Conservative management of Type II dens invaginatus with guided endodontic approach: A case series

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Abstract

Dens invaginatus (DI) is one of the rare malformations of teeth which results from an infolding of the dental papilla during the development of teeth. This defect gives rise to a possible communication between the pulp and oral environment, thereby increasing the susceptibility to caries, pulpititis, and pulp necrosis. Thus, early detection and conservative management of this invaginatus is of utmost importance. The present case series describes a conservative endodontic treatment technique for the management of teeth with Type II DI using a guided endodontic approach with three-dimensional printed surgical stents. This technique provides a precise and minimally invasive approach in the conservative management of DI, without compromising the vitality of main pulpal tissue.

Keywords: Three-dimensional printed surgical stents; dens in dente; guided endodontics; minimal invasive; Type II dens invaginatus

INTRODUCTION

During the morphodifferentiation stage of development of teeth, various malformations can develop. Dens invaginatus (DI) is a rare malformation that results in deepening or invagination of the enamel organ into the dental papilla before the calcification of the dental hard tissue.[1] It is frequently related to complicated crown and root canal morphology, proposing a challenge to the clinician in diagnosis as well as treatment. The reported occurrence ranges from 0.04% to 12%.2,3 The most commonly affected teeth are maxillary lateral incisors, and DI exhibits bilateral incidence in up to 43% of all reported cases.[1]

The degree of malformation associated with DI was classified by Oehlers in 1957. According to Oehlers classification, Type I is characterized by enamel lined invagination, which remains confined to the coronal part of the tooth. Type II represents the extension of the invagination in the root extending beyond the cementoenameal junction, which ends in a blind sac. Accordingly, Type IIIa is described as invagination that extends throughout the root and communicates laterally with Periodontal Ligament (PDL) space, and Type IIIb represents invagination extending through the root and communicating the PDL space at the level of the apical foramen.[4]

DI has variable clinical manifestation, with a variety of different shapes and sizes, including deformations such as grooves and slots, conical shape, barrel shape, or even talon cusp shape.[5] Therefore, the key diagnostic tool is the radiographic examination that provides essential information regarding the internal anatomy of the tooth. According to the literature, cone-beam computed tomography (CBCT) stipulates the precise interpretation of the internal anatomy in different planes and thereby provides the practitioners with a three-dimensional (3D) image.[6]
In recent times, guided endodontics has achieved great acceptance by the clinicians for managing endodontic challenges such as management of calcifications,[7] atypical tooth morphological variations,[8] DI,[9] conservative endodontic access cavity preparations in the normal tooth,[10] and for microsurgical endodontic procedures.[11]

With this innovative technique, a digitally scanned impression is acquired and is superimposed onto the data collected by CBCT software. A digital pathway for the drill is generated, and a surgical template is planned to access the root canal space using computer-aided designing software. Finally, by utilizing a 3D printer, this surgical guide is printed. With the help of this guided endodontic approach, iatrogenic errors may be drastically reduced while achieving access to the main root canal space or the DI. Moreover, this technique also reduces the duration of the treatment.[12-16] The present case series describe the conservative endodontic treatment of a Type II DI with guided endodontic approach and 3D printed surgical stents.

CASE REPORTS

Case report 1

A 16-year-old male patient reported to the department of conservative dentistry and endodontics, with the chief complaint of pain and discoloration in his upper front tooth region for 2 weeks. The patient gave the history of a fall 4 years back, and he did not report to any dental clinic at that time for treatment. A clinical examination revealed Ellis Class III fracture in relation to right and left maxillary central incisors (tooth numbers 11 and 21) [Figure 1a]. The tooth numbers 11 and 21 were tender on percussion. The clinical crown of tooth numbers 12 and 22 also displayed an increase in labiopalatal dimension, and a deep palatal pit was observed.

