Fifty-year follow-up of dens invaginatus treated by nonsurgical and surgical endodontic treatments: a case report

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ABSTRACT

This case report presents a lateral maxillary incisor with dens invaginatus (DI) type IIIb that was treated both nonsurgically and surgically over 50 years. Treatment of teeth with DI can be challenging. Suggested options may include nonsurgical root canal treatment, endodontic surgery, or extraction. In this case report, a 13-year-old patient with a lateral maxillary incisor with DI type IIIb was treated by nonsurgical root canal treatment, modern endodontic surgery, and reoperation over the course of 50 years. There was complete healing at the last follow-up, 11 years after the reoperation. Correct diagnosis and proper treatment using modern endodontic techniques can enable teeth with DI to survive throughout the life span of the patient.

Keywords: Apicoectomy; Dens in dente; Endodontics; Treatment outcome

INTRODUCTION

Dens invaginatus (DI) is a malformation of the teeth characterized by an early invagination of the enamel and dentine that can extend deep into the pulp cavity and the roots and may sometimes reach the apex [1]. The condition results from the invagination of the enamel during the soft tissue stage of development before the hard tissue mineralizes [2].

The etiology of DI malformation is controversial and remains unclear: Kronfeld [3] proposed that the condition is caused by a focal failure of growth of the internal enamel epithelium, which leads to proliferation of the surrounding normal epithelium with eventual engulfment of the static area. In contrast, Rushton [4] suggested that the invagination is a result of rapid and aggressive proliferation of a part of the internal enamel epithelium that then invades the dental papilla. He regarded this as a 'benign neoplasm of limited growth.' An alternative option was suggested by Oehlers [5], who considered that distortion of the enamel organ occurs during tooth development and results in protrusion of a

part of the enamel organ. Additional theories implicate fusion of tooth germs, infection, trauma, and genetics as possible contributing factors [1].

As a result of the changes, the arrangement of the mineralized tissue in DI appears opposite to normal, with the enamel located in the center and the dentine on the edges [6]. The prevalence of permanent teeth affected by DI is variable, ranging from 0.04% to 10% [7,8]. The most commonly affected permanent tooth is the maxillary lateral incisor (approximately 42% of all cases) [8].

Oehlers [5] classified DI into three categories: Type I, the invagination is confined within the crown, up to the cementoenamel junction; Type II, the invagination extends apically beyond the cementoenamel junction, where a connection between the invagination and the pulp is possible; Type III, the invagination extends beyond the cementoenamel junction and may involve a second foramen into the lateral periodontal ligament (IIIa) or periradicular tissue (IIIb).

The abnormal morphology of DI can be plaque retentive, thereby increasing the risk of caries, periodontal inflammation, and pulp necrosis [9]. In most cases, the thin or incomplete enamel lining of the invagination cannot prevent entry of bacteria into the pulp, which leads to pulp necrosis with an eventual periapical inflammatory response. The complex and atypical anatomy can hinder effective root canal instrumentation, thorough disinfection, and proper obturation of the canal system [1,10]. These anatomical irregularities increase the risk of residual infection and may compromise the overall success of endodontic treatment [11].

The difficulty in endodontic management is to gain adequate access to the canal space without severely compromising the strength of the tooth if the entire invagination is removed [12]. Advancements in endodontic diagnosis and treatment using cone-beam computed tomography (CBCT), magnification devices, modern endodontic surgery, and new bioceramic materials have significantly contributed to the effective management of complex cases such as DI [13,14]. In addition, guided endodontics offers a precise and minimally invasive approach to treating teeth with complex root canal systems [15]. The current case report presents a DI that was treated both nonsurgically and surgically over 50 years.

CASE REPORT

A 13-year-old girl was referred to the endodontic department in 1972, with a diagnosis of DI, pulp necrosis, and a chronic apical abscess in the left lateral maxillary incisor. Nonsurgical root canal treatment (NSRCT) was performed over three visits as described in a previous case report [16]. At the third visit, the tooth was asymptomatic and was obturated with gutta-percha and AH26 cement (DeTrey, Zurich, Switzerland) using the lateral condensation technique. A radiograph taken two years later showed evidence of healing of the periapical radiolucency (Figure 1), and complete healing was observed at the 3-year follow-up, as documented in the case report by Tagger [16].

