Minimally Invasive Endodontic Treatment of a Maxillary Lateral Incisor With Invasive Cervical Resorption and *Dens in Dente*: A Case Report

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Alfredo Iandolo[1,2], Davide Mancino[3], Massimo Pisano[4], Eduard Euvrard[1,2], Dina Abdellatif[1,2]

[1]Faculty of Dental Surgery, University of Franche-Comté, 25000 Besancon, France
[2]Laboratoire Sinergies EA 4662, University of Franche-Comté, 25000 Besancon, France
[3]Faculty of Dental Surgery, Federation of Medicine Translational of Strasbourg and Federation of Materials and Nanoscience of Alsace, University of Strasbourg, 67081 Strasbourg, France
[4]Department of Medicine, Surgery and Dentistry 'Scuola Medica Salernitana', University of Salerno, 84084 Baronissi, Italy

AIM: This case report describes the conservative endodontic treatment of a maxillary lateral incisor affected by both dens invaginatus and invasive cervical resorption.
CASE PRESENTATION: A maxillary lateral incisor (tooth 1.2), presenting with dens invaginatus and invasive cervical resorption, was diagnosed with irreversible acute pulpitis. Following 3D reconstruction using cone-beam computed tomography (CBCT), a minimally invasive root canal treatment was planned with a vestibular access through the resorption site to preserve as much tooth structure as possible. After removing the external resorptive tissue and placing a dental dam, the root canal system was shaped using modern rotary files in the martensitic phase. Subsequently, an effective irrigant activation protocol was implemented, and the canal was obturated with gutta-percha and a biosealer. After addressing the main root canal, the invaginated portion of the tooth was carefully treated to ensure complete disinfection and sealing.
RESULTS: The treatment, guided by a suite of advanced diagnostic and endodontic technologies, achieved optimal care and preservation of the affected tooth. This use of cutting-edge tools in the field informs us of the possibilities for advanced care and preservation.
CONCLUSIONS: A one-year clinical and radiographic follow-up confirmed the treatment's success, demonstrating excellent clinical outcomes and tooth stability.

Keywords: endodontic treatment; *Dens in Dente*; invasive cervical resorption; operative microscope; case report

Introduction

Root resorption is characterised by the progressive degradation of mineralised tooth tissue due to excessive odontoclastic activity, which refers to the activity of cells responsible for the breakdown of tooth structure. It can be classified as physiological, occurring during the exfoliation of deciduous teeth, or pathological, which can be further divided into internal and external root resorption [1,2].

External root resorption can be subdivided into external inflammatory resorption, external replacement resorption, external cervical resorption, and transient apical fracture [1]. External cervical resorption typically affects the cervical third of the tooth root, just below the epithelial attachment [2]. It is aggressive and invasive; hence, it is also referred to as 'invasive cervical resorption' [3]. From an epidemiological perspective, external cervical resorption was once considered rare, with prevalence reported between 0.02% and 0.08% [1,4]. This low figure may be attributed to diagnostic challenges, as the process is often asymptomatic in its early stages and only becomes apparent later in its progression [5]. The aetiology of external cervical resorption is not fully understood. However, it is widely accepted that damage to the root cementum beneath the epithelial attachment exposes the root surface to osteoclast activity, leading to dentin resorption [6]. Some researchers have viewed this resorption as an inflammatory process [7], while others consider it an aseptic phenomenon that may later become secondarily infected [7,8]. It has been hypothesised that microorganisms from the gingival sulcus or endodontium, particularly in teeth with necrotic pulps, may provide the stimuli necessary to sustain resorption lesions [9–11]. Studies investigating the pathogenesis of external cervical resorption have focused on histopathological findings and the cellular mechanisms involved.

