OPEN ACCESS

Saudi Journal of Oral and Dental Research

Abbreviated Key Title: Saudi J Oral Dent Res
ISSN 2518-1300 (Print) | ISSN 2518-1297 (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: https://saudijournals.com

Case Report **Dentistry and Endodontics**

Management of Dens Invaginatus with Concurrent Open and Closed Apex in a Single Root: A Detailed Case Report

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DOI: https://doi.org/10.36348/sjodr.2026.v11i07.002 | **Received:** 24.05.2026 | **Accepted:** 12.07.2026 | **Published:** 16.07.2026

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Abstract

Dens invaginatus is a developmental anomaly resulting from an infolding of enamel and dentin during odontogenesis, often leading to complex internal anatomy and early pulpal involvement. The presence of atypical apical morphology further complicates diagnosis and endodontic management. This case report describes the diagnosis and nonsurgical endodontic management of a rare variant of dens invaginatus in a maxillary anterior tooth, characterized by a single root exhibiting two different apical morphologies: one normally formed closed apex and an additional lateral open apex on the palate-distal aspect of the same root. The patient presented with severe anterior pain following recent trauma and was associated with a large periapical lesion. Cone-beam computed tomography (CBCT) played a decisive role in identifying the complex canal configuration and guiding treatment planning. A staged endodontic approach was adopted, including calcium hydroxide intracanal medicament, apical barrier formation using biodentine, and a hybrid obturation technique employing gutta-percha and thermoplasticized gutta-percha. Favorable clinical and radiographic outcomes were observed. This report emphasizes the importance of advanced imaging, careful canal negotiation, and customized obturation strategies in managing rare endodontic anomalies.

Keywords: Dens invaginatus, Open apex, Closed apex, CBCT, Biodentine, Apexification.

INTRODUCTION

Dens invaginatus, also known as dens in dente, is a developmental anomaly resulting from an infolding of the enamel organ into the dental papilla before the completion of calcification. This disturbance in tooth development creates a spectrum of anatomical variations, ranging from a shallow enamel-lined invagination confined to the crown to extensive invaginations extending into the root and communicating with the periodontal tissues. The condition was first described by Ploquet in 1794, while the term “dens in dente” was later introduced by Busch owing to its characteristic radiographic appearance of a tooth within a tooth. The reported prevalence ranges from 0.3% to 10%, with permanent maxillary lateral incisors being the most commonly affected teeth. The exact etiology of dens invaginatus remains uncertain, and several theories have been proposed to explain its development. These include focal growth retardation of the internal enamel epithelium, abnormal proliferation of the enamel organ, external forces acting on the developing tooth germ, and

genetic influences. Familial occurrence and bilateral presentation reported in several studies further support a possible hereditary component. Regardless of the underlying cause, the anomaly results in a highly complex internal morphology that can significantly complicate endodontic diagnosis and treatment.

The clinical importance of dens invaginatus lies in its susceptibility to early pulpal involvement and periapical disease. Defective enamel and dentin lining the invagination may allow microorganisms and irritants to reach the pulp tissue directly, often leading to pulpal necrosis even in teeth that appear clinically intact and free of caries. When pulpal infection occurs during root development, root maturation may be arrested, resulting in an open apex and thin dentinal walls. Furthermore, the intricate canal anatomy associated with this anomaly presents considerable challenges in achieving adequate cleaning, shaping, and obturation of the root canal system.

Oehlers' classification remains the most widely accepted system for categorizing dens invaginatus based on the extent of invagination. Type I lesions are confined to the crown, Type II lesions extend beyond the cementoenamel junction into the root without communicating with the periodontal ligament, and Type III lesions penetrate through the root and establish communication with the periodontal tissues either laterally or apically. Accurate classification and assessment of the internal anatomy are essential for successful treatment planning.

With the advent of cone-beam computed tomography (CBCT), clinicians are now able to visualize the three-dimensional morphology of dens invaginatus with greater accuracy than conventional radiography. CBCT facilitates identification of accessory canals, apical communications, root resorption, and associated periapical lesions, thereby improving treatment predictability. Contemporary management strategies emphasize conservative endodontic treatment whenever feasible, utilizing bioactive materials such as Biodentine and bioceramic sealers to promote healing and achieve effective sealing of complex canal systems. The present case report describes the successful nonsurgical management of an unusual variant of dens invaginatus in a maxillary lateral incisor exhibiting two distinct apical morphologies within a single root: a normally developed canal terminating in a closed apex and an additional canal associated with an open apex. The coexistence of open and closed apices within the same tooth is usually rare and posed significant diagnostic and therapeutic challenges. A multidisciplinary endodontic approach incorporating CBCT-based diagnosis, apexification with Biodentine, and three-dimensional obturation was employed to achieve a favorable clinical outcome.