Thirty years later (2002), the patient came back to the department with a complaint of pain and swelling and was diagnosed with an acute apical abscess in tooth #22. Informed consent was obtained and endodontic surgery was performed in the department (Figure 2). The tooth was treated with a modern surgical endodontic protocol, involving a dental operating microscope: local anesthesia with lidocaine 2% with epinephrine 1:100,000, triangular full mucoperiosteal flap, osteotomy, root-end resection with no bevel using a high-speed bur, curettage, retrograde preparation using ultrasonic tips, and root-end filling with intermediate restorative material (IRM; L.D. Caulk Company, Milford, DE, USA).

Clinical and radiographic follow-up was scheduled annually. Radiographic outcomes were assessed based on the criteria established by Rud *et al.* [17]. At a 2-year follow-up, the tooth was clinically asymptomatic, with good adaptation of the crown to the tooth and with radiographically normal periapical tissue (Figure 2C). The tooth remained asymptomatic with radiographically complete healing at an additional follow-up visit in 2006 (Figure 2D).

In 2011, 9 years later, the patient came back with a complaint of sensitivity in the area and purulent exudate. Clinically, the tooth was sensitive to percussion and palpation in the periapical area with signs of a sinus tract in the buccal apical area. A diagnosis of chronic apical abscess was made. A second endodontic surgery used the same technique as the previous treatment, taking care to minimize the apical resection in order not to
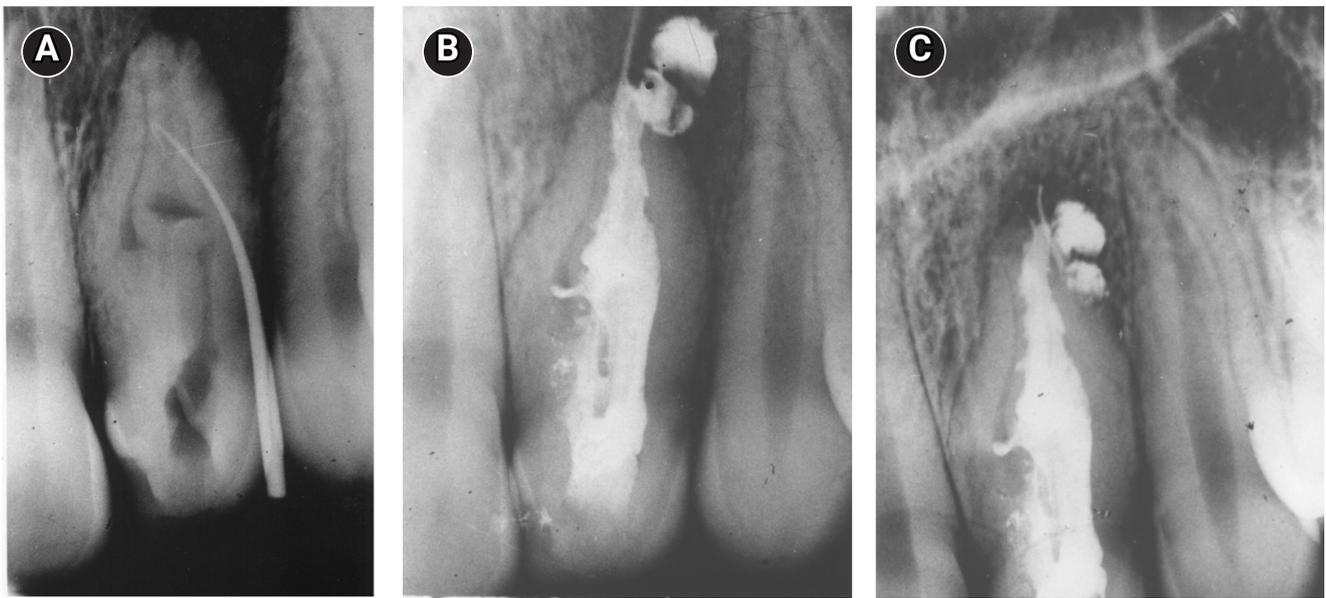
Figure 1. Nonsurgical root canal treatment on tooth #22. (A) Preoperative radiograph in 1972 showing a periapical radiolucent area that extends mostly on the distal surface of the root. Note: an access cavity was present. Gutta-percha cone inserted in the sinus tract leading to the sulcus of the tooth. Three pulp cavities are visible: the distal one exposed by the access cavity, the middle one partly lined with enamel, and the mesial one is closed and present only in the apical half of the root. (B) Postoperative radiograph in 1972. Note the extruded cement and gutta-percha point beyond the apex. Mesial cavity unfilled. (C) Two-year follow-up radiograph in 1974 showing a decrease in the size of periapical radiolucency. Excess filling material settled on the distal aspect of the root. Reprinted from the article of Tagger *et al.* [16] with the permission of Elsevier.
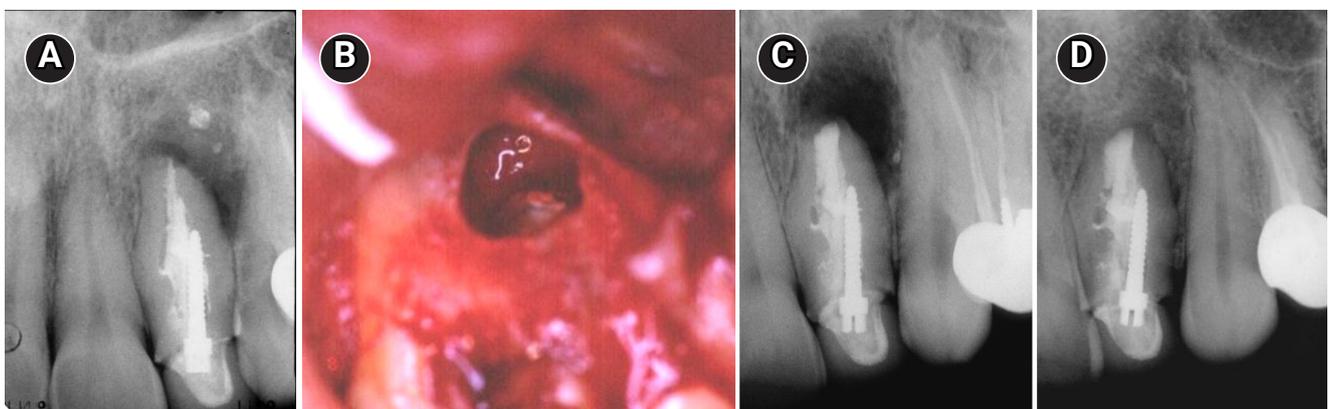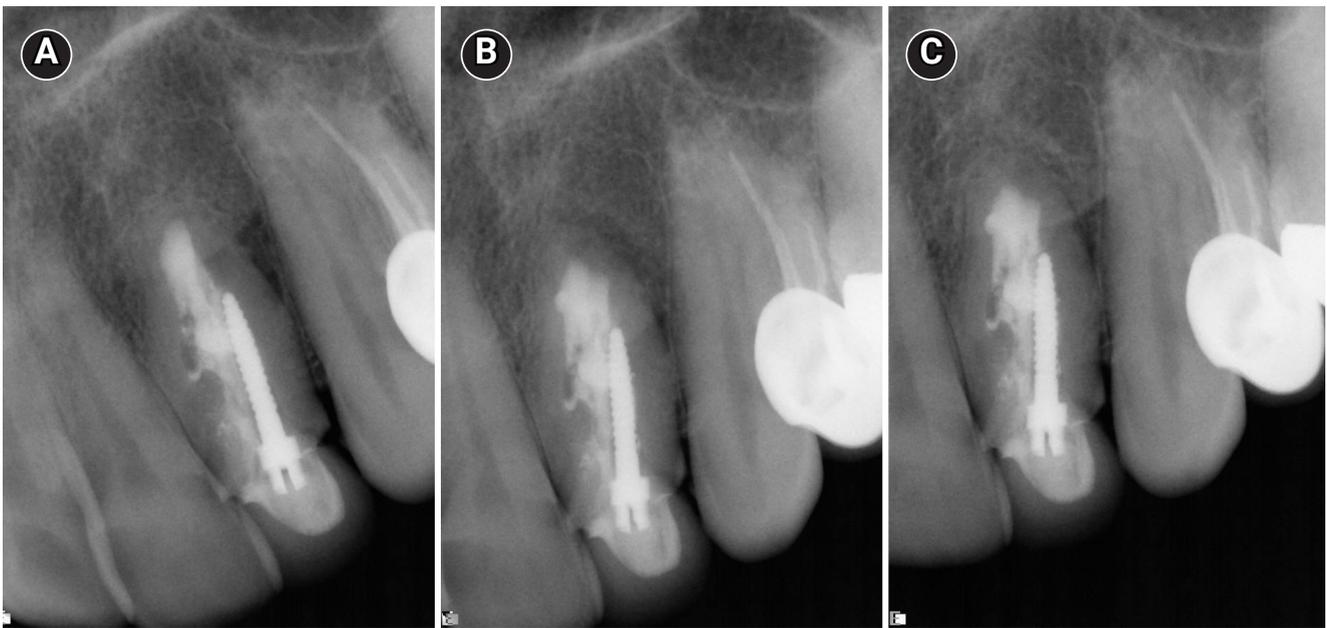