Histopathological examinations have identified multinucleated cells, resembling osteoclasts, within the resorptive tissue. These cells occupy resorption gaps, and as the resorption progresses, the defect is partially repaired with bone-

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Correspondence to: Alfredo Iandolo, Faculty of Dental Surgery, University of Franche-Comté, 25000 Besancon, France; Laboratoire Sinergies EA 4662, University of Franche-Comté, 25000 Besancon, France (e-mail: alfredo.iandolo@univ-fcomte.fr).

like tissue [12]. Key cellular players in this process include osteopontin and osteocalcin, which, found in high concentrations in dentinal tissue, facilitate osteoclastogenesis by acting as chemoattractants [13]. Additionally, bone sialoprotein, recognised by cells responsible for resorption, promotes osteoclast binding to the root surface, an essential step in the initiation of resorption [14]. Osteoclastogenesis has been linked to leukocyte infiltration [12], although the cause of the inflammatory response remains debated [10]. Two main theories have been proposed: the inflammation and infection theories. The first suggests that resorption is triggered by a non-infectious external stimulus that induces local inflammation in the periodontium [15]. The second posits a pathogenesis similar to periodontitis, where bacterial colonisation promotes leukocyte infiltration and bone resorption, implying that microorganisms may play a similar role in the early stages of external cervical resorption [16].

Several predisposing factors for external cervical resorption have been identified, including dental trauma [5,10], orthodontic treatment [5,17], intracoronal bleaching [5,18], periodontal therapy [5,18], and idiopathic causes [9,19].

Diagnosing external cervical resorption can be difficult, especially in its early stages, as it is often discovered incidentally during radiographic examinations. Its radiographic appearance typically correlates with lesion severity. Early-stage lesions are more likely to be detected on the proximal surfaces of teeth [1]. Radiographically, it presents as an asymmetrical radiolucency with irregular margins at the cervical third of the root. In advanced stages, the lesion may appear mottled due to the formation of bone-like tissue during the reparative process [4,5]. If the resorption involves the adjacent alveolus, it may present as an intraosseous defect radiographically [3,20]. Conventional radiography has limitations in providing detailed information about the extent of resorption [21], while cone-beam computed tomography (CBCT) offers more accurate diagnostic insights regarding the position and depth of the lesion relative to the root canal [22,23]. Treatment requires complete removal of the resorptive tissue and restoration of the defect. The root canal system's severity, location, and possible perforation must be assessed before treatment [1]. In cases of root canal perforation, endodontic therapy is critical before external repair [18].

Dens in Dente, also known as dens invaginatus, is a dental anomaly characterised by the inward folding of dental hard tissues into the pulp chamber during odontogenesis prior to tissue calcification [24–28]. Oehler's classification system [29] is the most commonly used to categorise *Dens in Dente* into three classes.

This report presents a comprehensive and clinically feasible approach to managing the rare coexistence of external cervical resorption and dens invaginatus, conditions that pose significant diagnostic and therapeutic challenges. This case emphasises the importance of advanced imaging techniques, meticulous treatment planning, and minimally invasive procedures to preserve tooth structure and functionality.

Case Report

This case report was conducted following the principles outlined in the Declaration of Helsinki. The rights, safety, and well-being of the patient were prioritized throughout the preparation of this article. Approval was obtained from the institutional ethical committee (AOU Federico II, Protocol Number 00008975-03/2023), and informed consent was obtained from the patient before the treatment and for publication. This case has been reported in line with the Case Report (CARE) Guidelines to ensure the accuracy and completeness of the report (**Supplementary material**).

A 30-year-old male patient presented to our private clinic, the Center of MicroEndodontics, complaining of pain and discolouration (pink spot) of the right maxillary lateral incisor. Clinical examination revealed pink discolouration on the labio-cervical aspect of the lateral incisor (Fig. 1A). Percussion and mobility tests were negative. The palatal-gingival sulcus was examined, and normal periodontal probing depth was observed. The tooth exhibited spontaneous pain, with relief from cold stimuli and continuous, intense pain triggered by heat.

The patient reported experiencing spontaneous pain for approximately one week but could not recall when he first noticed the pink discolouration of the tooth. He initially assumed it was a normal variation in colouration. An alternative treatment plan involving the extraction of tooth 1.2, followed by implant placement, was also presented to the patient. However, the operators recommended this second option only as a contingency in case the initial treatment plan failed. The costs, risks, and benefits of each treatment approach were thoroughly explained to the patient, ensuring he was fully informed before making his decision. Finally, the patient chose to save his tooth through a minimally invasive treatment.

