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Conservative Management of Dens Invaginatus Type IIIb Using Photodynamic Therapy: A Case Report

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Dens invagination (DI) is a developmental dental anomaly characterized by the infolding of the enamel organ into the dental papilla. Type IIIb DI, involving deep invagination that extends apically along the root, poses significant challenges in endodontic treatment due to its complex anatomy. We describe a case of type IIIb DI in a 13-year-old female referred with the chief complaint of spontaneous pain on the left maxillary lateral incisor. Clinical examinations showed tenderness to percussion and palpation as well as a positive response to cold test with lingering pain. Cone-beam computed tomography (CBCT) confirmed the presence of type IIIb DI associated with a periapical lesion. The final diagnosis was irreversible pulpitis with apical periodontitis for main canal (distal) and pulpless and infected root canal system with secondary acute apical periodontitis according to Abbott classification for the other canal. Two separate access cavities were prepared with the guidance of CBCT. Root canal therapy was performed on both root canals, using photodynamic therapy (PDT) and ultrasonic-activated sodium hypochlorite for enhanced disinfection. Calcium-enriched mixture cement was used to obturate the apical third, followed by thermoplastic gutta-percha in the middle and coronal thirds. The patient was asymptomatic at 6- and 12-month follow-ups, with radiographic evidence of complete healing. This case highlights the effectiveness of conservative endodontic treatment using PTD in managing complex DI cases, with a focus on maintaining tooth structure and achieving long-term success.

Keywords: Calcium-enriched Mixture Cement; Dens Invaginatus; Photodynamic Therapy; Cone-beam Computed Tomography

Introduction

During the morpho-differentiation phase of tooth development and prior to the calcification stage, an invagination of the enamel organ into the dental papilla can form a developmental malformation called dens invagination (DI). Other terms of this condition that are used in the literature are dens in dent, dents telescope, and gestant anomaly [1-3].

According to Oehler's classification, DI is classified into three groups based on depth of penetration and communication with periodontal ligaments [4].

Type I: Minor invagination that doesn't extend beyond the cementoenamel junction (CEJ).

Type II: The invagination extends to the root. This infolding may be connected to the pulp but has no communication with periodontal ligaments.

Type III: The invagination invades apically along the root and forms a second foramen in either the periodontal (type IIIa) or apical (type IIIb) region without any direct communication with the pulp.

The prevalence of this malformation is 0.04-10% and the maxillary lateral incisors are the teeth that are most commonly affected by it [5, 6]. DI occurs bilaterally in almost 43% of cases [7].

Genetics, trauma, infection, and pressure from adjacent teeth are considered as some etiopathogenic factors contributing to the development of this anomaly [8]. Multiple clinical forms, such as peg, barrel, or conical shapes, slots and grooves, association with talon cusps, large buccolingual dimensions, and even a normal morphology can be presented in DI [9-11].

Difficulty of diagnosis, access preparation, cleaning, shaping, and obturation make the management of DI cases challenging [12].

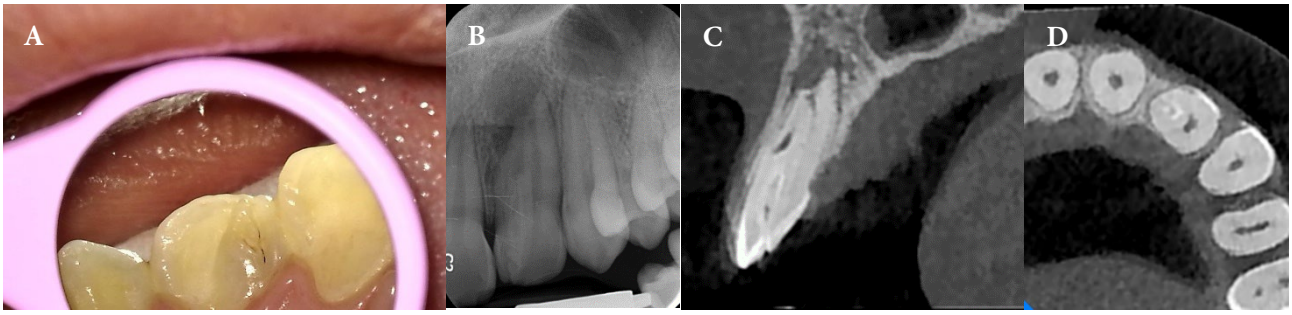

Figure 1. Preoperative documents; *A*) Preoperative photograph showing a depression area in the lingual pit; *B*) Periapical radiograph of tooth #10 showing dens invagination type IIIb with complex anatomical configuration of the canals; *C*) Sagittal view of the CBCT examination, the tooth showing both main and pseudo-canals; *D*) Axial view of the tooth showing two canals.

