

Diagnosis and endodontic treatment of type II dens invaginatus by using cone-beam computed tomography and splint guides for cavity access

A case report

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Dens invaginatus (DI) is defined as a dental malformation that develops during the process of odontogenesis as the result of the splitting of interdental papillae.^{1,2} It has a prevalence of between 0.04% and 10%.³ The maxillary lateral incisors are the most commonly affected,¹⁻⁷ and DI presents bilateral occurrence in up to 43% of cases.^{2,3}

This developmental anomaly may be associated with other anatomic disorders such as taurodontism, microdontia, macrodontia, tooth fusion, germination, and amelogenesis imperfecta. It also can be linked to specific medical syndromes.^{3,8}

The large number of terms relating to DI reflect the lack of consensus as to its etiology,⁸ and a number of hypotheses have attempted to clarify the phenomenon: focal failure of growth of the internal enamel epithelium while the surrounding normal epithelium invades the dental papilla; fast and aggressive invasion of the inner enamel epithelium of the dental papilla (benign neoplasm of limited growth); fusion of

ABSTRACT

Background and Overview. Dens invaginatus (DI) is defined as a rare dental malformation. The inherent structural variants of this anatomic disorder make it difficult to perform conventional endodontic treatment procedures by means of a conservative access cavity. In this clinical case report, the authors describe the treatment of a type II DI by means of guided splints for cavity access.

Case Description. This is a clinical report of a case of type II DI in a maxillary lateral incisor. The authors established the diagnosis by means of cone-beam computed tomography (CBCT). The authors manufactured 3 splint guides from a Digital Imaging and Communications in Medicine file and a stereolithography file obtained from a plaster model of the patient by using software for guided implant placement, for access opening, and for locating the root canals.

Conclusions. CBCT is an effective method for obtaining information about the root canal system in teeth with DI. In addition, guided implant surgery software is effective for manufacturing splint guides for endodontic treatment with conservative pulp chamber access.

Practical Implications. Information obtained from CBCT allows the clinician to fabricate splint guides for minimally invasive access opening in this type of case, thus reducing the loss of dental tissue.

Key Words. Dens invaginatus; root canal; computed tomography; endodontic therapy; dental pulp; computer-assisted therapy. JADA 2015;146(4):266-270

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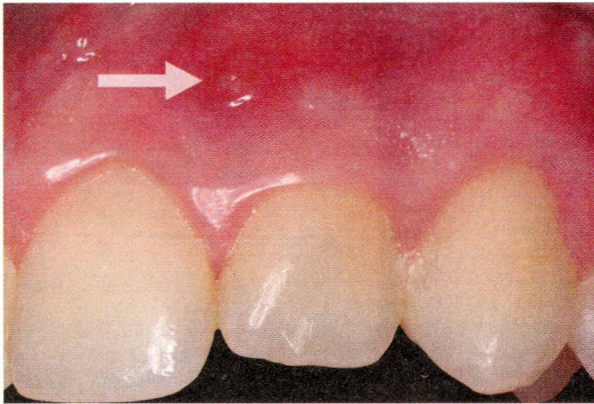


Figure 1. Intraoral view of fistulous lesion (arrow) located on the maxillary left lateral incisor.

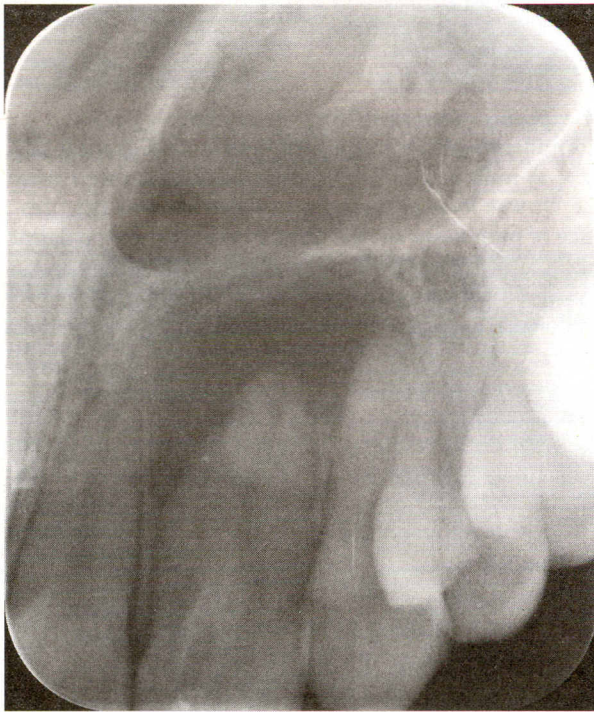


Figure 2. Periapical radiograph shows a periapical lesion and dens invaginatus. However, this radiograph failed to provide sufficient information about the root canal system's anatomy.