Figure 2. Endodontic surgery on tooth #22. (A) Preoperative radiograph in 2002 showing periapical radiolucent area around the apex and distal aspect of the root. Note the excess filling material outside the root. At the time of referral, the tooth had been restored with a post and crown. Marginal defects can be seen in the final restoration. (B) Intraoperative photograph in 2002. (C) Postoperative radiograph in 2002. The apical part of the mesial cavity was prepared and filled. Excess filling material that was outside the root was removed. (D) Four-year follow-up radiograph in 2006 showing complete healing with no periapical radiolucency present.

compromise the crown-root ratio. Two years following the second surgery, the tooth was asymptomatic and completely healed radiographically (Figure 3).

In 2021, when the patient (now aged 63 years) was referred by the treating dentist for evaluation, the tooth was still clinically asymptomatic with normal periapical tissues (Figure 4). The patient did not attend any follow-up appointments after 2021, despite multiple attempts to contact and recall her. A summary of events and outcomes is presented in Table 1.

Figure 3. Endodontic reoperation on tooth #22. (A) Preoperative radiograph in 2011. (B) Postoperative radiograph in 2011 showing minimal apical resection. (C) Two-year follow-up radiograph in 2012 showing complete healing with normal periodontal ligament space.
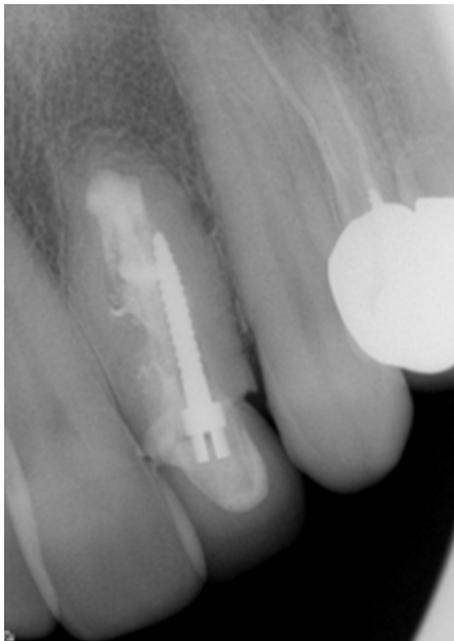
Figure 4. Radiograph taken in 2021 of tooth #22 showing normal periapical tissues, 10 years after endodontic reoperation.