This case report describes the endodontic management of a case of DI type IIIb in a lateral incisor with two root canals. Our method involved a proper diagnosis employing periapical radiographs and cone-beam computed tomography (CBCT) images and nonsurgical endodontic treatment with the aid of photodynamic therapy as disinfectant agent, along with biomechanical preparation and obturation of both the main and the pseudo-canals.

Case Presentation

A 13-years-old female patient was referred to the department of endodontics at Shahid Beheshti University of Medical Sciences with a chief complaint of pain on her left lateral incisor. The patient stated the presence of pain and discomfort on the same tooth about two years ago, which was relieved after some time and is now back and hurting her. There was no evidence of systemic diseases and medications in her medical history. There was also no history of trauma and no abnormalities on the extraoral examination.

Intraoral examinations showed a depression area in the mesial side of the lingual surface of tooth #10 (Figure 1A). Probing depth was within normal limits. Tenderness in palpation and percussion were also noticed. Hypersensitive response to the cold test with Roeko Endo-Frost (Coltène-Whaledent, Langenau, Germany) was observed on tooth #10. The tooth responded to the electric pulp test as well.

Radiographic evaluation showed an abnormal configuration of root canals in tooth #10 and revealed a periapical lesion (Figure 1B). Tooth #7 and other teeth showed normal canal morphology in the panoramic radiograph. Further CBCT examinations confirmed the presence of DI type IIIb and two canals at the mesial and distal sides of the root (Figure 1C-D).

The pulp and peri-apical diagnosis of each root canal according to Abbott classification was as follows: the main distal canal was presented with acute irreversible pulpitis and acute apical periodontitis, and the mesial canal was presented with a pulpless and infected root canal system and secondary acute apical periodontitis [13, 14]. Since both canals were associated with a periapical lesion and severe lingering pain in the cold test, root canal treatment of both canals of the tooth and further follow-up was considered as the desired treatment option; however, the estimated prognosis was fair. The other treatment option, which was extraction of the tooth and prosthetic rehabilitation until the patient reaches the appropriate age for implantation, was also explained.

Nonsurgical endodontic treatment and follow-up was accepted by the patient's parents. After fully explaining the diagnosis, steps, and complications of the treatment, a consent form was signed by the patient's parents.

At the first session, local anesthesia was administered by infiltration of 1.8 mL of 2% lidocaine with 1:80000 epinephrine (DarouPakhsh, Tehran, Iran). Rubber dam with clamp was employed for isolation of the tooth. Access cavity preparation was performed using a high-speed handpiece and a small round bur. In order to preserve more tooth structure, two separate access cavities of the two mesial and distal canals were prepared with the use of CBCT as a guide (Figure 2A). Root ZX apex locator (J Morita Co, Kyoto, Japan) and a #15 K file (Mani, Tokyo, Japan) were used to determine the canal's working length (WL), and periapical radiography was used to confirm the WL. The WL of the mesial and distal canals were measured at 19 mm and 19.5 mm, respectively.

The pseudo-canal consisted of a coronal and an apical part that were connected to each other with a narrow isthmus, which needed to be widened for proper preparation and obturation. Since martensite files were not able to remove the enamel barrier of the canal wall, Hero Shaper instruments (Micromega, Besançon, France) were used. The main canal was prepared with ProTaper Gold rotary files (Dentsply Sirona, New York, USA) to F2 finishing instrument, and the pseudo-canal was prepared to 25, 0.06 Hero Shaper.

