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Comprehensive treatment of *dens invaginatus* type IIIB

Терапија *dens invaginatus* типа *IIIB*

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SUMMARY

Introduction *Dens invaginatus* (DI) is a rare developmental anomaly characterized by invagination of the enamel organ into the dental papilla, creating complex internal anatomy. Type III DI, according to Oehlers' classification, presents diagnostic and therapeutic challenges, especially in teeth with incomplete root development. Early diagnosis and proper management are crucial to prevent pulpal and periodontal complications, preserve tooth vitality, function and aesthetics. The aim of this report is to describe the long-term interdisciplinary management of a rare DI type IIIB, highlighting diagnostic challenges, treatment strategies, successful tooth preservation, and importance of long-time controls.

Case outline A maxillary lateral permanent incisor with DI type IIIB in a 9-year-old boy presented with peri-invagination periodontitis while maintaining pulp vitality and incomplete root formation. A staged, minimally invasive approach was adopted, initially focusing on periodontal surgery and regenerative therapy to control infection while preserving pulp vitality and allowing continued root development. After more than two years of successful vitality maintenance, irreversible pulpitis developed, requiring complex orthograde root canal treatment followed by apical surgery. Long-term follow-up exceeding nine years demonstrated complete periapical healing, stable periodontal conditions, functional integrity, and retention of the tooth in the dental arch.

Conclusion Early diagnosis of DI is essential, as type III cases pose major challenges to pulp preservation and root canal treatment and are often considered for extraction. This case shows that long-term tooth preservation is achievable despite complex anatomy using an individualized, interdisciplinary approach.

Keywords: *dens invaginatus*; immature permanent tooth; interdisciplinary management

САЖЕТАК

Увод *Dens invaginatus* (DI) је ретка развојна аномалија коју карактерише инвагинација глеђног органа у зубну папилу, стварајући сложену унутрашњу анатомију. DI типа III, према Олерсовој класификацији, представља дијагностичке и терапијске изазове, посебно код зуба са незавршеним растом корена. Рана дијагноза и правилно лечење су кључни за спречавање пулпних и пародонталних компликација, очување виталности, функције и естетике зуба. Циљ овог приказа случаја је да опише дугорочно интердисциплинарно лечење ретког DI типа IIIB, истичући дијагностичке изазове, стратегије лечења и успешно очување зуба.

Приказ болесника Максиларни латерални стални секутић са DI типом IIIB код деветогодишњег дечака јавио се са периинвагинационим пародонтитисом, при чему је виталност пулпе очувана, а формирање корена непотпуно. Усвојен је етапни, минимално инвазивни приступ, првобитно фокусиран на пародонталну хирургију и регенеративну терапију како би се контролисала инфекција, уз очување виталности пулпе и омогућавање континуираног раста корена. Након више од две године успешног одржавања виталности, развио се иреверзибилни пулпитис, што је захтевало сложено ортоградно лечење коренског канала, а затим апикално хируршко лечење. Дугорочно праћење, дуже од девет година, показало је потпуно периапикално зарастање, стабилно пародонтално стање, функционални интегритет и задржавање зуба у зубном луку.

Закључак Рана дијагноза DI је неопходна, јер случајеви типа III представљају велике изазове за очување пулпе и лечење коренских канала и често се разматрају за екстракцију. Овај случај показује да је дугорочно очување зуба могуће упркос сложеној анатомији коришћењем индивидуализованог, интердисциплинарног приступа.

Кључне речи: *dens invaginatus*; зуб са незавршеним растом корена; интердисциплинарно лечење

INTRODUCTION

Dens invaginatus (DI) is a developmental anomaly characterized by invagination of the enamel organ into the dental papilla prior to calcification [1]. The extent of invagination and pulp

chamber anatomy varies considerably, with Oehlers' [2] classification—types I to III—being the most widely used.

