gutta-percha and AH-Plus sealer by the cold lateral compaction technique. At the 12-month follow-up, the tooth remained asymptomatic and exhibited normal clinical and radiographic findings. This case highlights the importance of CBCT and magnification-assisted endodontic treatment in the successful management of rare developmental anomalies with complex internal anatomy.

Keywords: Cone-beam Computed Tomography; Dens invaginatus; Endodontic Treatment; Gemination; Maxillary Lateral Incisor

Introduction

Dens invaginatus (DI), also known as dens in dente, is a developmental dental anomaly resulting from the invagination of the enamel organ into the dental papilla during odontogenesis. This condition most commonly affects maxillary lateral incisors and demonstrates a reported prevalence ranging from 0.04% to 10% in permanent dentition [1-3].

Radiographically, DI typically presents as a radiolucent invagination surrounded by a radiopaque enamel lining, which may be confined to the crown or extend into the root. Depending on its depth and complexity, the anomaly may predispose affected teeth to early pulpal involvement and periapical pathology due to microbial colonization within inaccessible anatomical spaces [4, 5].

Gemination is another developmental anomaly resulting from incomplete division of a single tooth germ, leading to an enlarged or bifid crown, often with a developmental groove. It is more frequently observed in primary dentition and the anterior regions [6-8], although it is rarely reported in posterior permanent teeth [9, 10].

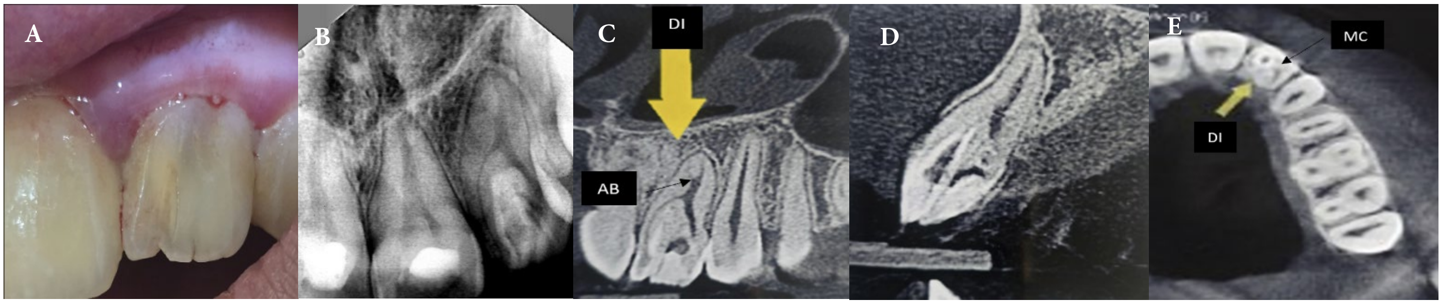

Figure 1. *A*) Preoperative clinical view of tooth #10 showing a bifid crown morphology; *B*) Preoperative periapical radiograph demonstrating type II dens invaginatus; *C–E*) CBCT images demonstrating the complex internal anatomy of the affected tooth. Arrows identify the key anatomical structures: DI indicates the dens invaginatus (invaginated canal), MC indicates the main canal, and AB indicates the apical bifurcation

The coexistence of DI and gemination in a single tooth is extremely rare and has been reported only in isolated cases [8]. Such complex morphological variations present significant diagnostic and therapeutic challenges.

Endodontic management of DI is complicated by highly variable internal anatomy, including canal irregularities, difficulties in negotiation, and challenges in complete disinfection and obturation [3, 8-11]. Therefore, accurate diagnosis and treatment planning are essential for successful outcomes.

Cone-beam computed tomography (CBCT) has significantly improved diagnostic accuracy by providing three-dimensional visualization of root canal morphology and the extent of invagination [8, 9]. In addition, magnification and ultrasonic irrigation techniques enhance the ability to manage complex canal systems predictably [8-10].