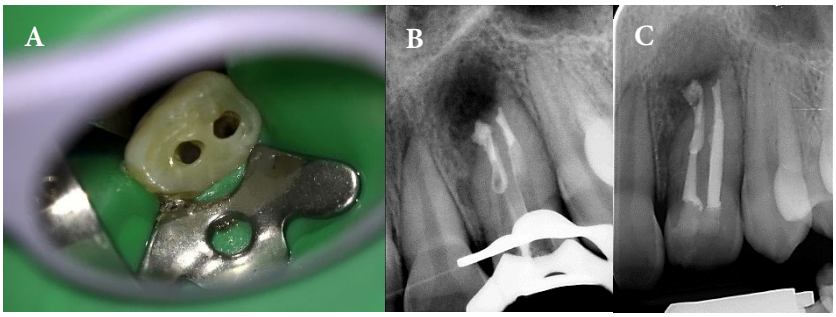

Figure 2. *A*) Truss access cavity preparation of the tooth; *B*) Post-obturation radiograph displaying CEM cement plug at the apical thirds of both canals; *C*) Post-operative periapical radiograph

Figure 3. Post-operative documents; *A*) Periapical radiograph at 6-month follow-up session; *B*) Periapical radiograph at 12-month follow-up session

During the procedure, irrigation was performed using 5.25% sodium hypochlorite (NaOCl) between each filing with a 30-gauge double side-vented needle (SybronEndo, Glendare, CA, USA). A PD1 ultrasonic tip attached to an NSK ultrasonic device (Varios 970; NSK, Tochigi, Japan), at a power level configured to 6 was used for passive activation of NaOCl solution for a duration of 20 sec [4, 15]. At the end of the chemomechanical preparation, canals were washed with 5 mL of sterile saline and dried using paper points (Dentsply Maillefer, Ballaigues, Switzerland). Calcium hydroxide (Golchai, Tehran, Iran) was inserted in the canals as an inter-appointment medicament, and the tooth was restored using temporary restoration (Cavisol; Golchai, Tehran, Iran).

After 1 week, the patient's symptoms that were reported at the first session were disappeared and the patient reported no pain.

At the second appointment, after administration of local anesthesia with 2% lidocaine and 1/80000 epinephrine, rubber dam was applied, and temporary restoration was removed. Canals were irrigated with sterile saline and 5.25% NaOCl to remove calcium hydroxide and the WL of the canals was confirmed with apex locator. Canals were dried with paper points and photodynamic therapy (PDT) was used to assure the proper disinfection of the canals [16]. Root canals were filled with methylene blue (Sigma-Aldrich, St. Louis, MO, USA) with a concentration of 25 mg/mL (67 mM) as the photosensitizer dye for 2 minutes. Extra amount of dye was removed using paper points. The root canals were irradiated by an infrared light-emitting diode (LED; Waldmann, Villingen-Schwenningen, Germany) with the output power of 2000 mW/cm^2 and emission of 630 nm. 17% EDTA (Nikdarman, Tehran, Iran) was used to remove smear layer [17]. Finally, the canals were irrigated using normal saline and then dried with paper points.

Canal irregularities and resorption at the apex lead to the use of calcium-enriched mixture (CEM) cement (BioniqueDent, Tehran, Iran) plug for a better seal in obturating the apical parts of both mesial and distal canals. A 3 mm CEM cement plug was used in the distal canal and a 6 mm plug was used in the mesial canal (Figure 2B). The more amount of CEM apical plug in the mesial canal is due to more canal irregularities and apical resorption in this canal. After placing CEM cement plug, the obturation of the middle and coronal parts of the canals was completed using the backfilled technique with injectable gutta-percha (Meta obturator; Meta Biomed, Cheongju-si, Chungbuk, South Korea). The access cavity was restored with temporary restoration and the patient was referred to the restorative department. Three days latert, permanent light-cured resin composite (Z250, A2 shade; 3M ESPE, St Paul, MN, USA) restoration of the tooth was performed (Figure 2C).

During the 6- and 12-month follow-up sessions, the patient remained asymptomatic. Clinical examinations of tooth #10 revealed no sensitivity to percussion or palpation, and no mobility was observed. Probing depth was within normal limits. Radiographic evaluations showed a reduction in the size of the periapical lesion at the 6-month recall (Figure 3A), indicating progressive osseous healing, with complete healing observed at the 1-year follow-up (Figure 3B).