![Figure 1](image)

Figure 1: Illustrations showing the guided prophylactic management of dens invaginatus. (a) Preoperative clinical image. (b) Clinical image of surgical stent in place (labial view). (c) Clinical image of surgical stent in place (incisal view). (d) Preparation of access to dens invaginatus

Tooth numbers 11 and 21 showed no response to an electric pulp test (Analytic Pulp Tester; Analytic Technology Corp., Richmond, VA, USA) and also thermal test (Pulper G; C Corporation, Tokyo, Japan). On examination, tooth numbers 12 and 21 responded to both the pulp sensibility tests (cold test and electric pulp test) depicting their vitality. A preoperative intraoral periapical radiograph of tooth numbers 12 and 22 revealed some abnormal morphology, with invagination that seemed narrow and was lined by enamel [Figure 2a]. This extended to the middle third part of the root surface. Along with this, a periapical radiolucency was noted in relation to tooth numbers 11 and 21. According to Oehlers classification, this type of DI was categorized as Type II DI. According to the above-mentioned clinical and radiographic findings, the diagnosis of pulp necrosis and chronic periapical abscess associated with tooth numbers 11 and 21 was established. Root canal treatment was advised for tooth numbers 11 and 21. In relation to tooth numbers 12 and 22, conservative treatment of DI by prophylactic sealing of dens with mineral trioxide aggregate (MTA) was advised to prevent any pulpal damage to the tooth due to deep palatal pits which are commonly vulnerable to carious lesion.

With informed consent, a CBCT scan (Carestream 9300; Carestream Health, Rochester, NY, USA) was performed, with a thickness of 0.65 mm per slice, and with an exposure parameter of 84 kV, 6.0 mA, and 12 s. The CBCT images of the DI confirmed no such evident communication with the main root canal system [Figure 2b]. As there was a possible high risk of iatrogenic errors, a 3D printed surgical template was designed to assist in gaining access to the DI in tooth numbers 12 and 22. Elastomeric impressions were made to obtain a study model of the maxillary arch. To obtain a stereolithography file of the maxillary arch, an AutoScan-DS200 Dental 3D Scanner (Shining 3S Tech Co. Ltd., Hangzhou, China) was utilized. This file together with the 3D implant planning software (Exocad Asia Ltd., Tsim Sha Tsui Kowloon, Hong Kong) assists in designing the surgical template [Figure 3]. The surgical guides were fabricated using a 3D Printer & Dental 5G resin (Formlabs Inc., Somerville, MA, USA). To obtain a straight-line access to the DI, a pathway for the drills was created. The guiding cylinder that was created had a length and diameter of 5 mm and 1.3 mm, respectively. For gaining access to the dens part, a MI 45F diamond bur (Mani Inc., Tokyo, Japan) with a bur head diameter of 1 mm and length of 19.2 mm was selected. The drilling depth for the access to the dens part was established on the basis of the CBCT images, ensuring a straight line access to the DI part of tooth numbers 12 and 22.

The anterior segment was isolated using rubber dam (Hygenic, Coltene Whaledent Inc., Akron, OH, USA). Thereafter, the 3D surgical guides were placed in position and checked clinically [Figure 1b and c]. Afterward,
access to the DI was created by the help of accurately positioned 3D surgical template for tooth numbers 12 and 22 [Figure 1d]. After cleaning and shaping of these cavities with the solution of ultrasonically activated 3% sodium hypochlorite (Novo Dental Products Pvt. Ltd., Mumbai, MH, India) using Ultra-X device (Changzhou Sifary Medical Technology Co. Ltd., Changzhou, China), MTA (ProRoot MTA; Dentsply Tulsa, Tulsa, OK, USA) was placed into them. MTA was the chosen material here as it has superior sealing properties. After placement of the MTA, it was ultrasonically activated with Ultra-X, and a wet cotton was placed over the filled MTA. The teeth (12 and 22) were then temporized, and the patient was recalled after 24 h to remove the cotton and seal the dens part with composite resin (3M ESPE Dental Products, St. Paul, MN, USA) [Figure 4a and b].

Furthermore, a straight-line access to the root canal of tooth numbers 11 and 21 was performed. With the help of #15 K-file (Dentsply Maillefer, Ballaigues, Switzerland), the root canal space was negotiated. To obtain the working length, an apex locator (E Pex Pro; Changzhou Sifary Medical Technology Co. Ltd., Changzhou, China) was used. Thereafter, the working length was confirmed by radiographs. Cleaning and shaping was performed using rotary NiTi instruments (NeoNiti; Neolix, Châtres-la-Forêt, France) and K-files up to a size #70. The canals were then irrigated with 3% sodium hypochlorite (Novo Dental Products Pvt. Ltd., Mumbai, MH, India) and saline and dried with absorbent paper points. Teeth 11 and 21 were apically sealed using MTA apical barrier and backfilled using FastFill device (Changzhou Sifary Medical Technology Co. Ltd., Changzhou, China) [Figure 4c]. Afterward, the cavity was restored using Filtek-Z250 composite resin (3M ESPE Dental Products).
**Case report 2**

A 16-year-old male patient reported to the department with the complaint of pain and discoloration in the upper front tooth region. The patient gave the history of fall 7 years back. A clinical examination revealed that tooth number 11 was tender on percussion.