CASE REPORT

A 23-year-old male patient was referred from a private dental clinic to the Department of Conservative Dentistry and Endodontics with a chief complaint of persistent pain in the upper anterior region for two weeks. The patient reported a history of a road traffic accident approximately two weeks prior to presentation, following which he developed pain in the maxillary anterior teeth. Initial treatment had been initiated at a nearby dental clinic, where access opening was performed in relation to the maxillary right lateral incisor (tooth 12). However, the symptoms persisted, and the patient was subsequently referred to our institution for further evaluation and management.

Clinical Examination

Extraoral examination revealed no facial swelling, sinus tract, or other significant findings. Intraoral examination demonstrated an access-opened maxillary right lateral incisor (12) that was tender to percussion. The surrounding soft tissues appeared normal, and no periodontal abnormalities were detected. The remaining dentition was clinically unremarkable.

Fig. 1: access-opened maxillary right lateral incisor

Radiographic Examination

An intraoral periapical radiograph revealed a radiolucent invagination involving the coronal portion of tooth 12 extending through the enamel and dentin towards the pulp space. The root canal appeared widened and was associated with a well-defined periapical radiolucency. Additionally, an irregular radiolucent defect was observed along the distal aspect of the apical

third of the root, accompanied by loss of the normal root outline, suggestive of external root resorption. Considering the unusual radiographic appearance and the possibility of complex root canal anatomy, cone-beam computed tomography (CBCT) was advised for detailed evaluation.

Fig. 2: Intraoral periapical radiograph revealing open apex with periapical radiolucency

CBCT Findings

CBCT examination revealed a radiopaque infolding extending from the cingulum into the crown, consistent with dens invaginatus. A single broad canal was observed in the cervical and middle thirds of the root. However, in the apical third, the canal bifurcated into two distinct pathways. The labial canal terminated in a normally developed closed apex, whereas the palatal canal exhibited an open apex and exited slightly distal to the root apex approximately 1 mm coronally.

The palatal canal measured approximately 1.6 mm in diameter, while the labial canal measured approximately 4 mm. Evidence of external root resorption was noted in the apical third of the root. A well-defined periapical radiolucency with partially corticated borders measuring approximately 6.2 mm mesiodistally, 7.1 mm labiopalatally, and 8.0 mm superoinferiorly was observed. Thinning of both the labial and palatal cortical plates was evident.

Based on the clinical and radiographic findings, a diagnosis of dens invaginatus associated with a periapical granuloma was established. The differential diagnosis included a radicular cyst. Considering the previous intervention and persistent symptoms, the tooth was diagnosed as previously initiated therapy with chronic apical abscess.