According to this classification [2], Type I is a minor, enamel-lined invagination restricted to the crown and not extending beyond the cementoenamel junction. Type II extends into the root but remains confined within it as a blind sac. Type III is the most severe form, in which the invagination extends through the root, creating a pseudo-foramen that opens either apically (Type IIIB) or laterally (Type IIIA) into the periodontal ligament. In Type III cases, the apical portion of the invagination is often lined with cementum [2].

Prevalence ranges from 0.25–10% in full-mouth surveys [1] and up to 26.1% in specific populations [3]. The maxillary lateral permanent incisor is most commonly affected, accounting for 86% of cases [4]. Although its aetiology is not fully understood, genetic factors are considered likely [5].

The abnormal anatomy predisposes affected teeth to caries, pulpal and periodontal inflammation, posing significant challenges for endodontic treatment, particularly in immature teeth with incomplete root formation [1, 2]. Management focuses on preserving pulp vitality to allow continued root development or maintaining symptom-free, adequately treated non-vital teeth, with extraction reserved for untreatable or severely compromised cases [4, 6].

The aim of this report is to present the long-term interdisciplinary management of a rare DI type IIIB (Oehlers), initially diagnosed with peri-invagination periodontitis and a vital pulp, emphasizing diagnostic challenges, treatment strategies, and the successful preservation of function and aesthetics.

CASE OUTLINE

Clinical and radiographic description

A nine-year-old boy was referred to the Department paediatric and preventive dentistry of the University Medical Centre Ljubljana due to the signs of inflammation in the area of erupting maxillary right lateral permanent incisor (the tooth 12). There was no history of trauma or dental caries. His parents reported a mild pain in this area, accompanied by oedema, which ceased nine days ago after antibiotic therapy (500 mg amoxicillin with 125 mg clavulanic acid, twice per day for five days). The antibiotic regimen was prescribed by the referring physician prior to the patient‘s presentation at our department. The choice of this broad-spectrum antibiotic is consistent with the management of acute odontogenic infections in paediatric patients, particularly when a mixed aerobic-anaerobic flora is suspected.

Clinical examination revealed healthy mixed dentition and healthy oral soft tissue, except red gingiva on the buccal side, associated with the tooth 12, with remnants of inactive sinus tract (Figure 1a). The crown of tooth 12 was yellowish and exhibited an unusual morphology. Enlarged palatal cingula, a disto-palatal groove, and a deep mesio-palatal radicular groove on each side of the cingula were noticed; however, invagination entrance was hardly visible. The patient‘s oral hygiene was good, with tooth surfaces free of microbial plaque, but abundant supragingival and subgingival calculus was present. There was no swelling of the surrounding mucosa, and no tenderness to palpation. The tooth was not sensitive to percussion nor pathologically mobile. Gentle periodontal probing revealed loss of attachment on the distobuccal aspect, with a probing pocket depth of 5 mm on the not fully erupted tooth crown. The dental pulp vitality of tooth 12 was confirmed using the electric pulp test and cold test. The periapical radiograph revealed a cylindrical root that was slightly widened apically. The coronal half of the invagination canal was very narrow and lined with a thin layer of enamel,

while in the apical half, the invagination canal expanded dramatically and opened widely into the periradicular tissues, giving a bell-shaped appearance. The dental pulp was compressed to the sides, encircling the bell-shaped invagination. A wide-open pulpo-periodontal communication was observed. Periapically, a diffuse bony radiolucency was present. Based on these findings, tooth 12 was diagnosed as dens invaginatus type IIIB according to Oehlers' classification [2] (Figure 1b).