This report describes the diagnosis and successful nonsurgical endodontic management of a maxillary lateral incisor exhibiting gemination associated with Oehlers type II dens invaginatus using CBCT-guided assessment and magnification-assisted treatment.

Case Presentation

A 14-year-old female patient with no relevant medical history was referred for management of the maxillary left lateral incisor (#10). The patient was asymptomatic and reported no history of trauma. According to the referral information, root canal treatment had been initiated by the referring practitioner following the patient's complaint of spontaneous pain. However, due to the unusual internal anatomy and difficulties in canal identification and negotiation, the patient was referred for further endodontic management.

The patient's medical, dental, and family histories were non-contributory. Extraoral examination revealed no abnormalities. Intraoral examination showed a temporary restoration on tooth #10 and a bifid crown morphology consistent with gemination, characterized by a developmental groove on the labial surface (Fig. 1A). The tooth was non-responsive to pulp sensibility testing and was asymptomatic to percussion and palpation. Periodontal probing depths were within normal limits.

Periapical radiography revealed an enamel-lined invagination extending beyond the cemento-enamel junction (CEJ), consistent with Oehlers type II DI (Fig. 1B). CBCT imaging confirmed a complex root canal configuration associated with the invagination and apical bifurcation (Figs. 1C & 1D). The invaginated structure was located palatally relative to the main canal (Fig. 1E). No periradicular radiolucency was observed. Axial CBCT sections further confirmed proximity between the invaginated space and the main root canal system at the root level, without evidence of communication with the periodontal ligament space (Figs 2A-2D). The surrounding periradicular tissues appeared normal.

Based on the clinical and radiographic findings, the diagnosis of previously initiated treatment with normal apical tissues was established. Differential diagnosis included gemination and fusion; however, clinical morphology and CBCT findings were more consistent with gemination associated with type II DI.

Written informed consent was obtained from the patient's legal guardian before treatment. Local anesthesia was achieved using 2% lidocaine with epinephrine at a concentration of 1:80,000 (DarouPakhsh, Tehran, Iran), and the tooth was isolated with a rubber dam. After removal of the temporary restoration, the access cavity was refined under a dental operating microscope (Zumax, Jiangsu, China). The invaginated canal and main canal were negotiated separately using C-Pilot file (VDW, Munich, Germany). Working lengths were determined using an electronic apex locator (Root ZX; J. Morita, Tokyo, Japan) and confirmed radiographically.

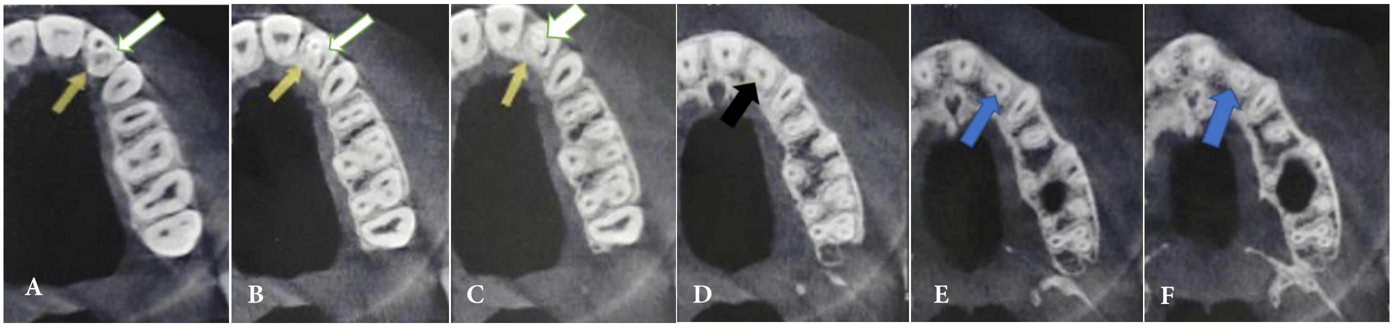

Figure 2. Sequential axial CBCT sections of the affected maxillary lateral incisor: *A–F)* represent consecutive axial slices from the coronal to the apical direction. Yellow arrows indicate the dens invaginatus (DI), and white arrows indicate the main canal (MC). The black arrow highlights the level at which the invaginated space and the main canal show their closest anatomical relationship. Blue arrows demonstrate apical bifurcation of the root canal system in the apical third