Discussion

Dens invaginatus (DI) is a developmental malformation where the enamel infolds into the pulp, often creating a deep invagination that can complicate the clinical management of affected teeth [18]. The absence or destruction of the enamel lining at the pit or groove of a DI tooth makes it particularly vulnerable to microbial infiltration, leading to pulpitis and apical periodontitis. Consequently, early diagnosis and appropriate classification of DI can help prevent severe complications during treatment [19].

Achieving an ideal prognosis of the root canal treatment largely depends on understanding the anatomical variations of the root canal system and the quality of chemomechanical preparation. Proper irrigation and the use of effective disinfectant agents are crucial to ensuring successful outcomes [20, 21]. This case report outlines the treatment of a maxillary lateral incisor with DI type IIIb, which had two root canals; a main mesial canal and a pseudo-canal in the distal region.

The complex root canal anatomy of DI type IIIb presents significant challenges for thorough disinfection and preparation of the canals. In this case, both canals were involved, and the pulp in the mesial canal showed signs of irreversible pulpitis with acute apical periodontitis [22], while the pseudo-canal had a pulpless and infected root canal system with secondary acute apical periodontitis [13, 14]. Despite these complications, root canal treatment was performed on both canals, with the use of PDT and ultrasonic activation of NaOCl to enhance canal disinfection.

There is no universal protocol for the treatment of DI, as management strategies depend on factors like the type of DI, the complexity of the root canal system, and the condition of the pulp [23]. Options for treating DI include non-surgical or surgical endodontic treatment, replantation, or extraction [24]. In cases where only the invaginated canal is infected and the main canal remains healthy, each canal can be treated separately [25, 26]. In our case, however, the pulp in the main canal was already compromised, necessitating treatment of both canals.

In cases with complex apical morphology, bioceramics, such as CEM cement, are often preferred over gutta-percha due to their superior adaptability and sealing properties [27]. Bioceramics, like CEM cement, have been shown to offer better tissue compatibility and can facilitate apical sealing while promoting healing of the periapical tissues [28]. Their ability to bond with the dentin and provide a better seal in irregular canal anatomies makes them particularly effective bio-obturation in cases where the canal system has significant variations or resorption [29]. In this case, CEM cement plugs were placed in the apical thirds of both canals, the remainder of the canals was obturated with thermoplastic gutta-percha to ensure a homogeneous seal that filled the irregular canal structure. Studies have demonstrated that biomaterials like CEM cement exhibit excellent sealing properties, even in complex root canal anatomies, making them an ideal choice for cases involving significant resorption or irregularities [30]. Furthermore, the bioceramic nature of CEM cement promotes favorable tissue responses, supporting periapical healing, as evidenced in several clinical studies [31]. Moreover, this biomaterial has demonstrated better outcomes in terms of post-treatment pain [32].

For conservative management, CBCT was essential for diagnosing the DI type and determining the exact distance between the two canals. This allowed for the preparation of two separate access cavities, preserving as much tooth structure as possible. To ensure complete disinfection, PDT was incorporated into the treatment plan. Photodynamic therapy, which activates a photosensitizer with light of a specific wavelength, generates highly reactive oxygen species such as singlet oxygen and free radicals. These molecules are effective in eliminating microorganisms in the root canal system [33]. Additionally, ultrasonic activation of NaOCl was used to further enhance canal disinfection.

Conclusion

This case report illustrates the successful conservative, non-surgical endodontic management of a maxillary lateral incisor with DI type IIIb using PDT and ultrasonic-activated NaOCl for disinfection. The use of CEM cement and thermoplastic gutta-percha for obturation, combined with proper disinfection techniques, resulted in a favorable outcome, with the patient remaining asymptomatic and showing complete radiographic healing at the 12-month follow-up.

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Conflict of interest
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Authors' contributions
Conceptualization: NN; Methodology: NN/MM; Formal Analysis and Investigation: MM; Writing-Original draft preparation: AY; Writing-review and editing: MM/AY; Supervision: NN. All authors read and approved the final manuscript.

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