On the first visit, a periapical radiograph of tooth 1.2 showed a mixed radiolucent and radiopaque area at the cervical region (Fig. 1B). The patient had no history of trauma, and his medical history was non-contributory. Based on suspicion of invasive cervical resorption, a second-level radiographic evaluation with 3D CBCT was performed. An 8100 3D CBCT (cone beam computed tomography) (3625 Cumberland Blvd., Ste. 700, 800-944-6365, Carestream Dental LLC, Atlanta, GA, USA) was used for the scan, with the smallest Field of Vision (FOV) (5 × 4) at a high resolution of 75 microns. The 3D imaging (Fig. 2A,B) confirmed a diagnosis of invasive cervical resorption in proximity to the pulp chamber and the presence of a *Dens in Dente*. Tooth 1.2 was diagnosed with irreversible acute pulpitis.

Following the 3D reconstruction of tooth 1.2, the treatment plan was determined to involve a minimally invasive root

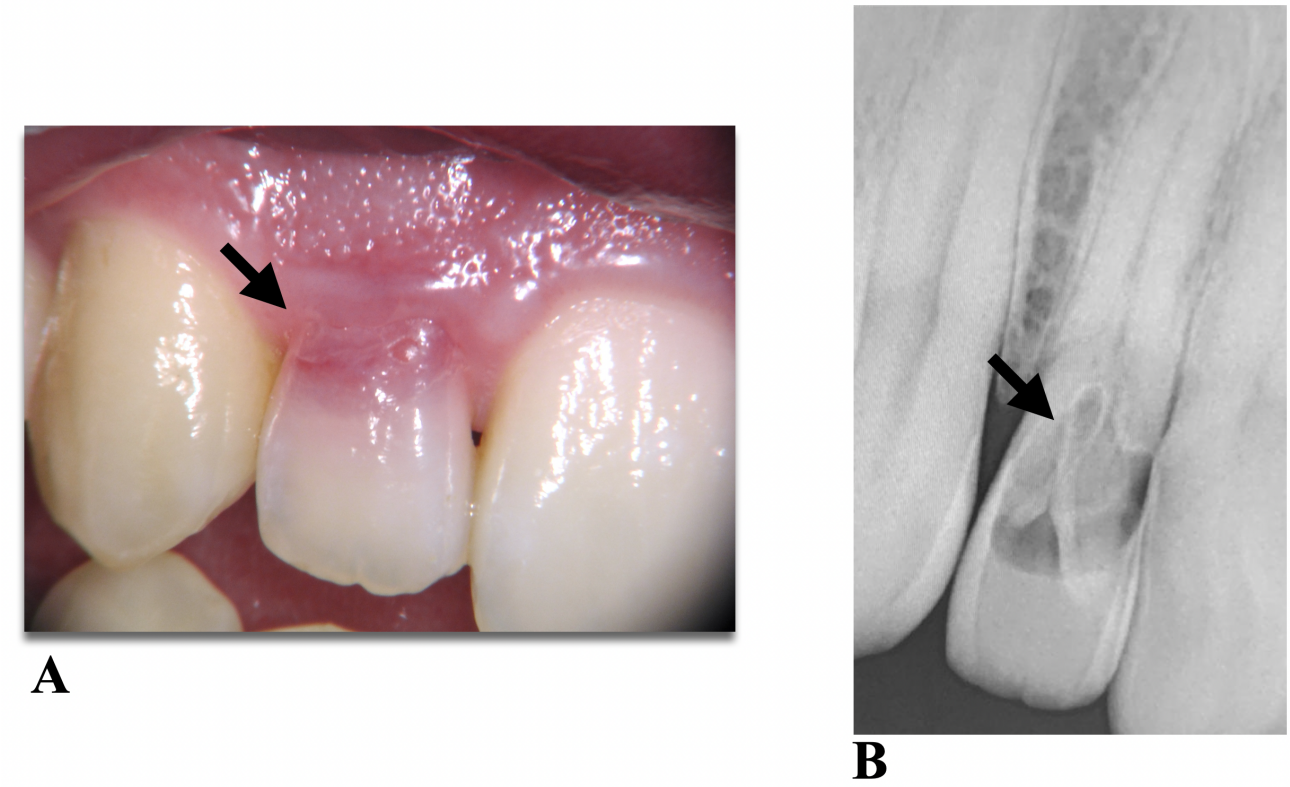

Fig. 1. Clinical and radiographic examination. (A) Clinically, the lateral incisor presented with pink discoloration on the vestibulo-cervical side, as indicated by the black arrow. (B) The pre-operative periapical radiograph of tooth No. 12 shows a radiolucent and radiopaque area at the cervical region, as indicated by the black arrow.

canal treatment of the main root canal and the dens in the dent and conservative microsurgery to remove and reconstruct the resorptive lesion (Fig. 2A,B).