Treatment Summary

The primary source of infection was determined to be periodontal (peri-invagination periodontitis), as direct communication between the invagination and the periodontal ligament facilitated bacterial contamination from the oral environment. Periodontal surgery was performed to treat peri-invagination periodontitis and prevent apical bacterial spread, aiming to preserve pulp vitality, in accordance with the principles of periodontal regenerative therapy. Following removal of hard and soft deposits using an ultrasonic scaler, a full-thickness mucoperiosteal flap was elevated. Granulation tissue and significant cortical bone loss were observed (Figure 1c, d); however, the apical region was left untouched to avoid pulp devitalization. The bone defect was irrigated with saline, and the exposed root surface was treated with 24% EDTA gel (PrefGel, Straumann, Switzerland) for 2 minutes, rinsed with saline and dried. Enamel matrix derivative gel (Emdogain, Straumann, Switzerland) was applied to stimulate new bone and connective tissue formation. The flap was sutured with resorbable sutures (Safil Quick 4/0, B. Braun Melsungen AG, Germany), and crown fissures were sealed with glass-ionomer cement - GIC (Fuji Triage Pink, GC Dental Products, Aichi, Japan). A week later, the crown was additionally sealed with resin (Helioseal F, Ivoclar

Vivadent, Liechtenstein). Initial healing was uneventful. The tooth remained vital and asymptomatic at 1-, 3-, and 6-month follow-ups.

The initial decision to perform periodontal surgery but no endodontic treatment was based on the fact that the tooth was vital and primary pathology was peri-invagination periodontitis, not an endodontic infection. The goals were to eliminate the periodontal inflammatory focus, promote bone regeneration, and preserve pulp vitality to allow continuing root development in this immature tooth.

At 12 months, the tooth was vital and asymptomatic with continued root formation confirmed on periapical image. Nevertheless, a new palatal sinus tract appeared, prompting additional surgery. A palatal mucoperiosteal flap was raised, granulation tissue excised, and the area irrigated. At 18-, 24- (Figure 1e), and 30-month (Figure 1g) evaluations, the tooth remained vital and symptom-free. Periapical radiographs showed continued root formation and attenuation of periapical radiolucency (Figs. 1f, h), although a sinus tract intermittently reappeared at the mucogingival junction.

At 33 months, despite vitality and lack of symptoms, the invagination canal was treated under the operating microscope (OPMI PICO, Carl Zeiss Meditec AG, Germany), with magnification up to 20×, coaxial halogen illumination, and a 250 mm working distance. The resin composite was removed from the palatal surface (Figure 2a, b), and the invagination entrance in the enlarged palatal cingulum was exposed and enlarged (Figure 2c). The canal was instrumented with hand files up to ISO 40, irrigated with 2.5% NaOCl and 17% EDTA, and medicated with calcium hydroxide paste (Calasept, Nordiska Dental AB, Sweden). The entrance was sealed with GIC.

At one- and three-month follow-ups, the tooth remained vital, but the sinus tract persisted. The persistence of the sinus tract after initial surgery was due to the inability to completely seal the

invagination and eliminate the bacterial reservoir, which eventually led to pulp involvement. Five months later, the patient presented with cold sensitivity and episodes of spontaneous pain. Vitality testing indicated irreversible pulpitis. CBCT analysis (Figure 2d, e, f) was followed by root canal treatment (RCT) under rubber dam and magnification. After local anesthesia (Scandonest 2% L, Septodont, USA), semi-circular access cavities to the pulp and invagination were made (Figure 2g). Cleaning included ultrasonic tips, XP-Endo rotary file (FKG Dentaire, Switzerland), and irrigation with 5%. To address the complex internal anatomy in type III dens invaginatus, 5% sodium hypochlorite was used. This choice was necessary because necrotic pulp tissue and microbial biofilm reside in narrow, irregular spaces that are very difficult, and sometimes impossible, to access mechanically. Therefore, a higher concentration of NaOCl provides enhanced tissue-dissolving and antimicrobial efficacy. In addition, 17% EDTA was used to remove the smear layer, thereby allowing deeper penetration of the irrigant. Calcium hydroxide was placed and sealed with GIC and Cavit W (3M Deutschland GmbH, Germany).

Two weeks later, canals were obturated with TotalFill BC Sealer (Brasseler U.S.A., Savannah, GA, USA) using single-cone and warm vertical gutta-percha (Figure 2h). A temporary seal was placed, and postoperative radiograph was taken (Figure 2i). Final resin composite restorations were placed at the next visit.