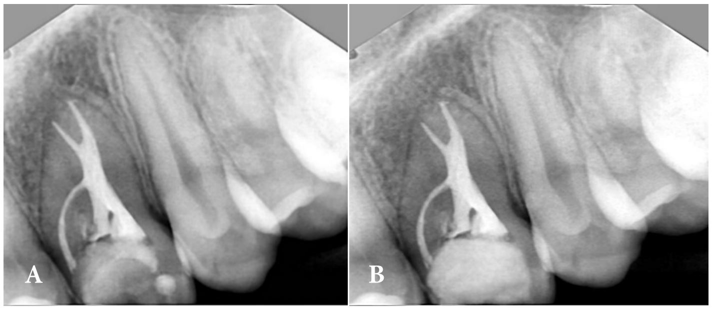

Figure 3. A) Postoperative periapical radiograph showing root canal obturation; *B)* 12-month follow-up radiograph

Cleaning and shaping were performed using ProTaper Gold (Dentsply Sirona, Long Island, NY, USA) rotary NiTi system with 5.25% sodium hypochlorite (Nikdarman, Tehran, Iran) irrigation delivered through a side-vented needle (COXO Medical Instrument, Guangzhou, China) and activated using passive ultrasonic irrigation (Eighteeth, Changzhou, China).

Following sodium hypochlorite irrigation, 17% EDTA (Nikdarman, Tehran, Iran) was used for 1 min to eliminate the smear layer's inorganic phase. A final 30-sec rinse with sodium hypochlorite was performed to improve tubule penetration and antimicrobial action [11]. The procedure was completed by irrigating the canals with 5 mL of sterile saline after chemomechanical preparation.

Calcium hydroxide (Golchai, Tehran, Iran) was placed as an intracanal medicament, and the access cavity was temporarily sealed.

At the second appointment, the patient remained asymptomatic. The intracanal medicament was removed, and irrigation was performed using sodium hypochlorite, saline, and 17% EDTA (Nikdarman, Tehran, Iran), with ultrasonic activation. Final irrigation was completed with sterile saline. After drying the canals, both the main canal and invaginated canal were obturated using gutta-percha (Meta obturator; Meta Biomed, Cheongju-so, Chungbuk, South Korea) and AH-Plus Sealer (Dentsply De Trey, Konstanz, Germany) using the cold lateral compaction technique. The access cavity was restored with a temporary filling material (Golchai, Tehran, Iran) (Fig.3A).

The patient was subsequently referred for definitive coronal restoration. At the 12-month follow-up, the tooth remained asymptomatic, with no clinical or radiographic signs of pathology (Fig. 3B).

Discussion

Early and accurate diagnosis of dens invaginatus is essential and requires careful clinical and radiographic evaluation [12].

Differentiating gemination from fusion can be challenging because both anomalies may present clinically as an enlarged crown [13]. Gemination is generally considered to result from incomplete division of a single tooth germ and typically presents as a bifid crown associated with a single enlarged root complex [14]. In contrast, fusion arises from the union of two developing tooth germs and may exhibit varying degrees of crown and root union depending on the stage of development at which fusion occurs [13]. In the present case, the diagnosis favored gemination based on the characteristic bifid crown morphology, the presence of a single root trunk with apical bifurcation

(Fig.1C, Figs. 2E & 2F), and CBCT findings demonstrating a distinct adjacent canine without radiographic evidence of union with a neighboring or supernumerary tooth. The three-dimensional assessment provided by CBCT was particularly valuable in supporting the diagnostic process and evaluating the complex internal anatomy.