two dental germs; traumatic backgrounds; linear distortions of enamel that end in the cingulum of the teeth, resulting in an irregular, deformed crown; genetic factors; infectious processes.^{1-3,5,7,9}

DI is classified according to the degree of malformation, and the classification system published by Oehlers¹⁰ in 1957 is the most widely accepted. Oehlers¹⁰

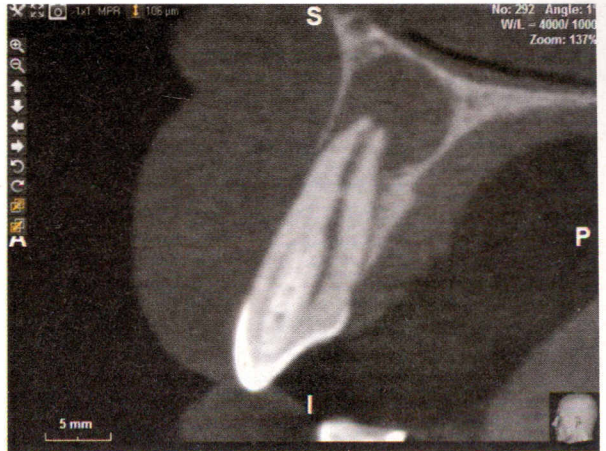


Figure 3. Cone-beam computed tomographic sagittal cross-section shows a periapical lesion and the presence of the dens invaginatus. A: Buccal. I: Incisal. mm: Millimeter. P: Palatal. S: Apical.

established 3 categories: type I, the invagination ends as a blind sac confined to the crown; type II, the invagination extends apically beyond the external cementoenamel junction, ending as a blind sac confined to the crown of the tooth; type III, the invagination extends beyond the cemento-enamel junction ending in the lateral (III a) or apical (III b) foramen.^{2,3,6-8,10-14}

DI is of varying clinical appearance, with a multitude of shapes and sizes, including grooves, slots, slight deformations, conical shape, plug shape, barrel shape, or talon cusp shape.^{1-3,7,9} For this reason, radiographic examination is a key diagnostic tool that provides essential information about the internal anatomy of the affected tooth. The literature highlights cone-beam computed tomography (CBCT) as the radiologic technique of choice because it allows interpretation of different planes and provides the clinician with a 3-dimensional (3-D) image.^{2,9}

In this clinical case, we describe endodontic treatment of a case of DI type II diagnosed using CBCT. We planned the access cavity by using guided implant placement software and splint guides fabricated by means of stereolithography.

CASE REPORT

A 22-year-old woman was referred from a private dental clinic to the university dental clinic, where the teaching staff of the master's degree program in clinical endodontics and periapical microsurgery treated her. Two of the authors (C.R.R. and J.M.) performed an intraoral

ABBREVIATION KEY. A: Buccal. CBCT: Cone-beam computed tomography. DI: Dens invaginatus. I: Incisal. P: Palatal. S: Apical. 3-D: 3-dimensional.