Periapical surgery was performed one month later due to persistent sinus tract. A 1 mm apicoectomy was done, canals were prepared with ultrasonic tips (ISO 25), and retrograde filling was completed using ProRoot MTA White (Dentsply Tulsa Dental Specialties, USA). Radiographs confirmed obturation (Figure 3a). After one week, healing was satisfactory and the patient remained asymptomatic.

Follow-up

At the control visits 6, 12, 18 months (Figure 3 c, d) and 9 years and 5 months after orthograde and retrograde treatment, the tooth 12 was asymptomatic, and with no sinus tract. Objective criteria confirming treatment success were as follows: (1) absence of clinical symptoms (pain, swelling, sinus tract), (2) normal periodontal probing depths and absence of pathological mobility, (3) normal response to vitality testing of adjacent teeth, and (4) radiographic evidence of complete periapical healing with a continuous lamina dura and a visible periodontal ligament space.

At the last follow-up, clinical examination revealed healthy gingiva around teeth 11, 12 and 13 (Figure 4a, b). The crown of tooth 12 was slightly yellowish in colour. No swelling or tenderness was elicited upon palpation of the surrounding mucosa. None of the teeth was tender to percussion testing and demonstrated normal mobility. Periodontal probing demonstrated normal periodontal depths of tooth 12. Both adjacent teeth (teeth 11 and 13) responded normally to dental pulp vitality tests. The periapical radiograph, taken 9 years and 5 months after the final treatment, showed completely healed bone adjacent to the root of tooth 12, with a visible lamina dura and a normal periodontal ligament space above the root apex (Figure 4b).

Ethics: The principles of the Declaration of Helsinki were respected in this case report. Written informed consent was obtained from the patient parent's for publication of this case report and any accompanying images. All identifying details have been removed or anonymized to ensure patient privacy.

DISCUSSION

This case demonstrates a staged, conservative approach to type III DI, prioritizing pulp vitality and long-term tooth retention despite complex anatomy. Initial treatment targeted peri-invagination periodontitis caused by bacterial contamination. Following coronal sealing, periodontal regeneration with enamel matrix derivatives was performed without membranes or grafts to avoid interference with craniofacial growth. Pulp vitality was maintained for 2.5 years, allowing root development, although irreversible pulpitis later required complex endodontic and surgical management. In this respect, it is important to distinguish between infection and pulpitis, the presence of microorganisms and the host's response, respectively. In this case, bacterial infection spread from the peri-invagination periodontitis, triggering an inflammatory reaction that progressed to irreversible pulpitis.

DI is often underdiagnosed due to its subtle presentation, typically limited to a small invagination entrance [7], and is frequently discovered incidentally on radiographs [8]. Despite its inconspicuous appearance, DI can compromise pulpal and periodontal health. The invagination may contain dental papilla or periodontal tissue remnants, creating a bacterial niche. The pulp may be separated from the invagination by a thin enamel or dentin layer [1] or communicate directly with it [4]. Direct communication increases the risk of early pulp infection, whereas pulpitis from caries progression occurs later [4]. Pulp necrosis may develop within a few years and sometimes precedes apical closure [1].

Management strategies for DI range from prophylactic sealing and restorative measures to endodontic treatment of the invagination, pulp amputation, conventional or surgical RCT or extraction [7]. However, outcomes remain unpredictable. Even after prophylactic intervention, pulp inflammation may occur; Ridell et al. [6] reported inflammation in 11.3% of type I and

100% of type II DI cases. Pulp survival depends on canal morphology, apical development, and avoidance of iatrogenic irritation [7].

Type III DI presents particular therapeutic challenges. Although pulp vitality preservation after obturation of the invagination has been reported [9], communication between the invagination and periodontal ligament facilitates continuous inflammatory insult [10]. Consequently, more than half of reported type III cases progress to pulp necrosis over time [11]. In the present case, irreversible pulpitis developed 2.5 years after periodontal surgery.