The educational significance of the present case lies not in the use of a novel treatment technique, but in the diagnosis and management of an unusual combination of developmental anomalies. The coexistence of gemination and Oehlers type II dens invaginatus, together with apical canal bifurcation, represents a rare and diagnostically challenging presentation that may complicate canal identification, disinfection, and obturation. Such anatomical variations increase the risk of missed anatomy and potential treatment failure if not properly recognized. Therefore, a detailed three-dimensional assessment and careful treatment planning were essential for successful management.

Recent case reports have highlighted the diagnostic challenges associated with dens invaginatus and emphasized the critical role of CBCT in precise anatomical delineation and treatment planning, thereby supporting the feasibility of nonsurgical endodontic management in cases of type II dens invagination[4, 15, 16].

In the present case, these imaging advantages were crucial in identifying the invaginated anatomy and associated canal complexity, enabling conservative nonsurgical treatment.

The case was initially diagnosed as “previously initiated therapy, normal apical tissues” according to AAE diagnostic terminology; however, CBCT assessment provided a more detailed three-dimensional evaluation of the root canal anatomy and confirmed the absence of periapical pathology.

Historically, teeth affected by dens invaginatus were considered to have a poor prognosis and were often extracted before the development of modern endodontic techniques[17]. However, advances in magnification, rotary instrumentation, irrigation protocols, and three-dimensional imaging have significantly improved the predictability of treating such complex cases. The present case further supports the shift toward tooth preservation, demonstrating that even teeth with severe anatomical complexity can be successfully managed using a conservative nonsurgical approach when comprehensive diagnostic information is available[18, 19].

This case also adds to the growing body of evidence regarding the management of complex anatomical variations, such as dens invaginatus associated with adjacent dental anomalies [20, 21]. Previous reports have highlighted the diagnostic challenges of such cases and the critical role of advanced imaging, particularly CBCT, in accurately delineating internal anatomy and guiding treatment planning [22]. Compared to previously published reports in which surgical or combined approaches were sometimes required [23, 24], the present case was successfully managed using a nonsurgical endodontic approach. Alternative treatment strategies described in the literature include surgical endodontic intervention [23], intentional replantation[25], and extraction in cases with severe anatomical complexity or unfavorable prognosis [26]. However, treatment selection should always be individualized based on the extent of invagination, pulpal involvement, periapical status, and restorability of the tooth. Despite the favorable outcome, certain limitations should be acknowledged. As a single case report, the findings cannot be generalized, and the follow-up period may not be sufficient to confirm long-term success. Further studies with larger case series and longer follow-up periods are required to establish more definitive treatment guidelines.

In addition, the presence of apical canal bifurcation further increased the anatomical complexity of the root canal system and the risk of missed anatomy [27]. Cold lateral compaction was selected as a predictable obturation technique because it allowed satisfactory control of working length and obturation material placement within both the bifurcated main canal system and the invaginated canal [28].

CBCT imaging was essential in evaluating the complex internal anatomy and guiding treatment planning [5, 26]. It allowed an accurate assessment of the spatial relationship between the invaginated structure and the main canal system, which cannot be reliably achieved using conventional radiography alone [26].

The educational value of this case lies in the diagnostic complexity and anatomical variability rather than the use of novel treatment techniques. This case highlights the importance of CBCT-assisted evaluation in identifying and managing rare developmental anomalies that may complicate endodontic treatment.

Conclusion

Successful management of teeth with complex developmental anomalies depends on accurate diagnosis supported by advanced imaging techniques such as CBCT, combined with meticulous endodontic treatment. The favorable 12-month outcome in this case supports the feasibility of nonsurgical management in such anatomically challenging situations.

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Conflict of interest

None.

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Authors' contributions

MDM is the sole author and is solely responsible for all aspects of the study, including conception, data collection, analysis, and manuscript preparation.

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