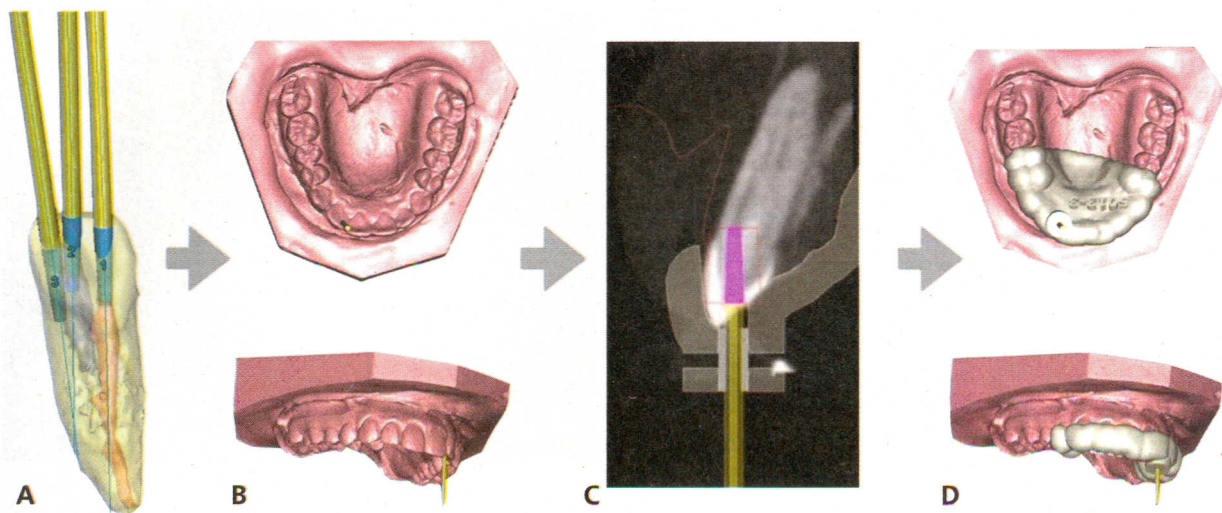


Figure 4. We converted the Digital Imaging and Communications in Medicine file into a stereolithography file that we used to determine the 3 cavity accesses (A and C). We used a stereolithography file of the plaster model obtained from an alginate impression and implant planning software to design 3 splints for the maxillary lateral incisor root canals (B and D).



Figure 5. Splint guides used for pulp cavity access. We used each splint to access each of the maxillary lateral incisor root canals.

examination, which revealed a fistulous lesion located at the level of the maxillary left lateral incisor (Figure 1). During clinical examination, we observed a malformed cingulum on the tooth's palatal surface, as well as a mesiodistal size slightly greater than that of the contralateral maxillary lateral incisor.

We identified symptomatic apical periodontitis with pulpal necrosis of tooth no. 2.2 and recommended endodontic treatment. One of the clinicians (C.R.R.) obtained a periapical radiograph with the paralleling technique, which helped confirm a diagnosis of DI type II (Figure 2). To understand the internal anatomy of the affected tooth, we decided to complement radiographic examination with CBCT (WhiteFox, Acteón Médico-Dental Ibérica S.A.U.-Satelec). The parameters

of exposure were as follows: 105.0 kilovolt peak, 8.0 milliamperes, 7.20 seconds, and a field of view of 15×13 millimeters. Tooth cross-sections showed that the DI was located mesially and also showed the presence of pulp tissue on the mesiobuccal and distopalatine surfaces of the tooth (Figure 3). The difficulty of preparing an access cavity justified the use of 3 splints to guide access to the DI root canal and to the dental pulp tissue on the surfaces described.

Two of the authors (A.F. and L.O.A.E.) took an alginate impression to produce models of both arches. We used an extraoral scanner (D710 scanner, 3Shape) to obtain a stereolithography file of both arches to be used in computer-assisted design of the splints. We designed the splints by means of 3-D implant planning software (SIMPLANT, Densply Implants) (Figure 4). We used a 3-D printer (ProJet 6000, 3D Systems) to fabricate the 3 splints, as well as a 3-D replica of the tooth and adjacent structures (Figure 5). We made the splints from stereolithography resins for use in medical models, with the exception of the stainless steel cylinder used to guide the milling process. The length and the diameter of the guiding cylinder were 5 mm and 1.3 mm, respectively. We selected a dental diamond burr surface (882 314 012, Komet Medical) with a diameter of 1.2 mm on the active part and a total length of 14 mm. We chose the milling depth on the basis of the CBCT images, ensuring access to the pulp tissue to produce access cavities of 12, 11, and 13 mm.

One of the authors (A.Z.M.) performed the endodontic treatment, first applying periapical anesthetic (articaine hydrochloride 40 mg with epinephrine

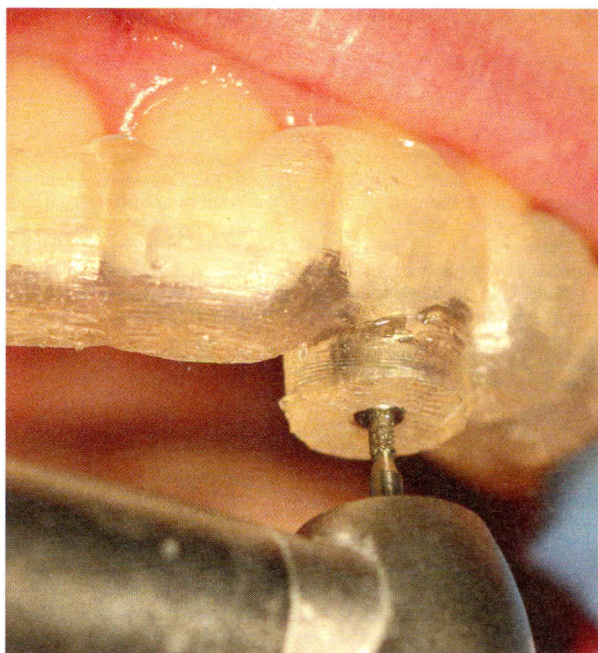


Figure 6. Intraoral view of 1 of the splints used to create the first cavity access and introduction of the diamond burr into the splint's guiding cylinder.