The sinus tract that developed during the vitality maintenance period originated from the peri-invagination periodontitis, not from pulp necrosis. Because the invagination communicated directly with the periodontal ligament, bacterial products and inflammatory exudate drained through the periodontal tissues, forming a sinus tract at the mucogingival junction. Pulp vitality was maintained because the pulp remained separate from the invagination and remained uninfected.

In this case, the invagination canal was wide and irregular, directly communicating with the periodontal ligament and partly inaccessible to both orthograde and retrograde approaches, as previously described in type III DI [12]. Furthermore, apical dilatation can cause inflammatory complications and eruption disturbances [13], but in this case eruption and alignment proceeded uneventfully.

Despite severe anatomical irregularities, the tooth was successfully preserved. Effective infection control, meticulous endodontic management, and adjunctive surgery achieved long-term stability exceeding 9 years, demonstrating that extraction is not inevitable even in complex DI cases.

In conclusion, early diagnosis and timely management of DI are essential, ideally before the onset of pulpal or periodontal inflammation. Type III DI presents a particular challenge in preventing pulp infection, maintaining vitality, and performing RCT, and due to its complex anatomy is often considered for extraction. However, this case demonstrates that long-term tooth preservation can be achieved even in the presence of highly complex root morphology and internal anatomy through an individualized, interdisciplinary treatment approach.

Conflict of interest: None declared.

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REFERENCES

1. Hülsmann M. Dens invaginatus: aetiology, classification, prevalence, diagnosis, and treatment considerations. Int Endod J. 1997;30(2):79–90. [DOI: 10.1046/j.1365-2591.1997.00065.x] [PMID: 10332241]
2. Oehlers FA. Dens invaginatus (dilated composite odontome). I. Variations of the invagination process and associated anterior crown forms. Oral Surg Oral Med Oral Pathol. 1957;10(11):1204–18 contd. [DOI: 10.1016/0030-4220(57)90077-4] [PMID: 13477660]
3. Kfir A, Flaisher Salem N, Natour L, Metzger Z, Sadan N, Elbahary S. Prevalence of dens invaginatus in young Israeli population and its association with clinical morphological features of maxillary incisors. Sci Rep. 2020;10(1):17131. [DOI: 10.1038/s41598-020-74396-z] [PMID: 33051551]
4. Alves Dos Santos GN, Sousa-Neto MD, Assis HC, Lopes-Olhe FC, Faria ESAL, Oliveira ML, et al. Prevalence and morphological analysis of dens invaginatus in anterior teeth using cone beam computed tomography: A systematic review and meta-analysis. Arch Oral Biol. 2023;151:105715. [DOI: 10.1016/j.archoralbio.2023.105715] [PMID: 37146389]
5. Grace M, Aarthi J, Elangovan A, Chenchugopal M, Gopalakrishnan S. Role of Genes in Dens Invaginatus: A Whole Exome Sequencing Study. Int J Clin Pediatr Dent. 2025;18(10):1255–9. [DOI: 10.5005/jp-journals-10005-3291] [PMID: 41211368]
6. Ridell K, Mejàre I, Matsson L. Dens invaginatus: a retrospective study of prophylactic invagination treatment. Int J Paediatr Dent. 2001;11(2):92–7. [DOI: 10.1046/j.1365-263x.2001.00234.x] [PMID: 11310143]
7. Baruwa AO, Anderson C, Monroe A, Cracel Nogueira F, Corte-Real L, Martins JNR. Dens Invaginatus: A Comprehensive Review of Classification and Clinical Approaches. Medicina (Kaunas). 2025;61(7). [DOI: 10.3390/medicina61071281] [PMID: 40731909]
8. Aksoy Çalıoğlu D, Koçak S, Geduk G. Prevalence and distribution of dens invaginatus in the western black sea region of Turkey: a retrospective radiographic study. Sci Rep. 2025;15(1):38449. [DOI: 10.1038/s41598-025-22444-x] [PMID: 41184566]
9. Li Y, Li Z, Wang B, Zhang L, Liu F, Guo Q. Treatment of Oehlers type III dens invaginatus in young permanent teeth: case reports. J Clin Pediatr Dent. 2026;50(2);209–16. [DOI: 10.22514/jocpd.2026.050]
10. Hegde V, Mujawar A, Shanmugasundaram S, Sidhu P, Narasimhan S, Setzer FC, et al. Prevalence of dens invaginatus and its association with periapical lesions in a Western Indian population-a study using cone-beam computed tomography. Clin Oral Investig. 2022;26(9):5875–83. [DOI: 10.1007/s00784-022-04545-3] [PMID: 35648236]
11. Lin F, Yue L. Preservation of Pulp Vitality in Type IIIA Dens Invaginatus with an Extensive Peri-invagination Lesion: a case Report with 5-year Follow-up. Chin J Dent Res. 2024;27(2):175–82. [DOI: 10.3290/j.cjdr.b5459617] [PMID: 38953483]
12. Zhang J, Wang Y, Xu L, Wu Z, Tu Y. Treatment of type III dens invaginatus in bilateral immature mandibular central incisors: a case report. BMC Oral Health. 2022;22(1):28. [DOI: 10.1186/s12903-022-02059-8] [PMID: 35120475]
13. Holtzman L, Lezion R. Endodontic treatment of maxillary canine with dens invaginatus and immature root. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1996;82(4):452–5. [DOI: 10.1016/s1079-2104(96)80314-3] [PMID: 8899787]