On further examination, tooth number 11 did not have any response to electric pulp test (Analytic Pulp Tester; Analytic Technology Corp., Richmond, VA, USA) and also thermal test (Pulper G; C Corporation, Tokyo, Japan). However, tooth number 12 gave response to both of the pulp sensibility test depicting their vitality. A preoperative intraoral periapical radiographic examination of tooth number 11 revealed calcification in pulpal cavity and periapical radiolucency [Figure 5]. Tooth number 12 which was clinically seen normal revealed some abnormal morphology in the coronal area. This appeared like an invagination that, according to Oehlers classification, was named as Type II DI. According to the clinical and radiographic findings, a diagnosis of pulpal necrosis was made with tooth number 11. Root canal treatment was advised for tooth number 11 and for tooth number 12, and conservative prophylactic treatment of DI by sealing of dens was advised. Conservative prophylactic sealing of the DI with MTA was planned for tooth number 12 [Figure 6]. In this case, similar treatment procedure was followed as explained in the earlier case report.

**DISCUSSION**

Endodontic management of the invaginated teeth is commonly associated with difficulties arising from...
complex variations of root canal anatomy.[1,17] Therefore, an early diagnosis of DI is crucial and requires a thorough clinical examination. These invaginations act as a niche for bacterial growth and may jeopardize the status of the main canal. In the present case series, the treatment modality was to prophylactically seal the DI with a biocompatible material like MTA, thereby treating the invagination yet retaining the pulp vitality in the main canal.[18]

The classification system which was introduced by Oehlers in 1957 is useful when treatment options are considered. To identify the type of dens invagination, a thorough preoperative radiographic evaluation, often with radiographs taken at different angles, is important. In recent time with advancement in radiographic techniques with CBCT imaging, a three-dimensional reconstruction of the affected tooth is achievable.[19]

There are numerous treatment possibilities for DI depending on its complexity and pulpal status. Prophylactic sealing of the invagination and constant monitoring are required in less complex cases (Oehlers Type I & Type II DI) with healthy pulp.[20] If the invagination that is communicating with the root canal exhibits signs of pulp pathosis, endodontic treatment is required. In cases where the invagination may not communicate with the root canal, sealing the invagination and preserving the pulp vitality may be considered. In the above-presented cases, the vitality of the affected tooth was preserved, thereby prophylactic sealing of the DI was considered as the most conservative treatment option.

In recent times, an era of digitalization has taken over the specialization of endodontics. A recently available technique, guided endodontics, is preferred by clinicians to achieve predictable and successful results for endodontic challenges such as partial or complete calcified canals, anomalous root canal morphology, DI, conservative access cavity preparation, and microsurgical endodontic procedures. It was introduced by Krastl et al.,[21] who presented its use for teeth with pulp canal calcification that required root canal treatment. The present case series is one of the first, describing the use of the guided endodontic technique in lateral incisors with DI with the assistance of CBCT-guided 3D printed surgical stent.

With the help of a special designing software (Exocad Asia Ltd., Tsim Sha Tsui Kowloon, Hong Kong), alignment with a CBCT and surface scan, a virtual planning for gaining an ideal access to the DI can be achieved. Subsequently, a surgical template was produced by means of a 3D printer. This surgical stent guides a minimally invasive drill to the DI part which was filled with MTA and sealed coronally with resin composite. Although the planning of guided endodontics appears to be very time-consuming, the chairside time during treatment is nominal. The additional costs for CBCT and the 3D surgical stent may be justified by the reduction of the probability of iatrogenic errors such as perforation, thereby increasing the chances of success.

**CONCLUSION**

Conservative prophylactic sealing of DI and preservation of pulp vitality of the main root canal was achieved in both the above reported cases using guided endodontic approach with a CBCT-guided 3D printed surgical stent. This technique can be a valuable tool for negotiating the Dens part, thereby reducing chairside time and more significantly decreasing the risk of iatrogenic damage to the remaining tooth structure.

**Declaration of patient consent**
The authors certify that they have obtained all appropriate patient consent forms. In the form, the patients have given their consent for their images and other clinical information to be reported in the journal. The patients understand that names and initials will not be published and due efforts will be made to conceal identity, but anonymity cannot be guaranteed.