Consequently, the treatment was scheduled for the next available day for the patient, one month after the first visit. On the day of treatment and under local anaesthesia, a surgical flap was raised to expose the cervical resorption. A micro-scalpel (Full radius round MB 69, Hu-Friedy Mfg. Co., Inc. Chicago, IL, USA) was used to perform the incision (Fig. 3A). The surgical field was isolated with both a rubber dam (Flexi Dam, Coltene/Whaldedent Inc., Cuyahoga Falls, OH, USA) and a liquid dam (Hysolate, Coltene/Whaldedent Inc., Cuyahoga Falls, OH, USA). The resorption area was removed using a multi-blade rosette bur and a small excavator (Fig. 3B). This step was performed with constant 8× magnification and illumination from an operating microscope (Karl Kaps Som 32 Optik-Feinmechanik-Gerätebau GmbH & Co. KG., Europastraße, Aßlar, Germany). The pulp chamber became visible, and endodontic treatment was initiated through the same buccal opening to conserve tooth structure (Fig. 3C–E).

Had traditional palatal access been used, more enamel and dentin would have needed to be removed, leading to greater structural weakening of the tooth.

The mechanical preparation was done using the latest rotary files, HyFlex EDM (OGSF, Coltene/Whaldedent Inc., Cuyahoga Falls, OH, USA), made from martensitic alloy, were employed for the shaping phase. The sequence of files used was K-File 0.10, HyFlex EDM 15.03, and 20.05. The working length was determined using an apex locator (Root ZX Mini, Morita, MC3 COMUNICATION, Via Aldo Villa 17\B, 20091, Bresso, Milano, Italy). The vestibular access increases cyclic fatigue, which can contribute to instrument separation. However, using modern files with small diameters and tapers enabled safe work without causing iatrogenic damage.

Recent studies have emphasised that conservative shaping combined with effective active cleaning can yield excellent results [30–33].

During the shaping phase, 5.25% sodium hypochlorite (Canal Pro, Sodium Hypochlorite (NaOCl), 5.25% Coltene/Whaldedent Inc., Cuyahoga Falls, OH, USA) was used, followed by active irrigation of the endodontic space.

After completing rotary instrumentation, a final rinse with 5.25% NaOCl was performed, followed by drying with sterile paper points (Roeko paper points, Coltene/Whaldedent Inc., Cuyahoga Falls, OH, USA), demineralised water, and a 17% EDTA solution (Canal Pro, EDTA 17%, Coltene/Whaldedent Inc., Cuyahoga Falls, OH, USA) for 60 seconds. NaOCl was then used to neutralise the EDTA, followed by another fresh 5.25% NaOCl application. Activation was carried out following the 3D Cleaning protocol