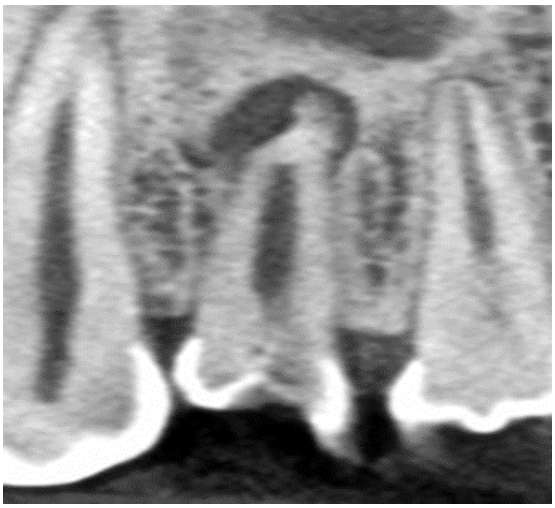

Fig. 3: Radiopaque infolding and foramen

Fig. 4: CBCT with open and closed apex inviginatous

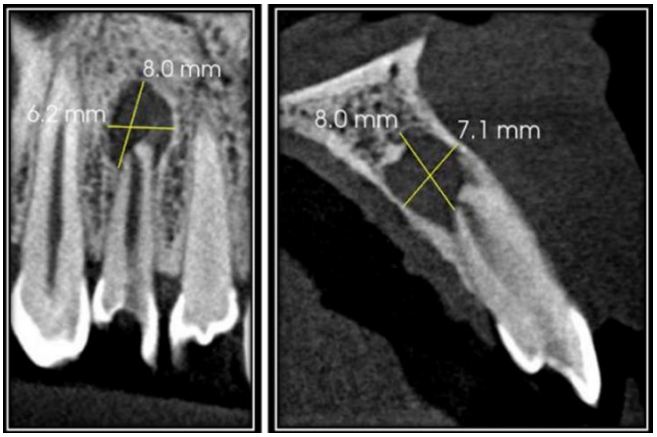

Fig. 5: measurement of the lesion

Fig. 6: root resorption

Treatment Procedure

After obtaining informed consent, nonsurgical endodontic treatment was planned. Local anesthesia was administered using 2% lignocaine containing 1:100,000 adrenaline. Access refinement was performed under a dental operating microscope using Gates-Glidden drills to improve visualization and facilitate canal identification.

The canal terminating in the closed apex was first identified and negotiated using a size 10 K-file. Working length determination was performed, and cleaning and shaping were completed up to ProTaper F2 size. Care was taken to preserve the remaining root structure while achieving adequate canal debridement.

Guided by the CBCT findings, a second canal was located in the palatodistal aspect of the root. This canal communicated with the open apex and was negotiated using a size 10 K-file. Circumferential filing was carried out to effectively clean the irregular canal walls and remove necrotic tissue and debris.

Copious irrigation was performed using 3% sodium hypochlorite and normal saline. Passive ultrasonic activation of the irrigant was carried out while maintaining the ultrasonic tip short of the working length to minimize the risk of irrigant extrusion through the open apex. Following chemomechanical preparation, the canals were dried with sterile paper points.

Calcium hydroxide was placed as an intracanal medicament, and the access cavity was temporarily sealed. At subsequent appointments, a double antibiotic paste was placed to enhance microbial control and was maintained for five days. Calcium hydroxide dressing was then reapplied and retained for an additional five days before obturation.

Obturation Procedure

Following confirmation of the absence of symptoms and satisfactory canal disinfection, obturation was performed. The canal exhibiting a closed apex was obturated using a sectional obturation technique with gutta-percha and a bioceramic sealer. Excess gutta-percha was removed at the level of canal bifurcation using a heat carrier under magnification to establish a dense and well-adapted apical seal.

The canal associated with the open apex was managed using Biodentine as an artificial apical barrier. Biodentine was carefully placed and condensed up to the level of canal bifurcation under a dental operating microscope to achieve adequate sealing of the open apical region.

After complete setting of the Biodentine barrier, the remaining canal space was obturated using thermoplasticized gutta-percha to achieve three-dimensional filling of the irregular canal anatomy. A postoperative radiograph confirmed satisfactory obturation of both canal systems.

Finally, the access cavity was restored using resin composite to ensure an effective coronal seal.

Fig. 7: acess opening, locating 2 canals, sectional obturation of closed apex and open apex managed with biodentine, immediate post-operative radiograph

Follow-Up

The patient was recalled periodically for clinical and radiographic evaluation. At the six-month follow-up visit, the patient remained asymptomatic with no tenderness to percussion or palpation. Radiographic examination demonstrated a reduction in the size of the periapical radiolucency, indicating favorable healing of the periapical tissues. The tooth remained functional, and no signs of reinfection or treatment failure were observed.

The successful outcome highlighted the importance of advanced imaging, meticulous canal disinfection, and the use of bioactive materials in the management of complex anatomical variations associated with dens invaginatus.

Fig. 8: pre operative, 6-month review

DISCUSSION

Dens invaginatus represents a developmental alteration that occurs during tooth formation and results in the formation of an enamel-lined invagination within the tooth structure. The condition is characterized by considerable anatomical variability, making diagnosis and treatment challenging. Because the invagination may extend to varying depths within the crown or root, each case requires careful radiographic and clinical evaluation before treatment planning. Several theories have been proposed to explain the development of dens invaginatus. One widely accepted explanation suggests that localized disruption in the growth of the internal enamel epithelium during odontogenesis leads to inward folding of the enamel organ. Genetic influences have also been implicated, as familial occurrence and bilateral involvement have been reported in the literature. Despite the uncertainty regarding its exact pathogenesis, the resulting abnormal anatomy frequently predisposes affected teeth to pulpal and periapical disease.