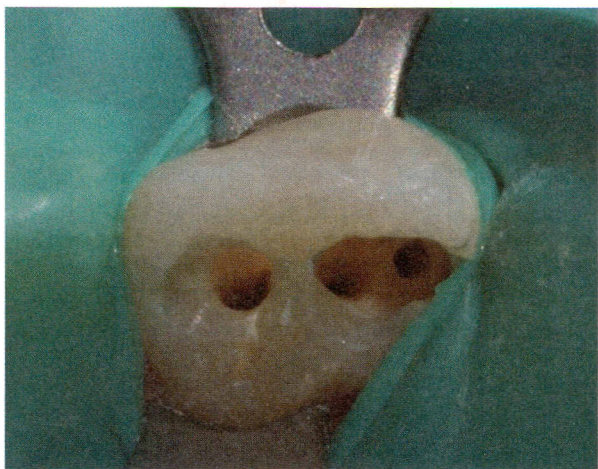


Figure 7. Intraoral view of access to each root canal with conservative cavity access.

1:100000 [Artinibsa]) before preparing the access cavities by using the splints (Figures 6 and 7). He determined the root canal working length by means of an electronic apex locator (Root ZX, Morita). He prepared the root canals by using an endodontic rotary instrumentation system (Mtwo, VDW) up to a 25/.06 file (size 25 tip and size .06 taper). He irrigated the root canals with 5.25% sodium hypochlorite by using an ultrasonic



Figure 8. Final cone-beam computed tomographic sagittal cross-section image 6 months after treatment.

tip (IRRI S, VDW) to enhance the contact between the irrigating solution and the surface of the root canal walls. Afterward, he dried the root canals by using sterile paper points (Dentsply Maillefer). He sealed the root canals with a warm gutta-percha system (Calamus, Dentsply Maillefer) and an epoxy resin-based cement (AH Plus, Dentsply DeTrey). One week later, he filled the access cavity by using a flowable resin (Filtek Supreme XTE, 3M ESPE). At the 6-month follow-up, he performed an examination and CBCT of the lesion, finding that the lesion had disappeared completely and that the patient no longer had any signs or symptoms (Figure 8).

DISCUSSION

Investigators have proposed a range of alternative therapies for treating DI: nonsurgical canal treatment, endodontic surgery, intentional replantation, extraction, or a combination of these.¹⁻³ This therapeutic range has arisen as a result of ignorance of the internal anatomy of these teeth. The inherent structural variations in this dental anatomic disorder complicate conventional endodontic treatment, a situation that has generated new therapeutic procedures for dealing with these teeth. Some authors stress the importance of preventive treatments that favor sealing communication between the DI and the outer surface of the tooth to prevent bacterial contamination of the DI.^{2,3,6}

The therapeutic prognosis of this anatomic disorder has been associated closely with technical advances in radiology. The introduction of radiologic techniques such as CBCT have allowed clinicians to obtain better information about the internal anatomy of these teeth.² In turn, better information allows a more predictable treatment plan.⁷

Guided splints are an adjuvant method for locating root canals. However, they have a number of limitations, such as inaccuracy, high economic cost, and long therapeutic time. Although few adverse effects have been documented, the cylinder guide may separate from a guided splint, or the splint can fracture.⁴ Several authors have proved the accuracy of these splints in the field of oral implant dentistry, relating presurgical planning to postsurgical outcomes. In this way, they found a 0.99-mm horizontal deviation (ranging from 0.0 to 6.5 mm) at the level of the implant platform of the osseointegrated implants, a 1.24-mm horizontal deflection (ranging from 0.0 to 6.9 mm) at the osseointegrated implant apex, and an average angle deviation of 3.81° (ranging from 0.0° to 24.0°) to the longitudinal osseointegrated implant axis.^{15,16} In the field of oral implant dentistry, these values have a major effect on cases of low bone mass and other challenging anatomic structures.

In the field of endodontics, a lack of precision can make it difficult to locate the root canals and can lead to unexpected complications. On certain occasions, satisfactorily locating the root canal depends mainly on the skill of the clinician.¹⁴ The values defining the accuracy of guided splints depend on various factors, such as the type of study, type of support, planning software, techniques used to fabricate the splint, discrepancy between drill and cylinder guide, degree of wear and tear the drill is subjected to, or number of guides used.^{15,16}

CONCLUSIONS

In this clinical case, CBCT was an effective diagnostic method for revealing the internal anatomy of a tooth with anatomic malformations. In addition, we were able to use CBCT information to fabricate splints to create conservative pulp chamber access for this type of anomalous tooth. Nevertheless, exactly locating the root canal ultimately depends on the skill and experience of the clinician. ■

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