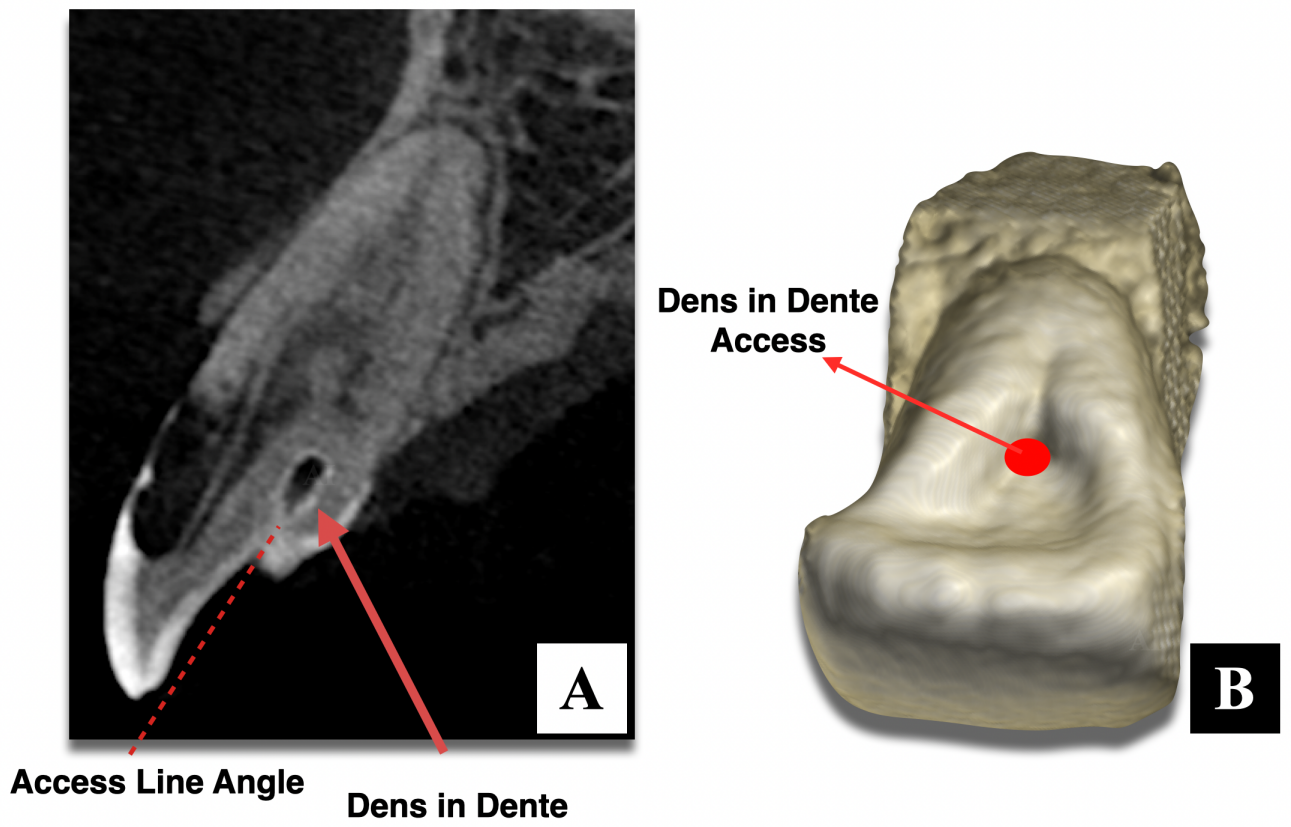

Fig. 2. 3D CBCT imaging. (A) The 3D CBCT scan revealed invasive cervical resorption in close contact to the pulp chamber, along with the presence of a *Dens in Dente*. (B) Three-dimensional reconstruction of tooth 1.2 to plan a correct treatment plan. CBCT, cone-beam computed tomography.

described in the literature by Iandolo *et al*. [30], a well-documented irrigant activation technique [31–35].

NaOCl was heated using a 30/04 heat carrier from System B (Immeuble Cap de Seine, 3e étage 45-47 Boulevard Paul Vaillant Couturier, KERR DENTAL FRANCE-EH France SAS, Ivry-Sur-Seine, France). The heat carrier was positioned 5 mm from the working length and activated at 180° for 6 seconds with up-and-down movements. Ultrasonic activation of the NaOCl was performed for 20 seconds using a specialised device with a smooth, dedicated tip (25/00) (Ultra Smart AI, COXO, Foshan, China), positioned 2 mm from the working length. After activation, the NaOCl was left to act for 60 seconds, after which the solution was refreshed, and the 3D Cleaning process was repeated three times.

A 30-gauge endodontic needle (Canal Pro, Coltene/Whaldedent Inc., Cuyahoga Falls, OH, USA) with a closed tip and lateral opening delivered irrigants to 2 mm of the working length.

Once the canal was dried with sterile paper points, it was obturated with a gutta-percha cone (25.04, Coltene/Whaldedent Inc., Cuyahoga Falls, OH, USA) and bioceramic sealer (Bioseal, Coltene/Whaldedent Inc., Cuyahoga Falls, OH, USA).

Next, the palatal access to the *Dens in Dente* was addressed. With the aid of the 3D imaging and operating microscope, precise and minimal access was created (Fig. 3F). Shaping, active cleaning, and bioceramic obturation followed the same protocols used for the main canal. The sequence of files used was K-File 0.10, HyFlex EDM 15.03, and 20.05, and 3 cycles of 3D Cleaning followed by a filling with gutta-percha cone and bioseal.