DISCUSSION

Treatment of teeth with DI can be challenging due to the complex morphology. Identifying the invagination type is important for choosing the proper treatment. Following the first classification of DI published by Hallett [18], Schulze and Brand [19] proposed a more detailed classification, including invaginations starting at the incisal edge or the top of the crown, and also described dysmorphic root configuration. The classification scheme of Oehlers [5] is probably the most useful version and simplifies evaluation and treatment planning.

Various treatment methods may be suggested for the management of DI. These include NSRCT, endodontic apical surgery, intentional replantation, and extraction. Nonsurgical treatment sometimes fails because it is difficult to gain access to all parts of the root canal system [8], and additional treatment should be considered for a successful outcome.

Over the past five decades, there has been a significant advancement in root canal diagnosis and treatments with the integration of new technologies and materials such as CBCT, operating microscope, and bioceramics [13,20,21]. As a result, nowadays, the management of challenging cases with DI would follow a more advanced and evidence-based approach.

CBCT has transformed endodontic diagnostics by providing three-dimensional imaging of the tooth and surrounding structures and has led to more accurate

Table 1. Summary of events and outcomes

Date	Clinical findings	Radiographic findings	Diagnosis	Treatment	Outcome
1972	Sinus tract	Periapical radiolucency	Chronic apical abscess	Nonsurgical root canal treatment	1975: Complete healing 2002: Failure
2002	Swelling	Periapical radiolucency	Acute apical abscess	Endodontic surgery	2006: Complete healing 2011: Failure
2011	Sinus tract	Normal apical tissues	Chronic apical abscess	Reoperation	2013: Complete healing
2021	No signs/ symptoms	Normal apical tissues	Normal apical tissues	Evaluation	Complete healing

treatment planning [22]. It is particularly useful for assessing teeth with known complex anatomy, such as DI [23]. The increased diagnostic data (e.g., canal morphology, the extent of invagination, and periapical pathology) should result in more accurate diagnosis and, therefore, improved decision-making for the management of these cases [13]. While CBCT was not used in this case report, it should be considered for the management of complex endodontic cases [24].

Surgical operating microscope offers magnification and enhanced lighting, enabling endodontists to visualize the root canal system with greater clarity. This advancement has improved the success rates of nonsurgical and surgical procedures by allowing more precise interventions [25].

In the early 1990s, mineral trioxide aggregate (MTA) was introduced, and since then, there has been a great development of more bioceramic materials [26]. Bioactivity, biocompatibility, physical properties, and good sealing ability of these materials have highly advanced the clinical practice of endodontics [21,26,27].

This case presents a unique opportunity to observe the outcome of nonsurgical and surgical endodontic treatment of teeth with DI across a span of 50 years. Schmitz *et al.* [28] reported a case of NSRCT and endodontic surgery of a lateral maxillary incisor with DI, with a long-term follow-up showing complete healing after 11 years. In their case, the tooth had an open apex and DI type I. Surgical intervention was required due to the persistence of exudates and incomplete root canal development after conservative endodontic treatment. Retrograde preparation was deemed unnecessary.

We are not aware of any publications on DI that reported outcomes of endodontic reoperation on our cases with follow-up periods longer than 11 years following surgical treatment.

In our case, the intention was to conduct annual clin-ical and radiographic follow-up of the treatment. However, the patient did not attend all scheduled follow-up appointments despite multiple attempts to contact her. The tooth was treated for the first time in 1977 by Tagger [16]. At the 3-year follow-up, the periapical radiograph showed complete healing [16]. That case was managed before the introduction of diagnostic tools such as CBCT, the development of the modern apex locators, the introduction of the dental operating microscope, ultrasonic instrumentation, and advanced obturating materials. Thus, access cavity design, canal shaping, and obturation were limited to manual methods and relatively rudimentary instruments and obturation using gutta-percha with AH26 sealer.

Today, a different approach would be recommended, including CBCT before the treatment, the use of a dental operating microscope during the treatment, and obturation using a bioceramic material [14,29]. In recent years, guided endodontics has also emerged as a valuable tool for the treatment of such cases, enhancing the clinician's ability to navigate challenging anatomy with greater accuracy and confidence [15].