Figure 1. Preoperative clinical examination (a) and radiograph (b) showing an erupting maxillary right lateral incisor with type III dens invaginatus; a large bony defect identified during flap surgery was carefully debrided (c, d); clinical and radiographic views of the vital and asymptomatic maxillary lateral incisor at the 24-month (e, f); 30-month (g, h) follow-up examinations

Figure 2. Tooth 12 with a sealant placed on the palatal surface (a); after removal of the resin composite and preparation using a small carbide bur and a scaler, the entrance of the invagination became evident (b); the invagination entrance was then slightly enlarged (c); cone beam computed tomography images of the maxillary right lateral incisor showing the invaginated developmental canal on sagittal (d); frontal (e); and axial (f) cross-sectional views; entry of the invagination canal with a surrounding semicircular root canal orifice (g); both canal systems filled with gutta-percha (h); a periapical radiograph shows the root canal obturation (i): the distal canal is filled up to the apical constriction, whereas the palatal and buccal canals are filled only up to the "bending point;" a fractured ultrasonic file is visible in the apical portion of the invagination

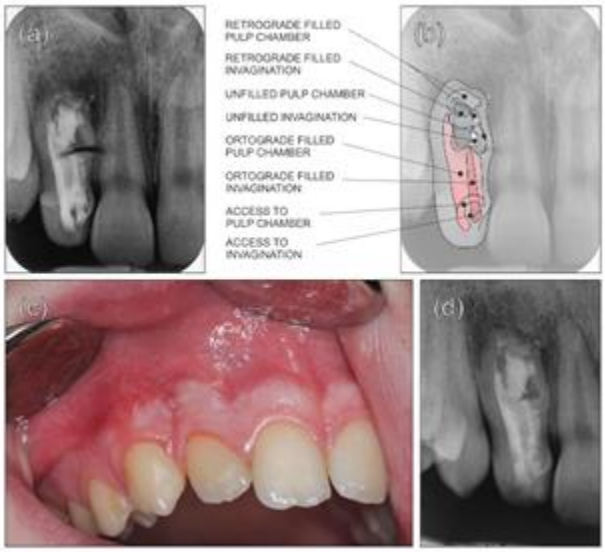

Figure 3. Periapical radiograph obtained after periapical surgery (a) with a schematic representation of the retrograde and orthograde obturation (b); clinical and radiographic views of the maxillary lateral incisor at the 18-month follow-up after periapical surgery (c, d)

Figure 4. Clinical (a, b) and radiographic (c) views of the maxillary lateral incisor at the follow-up examination nine years and five months after periapical surgery; the tooth is functionally and aesthetically well positioned in the dental arch