The treatment was completed with adhesive composite restoration, and the surgical flap was sutured using 6.0 Prolene sutures (Fig. 4A). A post-treatment periapical X-ray confirmed the procedure's success (Fig. 4B).

Five days later, the sutures were removed, and the patient reported no symptoms during the follow-up examination.

Clinical and radiographic evaluations were performed at the 15-day and one-year follow-ups, and the results were considered satisfactory (Fig. 4C–E).

Discussion

Root resorption is the loss of dental tissue due to odontoclast activity. This process is physiological in deciduous teeth, but in permanent teeth, it is considered pathological [1]. Resorption can occur internally within the root canal or externally on the root surface. It is an irreversible condition

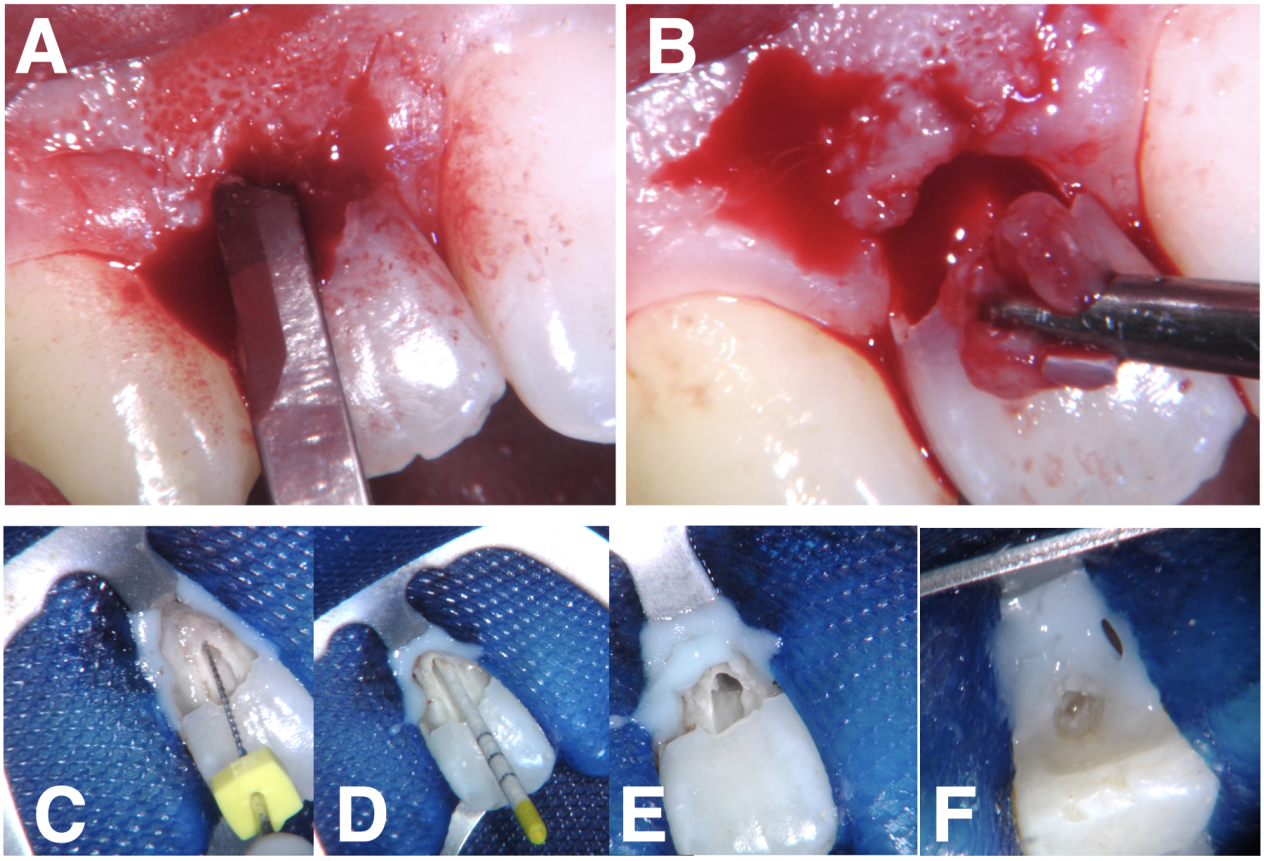

Fig. 3. Treatment steps of tooth 1.2. (A,B) Illustrating the surgical procedure, (C–E) isolation, and conservative endodontic treatment of the main canal through the buccal side, (F) as well as the treatment of the *Dens in Dente* from palatal side.

that may lead to premature tooth loss. Odontoclasts create resorptive cavities known as Howship's lacunae in mineralised tissue [2]. Resorption may go unnoticed clinically unless associated with infection or pressure, which can exacerbate the loss of tooth structure, making it challenging to diagnose and treat.