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**Conflicts of interest**
There are no conflicts of interest.

**REFERENCES**

1. Hülsmann M. Dens invaginatus: Aetiology, classification, prevalence, diagnosis, and treatment considerations. Int Endod J 1997;30:79-90.
2. Hovland EJ, Block RM. Nonrecognition and subsequent endodontic treatment of dens invaginatus. J Endod 1977;3:360-2.
3. Kirziolu Z, Ceyhan D. The prevalence of anterior teeth with dens invaginatus in the western Mediterranean region of Turkey. Int Endod J 2009;42:727-34.
4. Zoya A, Ali S, Alam S, Tewari RK, Mishra SK, Kumar A, et al. Double dens invaginatus with multiple canals in a maxillary central incisor: Retreatment and managing complications. J Endod 2015;41:1927-32.
5. Akers HF, Henderson CM, Foley MA. Diagnosis and management of a maxillary lateral incisor exhibiting dens invaginatus and dens evaginatus. Aust Endod J 2014;40:32-8.
6. Muppurapu M, Singer SR, Goodchild JH. Dens evaginatus and dens invaginatus in a maxillary lateral incisor: Report of a rare occurrence and review of literature. Aust Dent J 2004;49:201-3.
7. Torres A, Shaheen E, Lambrechts P, Politis C, Jacobs R. Microguided Endodontics: A case report of a maxillary lateral incisor with pulp canal obliteration and apical periodontitis. Int Endod J 2019;52:540-9.
8. Byun C, Kim C, Cho S, Baek SH, Kim G, Kim SG, et al. Endodontic treatment of an anomalous anterior tooth with the aid of a 3-dimensional printed physical tooth model. J Endod 2015;41:961-5.
9. Mena-Álvarez J, Ricco-Romano C, Lobo-Galindo AB, Zubizarreta-Macho A. Endodontic treatment of dens evaginatus by performing a splint guided access cavity. J Esthet Restor Dent 2017;29:396-402.
10. Connert T, Zehnder MS, Amato M, Weiger R, Kühli S, Krastl G. Microguided endodontics: A method to achieve minimally invasive access cavity preparation and root canal location in mandibular incisors using a novel computer-guided technique. Int Endod J 2018;51:247-55.
11. Srbac GD, Schnappauf A, Giannis K, Moritz A, Ulm C. Guided modern
endodontic surgery: A novel approach for guided osteotomy and root resection. J Endod 2017;43:496-501.

12. Ackerman S, Aguiler FC, Buie JM, Glickman GN, Umorin M, Wang Q, et al. Accuracy of 3-dimensional-printed endodontic surgical guide: A human cadaver study. J Endod 2019;45:615-8.

13. Chong BS, Dhesi M, Makdissi J. Computer-aided dynamic navigation: A novel method for guided endodontics. Quintessence Int 2019;50:196-202.

14. Connert T, Krug R, Eggmann F, Emsermann I, ElAyouti A, Weiger R, et al. Guided Endodontics versus conventional access cavity preparation: A comparative study on substance loss using 3-dimensional-printed teeth. J Endod 2019;45:327-31.

15. Fan Y, Glickman GN, Umorin M, Nair MK, Jalali P. A novel prefabricated grid for guided endodontic microsurgery. J Endod 2019;45:606-10.

16. Maia LM, de Carvalho Machado V, da Silva NR, Brito Junior M, da Silveira RR, Moreira Junior G, et al. Case reports in maxillary posterior teeth by guided endodontic access. J Endod 2019;45:214-8.

17. Sousa SM, Bramante CM. Dens invaginatus: Treatment choices. Endod Dent Traumatol 1998;14:152-8.

18. Steffen H, Splieth C. Conventional treatment of dens invaginatus in maxillary lateral incisor with sinus tract: One year follow-up. J Endod 2005;31:130-3.

19. Patel S, Dewood A, Ford TP, Whaites E. The potential applications of cone beam computed tomography in the management of endodontic problems. Int Endod J 2007;40:818-30.

20. Ridell K, Mejàre I, Matsson L. Dens invaginatus: A retrospective study of prophylactic invagination treatment. Int J Paediatr Dent 2001;11:92-7.

21. Krastl G, Zehnder MS, Connett T, Weiger R, Kühl S. Guided endodontics: A novel treatment approach for teeth with pulp canal calcification and apical pathology. Dent Traumatol 2016;32:240-6.