The tooth was referred to our department thirty years after the initial treatment and was diagnosed with an acute apical abscess. The complex anatomy of DI limits the effectiveness of optimal instrumentation and irrigation, compromising thorough disinfection and sealing of the root canal system [1,10]. This limitation may increase the risk of treatment failure and subsequent reinfection [11]. At the time of referral, the tooth had been restored with a post and crown. Currently, the placement of a post in such teeth is not recommended due to the risk of compromising the remaining tooth structure. Marginal defects were noted in the final restoration, a factor known to affect the long-term prognosis of the tooth. Nevertheless, clinical examination revealed good adaptation of the crown to the tooth.

The surgical endodontic treatment performed decades later reflects a dramatic shift in both philosophy and technology. The introduction of the dental operating microscope allowed precise root-end resection with a minimal bevel and retrograde preparation using ultrasonic tips [14]. The meta-analysis by Tsesis *et al*. [14] showed a 89% success rate for endodontic surgery using the modern technique. Setzer *et al*.'s meta-analysis [29] reported a significantly lower success rate of 59% with the traditional technique without magnification and using surgical burs and amalgam for root-end filling.

Although IRM was used as the retro-filling material, the technique employed in the 2011 reoperation already incorporated principles of modern endodontic microsurgery. IRM has been considered an available, easy-to-manipulate, dimensionally stable, and non-expensive material for many years [30–32]. While studies found no conclusive significant difference in outcomes between MTA and IRM [33], MTA and newer-generation fast-setting bioceramics with improved handling properties are now preferred over traditional materials like IRM for root-end fillings [33,34]. These materials offer superior sealing ability and biocompatibility, enhancing surgical outcomes [14,21].

Endodontic surgery may be considered to manage permanent teeth with apical periodontitis when nonsurgical root canal retreatment is impractical [14,35]. Endodontic reoperation is a valid alternative to extraction with reported success rates of >90% [36].

Root canal treatment and endodontic surgery are predictable procedures with an excellent long-term prognosis. A success rate of 95% was reported for NSRCT with a follow-up period of more than 20 years [37] and survival rates of 97% after eight years of follow-up [38]. Long-term success rates of >90% were reported for surgical endodontic treatment using modern techniques [14,36], when outcome was assessed as healed based on the criteria established by Rud *et al*. [17].

Long-term failures following endodontic surgery have been reported, where 5% to 25% of teeth recorded as healed at the short-term have been reported to regress when observed 3 years or longer after surgery [39,40]. While this regression may occur due to a variety of causative factors, including missed anatomy, insufficient root resection or root-end filling, and residual biofilm in isthmuses [41,42], in the present case, the failure of the apical seal was suspected as the reason for the recurrent lesion. Therefore, after a late failure in this case report, reoperation was performed using a modern technique, resulting in a successful outcome. A comparison of endodontically treated teeth and dental implants is challenging [43–45]. For example, while strict success criteria are very often used in endodontic outcome studies, the majority of implant studies rely solely on survival for outcome evaluation [43–45].

Advantages of endodontically treated teeth over implants include better function in that the former can return to a level of masticatory function that is similar to that of natural teeth, while an implant-supported crown tends to have reduced levels of masticatory function [46]. In addition, endodontically treated teeth tend to have better esthetics, especially in the anterior maxilla, and are less susceptible to biological and technical complications [44].

Although both treatment options are predictable with reported survival rates of ≥95% [44], there are no lifetime guarantees for either a natural tooth or a dental implant. For this reason, it is conceivable to assume that the two options should complement each other, and priority should be given to preserving the natural dentition rather than extraction when nonsurgical or surgical endodontic treatment can provide a good prognosis.

In this case report, a lateral maxillary incisor with DI type IIIb, was treated by NSRCT, followed by endodontic surgery and reoperation. Fifty years after the initial treatment, 11 years after the reoperation, the tooth appeared completely healed.

We therefore conclude that correct diagnosis and proper treatment using modern endodontic techniques and tools can result in survival of the natural tooth throughout the life span of a patient.

CONFLICT OF INTEREST

FUNDING/SUPPORT

AUTHOR CONTRIBUTIONS

DATA SHARING STATEMENT

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