External root resorption can be classified based on its pathogenesis into several types: external surface resorption, external cervical resorption, external inflammatory resorption, external replacement resorption, and transient apical resorption. In the present case, we are dealing with external cervical resorption, which can be asymptomatic in its early stages but may later manifest with symptoms of pulpitis, apical periodontitis, or a periodontal defect, often with significant bleeding [8]. The affected tooth may appear healthy and vital or exhibit discolouration and necrosis. In our case, the patient reported pain and discolouration. Clinical examination revealed pink discolouration, insensitivity to percussion, and no mobility. The pink hue results from fibrovascular granulation tissue filling the resorptive cavity. Periodontal probing was within normal limits, but the patient experienced spontaneous pain, relief with cold stimuli, and continuous, intense pain with heat. External cervical resorption typically begins in the cervical third of the tooth but may extend to the middle or apical third in more advanced stages. In this case, the resorption was confined to the cervical third.

Radiographically, early-stage cervical resorption appears as a symmetrical radiolucency, while more advanced stages show a mottled radiopaque area with potential root canal perforation. 3D CBCT imaging confirmed the diagnosis of invasive cervical resorption, showing the lesion near the pulp chamber.

The exact cause of external cervical resorption remains unclear but is considered multifactorial. Orthodontic treatment, prior dental trauma, and parafunctional habits are frequently associated with its development.

The goal of treating invasive cervical resorption is to remove the lesion to halt the process, restore the defect, and prevent recurrence. This therapy can involve external repair with or without root canal therapy. The restoration can be completed using composite, glass ionomer cement, or biodentine.

In cases where the resorption is inaccessible and untreatable, and if asymptomatic, the clinician and patient may opt to monitor the lesion to track its progression [16].

In addition to external cervical resorption, this clinical case also presented with a *Dens in Dente*. This developmental