The maxillary lateral incisor is the tooth most frequently affected by dens invaginatus, which corresponds with the findings in the present case. The anomaly is of particular clinical significance because microorganisms can penetrate the pulp through defects present within the invaginated structure. Consequently, pulpal necrosis and periapical pathology may develop even when the external tooth surface appears clinically intact. In the present case, the extensive periapical lesion associated with tooth 12 was likely a consequence of long-standing microbial contamination through the invagination.

Oehlers classified dens invaginatus into three major categories based on the extent of invagination. In the present case, the deep extension of the invagination into the crown with associated periapical pathology suggests a Type I variant. CBCT examination revealed a highly unusual configuration in which a single root contained two distinct apical pathways. One canal terminated in a mature closed apex, whereas the second canal was associated with an open apex and communicated with the periapical tissues. Such a presentation is rarely encountered and emphasizes the wide spectrum of anatomical variations that may occur in teeth affected by dens invaginatus.

A major factor contributing to the successful management of this case was the use of cone-beam computed tomography. Conventional radiographs provided only limited information regarding the internal anatomy and extent of pathology. CBCT enabled precise visualization of the enamel infolding, canal configuration, external root resorption, and the dimensions of the periapical lesion. The three-dimensional assessment facilitated accurate diagnosis and allowed the treatment plan to be tailored according to the unique anatomy of the tooth.

The primary objective of treatment was elimination of intracanal infection while preserving the tooth. Because of the complex canal system, thorough cleaning and shaping were essential. Mechanical instrumentation was combined with copious irrigation using sodium hypochlorite to maximize disinfection. Ultrasonic activation of the irrigating solution was performed to enhance penetration into areas that were inaccessible to instruments. Particular caution was exercised during irrigation because of the presence of the open apex, where extrusion of irrigants could potentially damage the surrounding tissues. Intracanal medicaments were used to further reduce the microbial load before obturation. Calcium hydroxide was selected because of its antibacterial action and ability to create an alkaline environment unfavorable for bacterial survival. The additional use of double antibiotic paste provided broad-spectrum antimicrobial activity and helped achieve satisfactory disinfection of the intricate canal system. The resolution of symptoms prior to obturation indicated successful control of infection.

The presence of both an open and a closed apex within the same tooth required two different obturation strategies. The canal associated with the mature closed apex was treated using gutta-percha in conjunction with a bioceramic sealer. Bioceramic sealers are known for their excellent sealing properties, dimensional stability,

and bioactivity, making them particularly useful in complex endodontic cases. Sectional obturation allowed an effective seal while preserving the anatomy at the canal division. Management of the open apex presented a greater challenge. Creation of an apical barrier was necessary to facilitate obturation and prevent extrusion of filling materials. Biodentine was selected for this purpose because of its favorable biological properties, including biocompatibility, bioactivity, and ability to promote hard tissue formation. The material provided a predictable artificial apical stop and enabled completion of treatment within a shorter period compared with traditional long-term calcium hydroxide apexification procedures.

Following placement of the Biodentine barrier, thermoplasticized gutta-percha was used to obturate the remaining canal space. This technique was particularly advantageous in the present case because it allowed the filling material to adapt closely to the irregular canal walls and anatomical complexities associated with dens invaginatus. Achieving a three-dimensional seal is critical in such cases to minimize the possibility of residual spaces that could harbor microorganisms.

Clinical and radiographic findings at the six-month review demonstrated favorable healing. The patient remained asymptomatic, and a reduction in the size of the periapical radiolucency was observed, indicating resolution of the inflammatory process. The successful outcome reinforces the importance of early diagnosis, detailed anatomical assessment using CBCT, effective disinfection protocols, and the use of contemporary bioactive materials in the management of developmental anomalies.

This case highlights that even highly complex presentations of dens invaginatus can be managed successfully through a conservative nonsurgical approach when diagnosis is accurate and treatment is carefully individualized. The coexistence of open and closed apices within a single root represents an unusual anatomical variation and underscores the need for thorough evaluation and flexible treatment strategies in endodontic practice.

CONCLUSION

The coexistence of open and closed apices within a single tooth affected by dens invaginatus is an uncommon clinical finding that poses considerable diagnostic and therapeutic challenges. Accurate assessment using CBCT and a tailored treatment approach incorporating Biodentine and three-dimensional obturation enabled successful nonsurgical management of this complex case. Careful diagnosis and appropriate use of contemporary endodontic materials can significantly improve treatment outcomes in teeth with unusual anatomical variations.

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