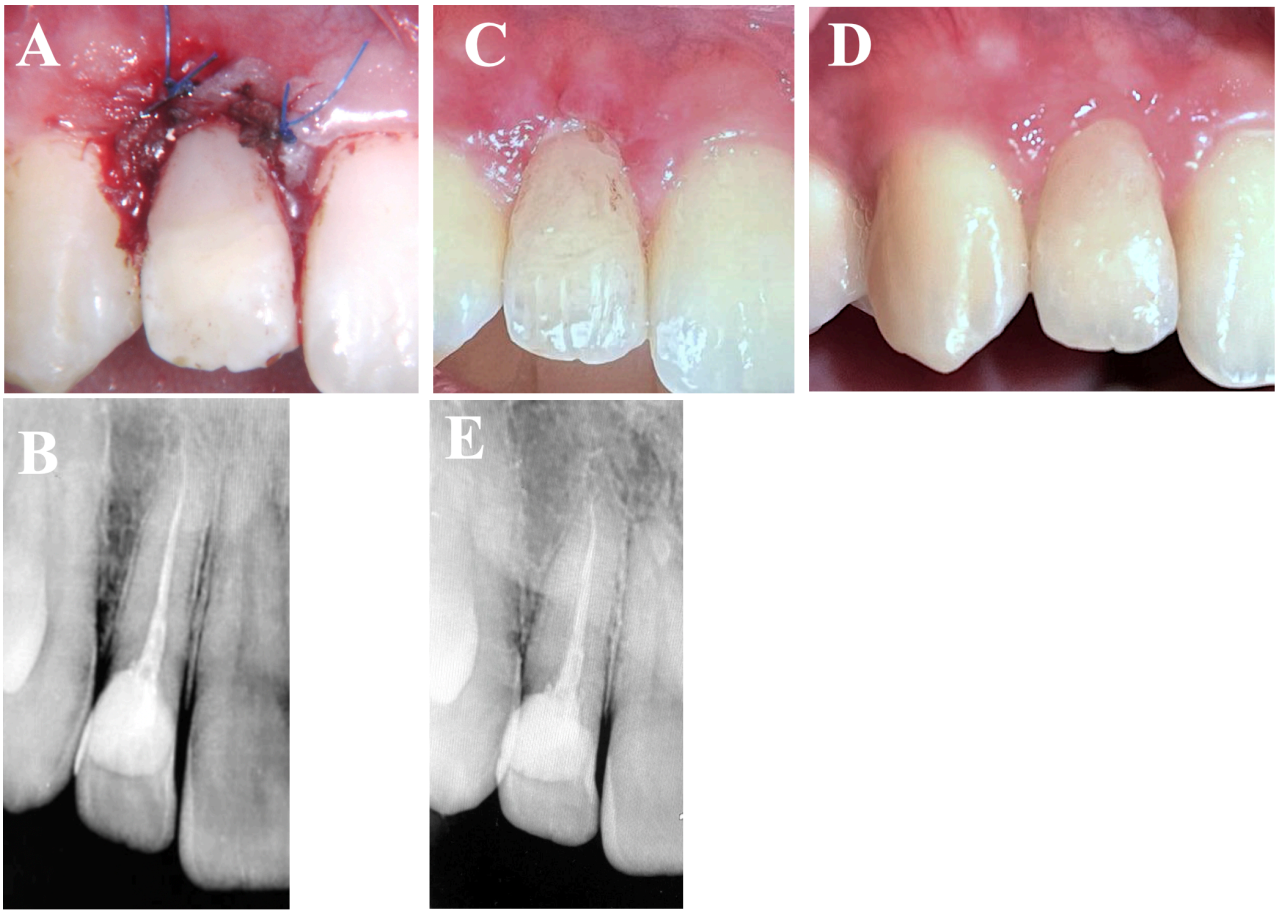

Fig. 4. Post-treatment and follow-up images. (A) Postoperative photograph showing sutures. (B) Postoperative radiograph. (C) Clinical examination at the 15-day follow-up. (D) Clinical evaluation at the one-year follow-up. (E) Radiographic assessment at the one-year follow-up.

anomaly involves invading the enamel organ into the dental papilla before calcification is complete [28]. The invagination typically starts in the crown and may extend into the root, leading to the deposition of organic material beneath the enamel. Oehler's classification system [29] is the most commonly used to categorise *Dens in Dente* into three classes. Its aetiology is unclear, with hypotheses ranging from embryonic developmental defects [25] to trauma affecting the developing dental germ [26] or infections [27]. The prevalence of *Dens in Dente* ranges from 0.25% to 7.7% [28]. Oehlers' classification (1957) [29] categorises the anomaly into three types:

• Type I: The invagination is limited to the coronal portion of the tooth, covered by enamel, and occurs in 79% of cases.

• Type II: The invagination extends beyond the enamel-cementum junction and may or may not communicate with the pulp, remaining confined to the root canal.

• Type III: The invagination extends through the root, often without pulp communication. There are two subtypes: (a) lateral communication with periodontal tissues via a pseudo-foramen or (b) apical communication. Lateral incisors are the most commonly affected teeth.

In this case, the patient did not report specific symptoms related to the *Dens in Dente*, but the anomaly was incidentally diagnosed during the 3D evaluation of the resorption. CBCT was invaluable in assessing the anatomy before treatment [21]; the tooth was treated with conservative root canal treatment due to irreversible pulpitis. The three-dimensional imaging allowed for precise, minimally invasive access and conservative shaping, using the same techniques as the main canal while fully understanding the anatomical complexities. Highly flexible martensitic alloy files were chosen to minimise the fracture risk, as the files worked without straight-line access.

Advantages of the proposed and executed treatment include the preservation of the natural tooth through a minimally invasive procedure conducted in a single session. Limitations of the treatment arise from the reliance on advanced technologies, such as an operating microscope, modern rotary files in martensitic alloy, and effective irrigant activation protocols capable of thoroughly cleaning the complex endodontic space while maintaining conservative shaping.

These measures underscore the importance of tailored, technology-driven, and conservative approaches in suc-

cessfully managing complex endodontic cases. As demonstrated by the positive outcomes in this case, leveraging advanced imaging and minimally invasive techniques can lead to optimal clinical results and long-term tooth preservation.

Conclusions

Owing to modern technologies such as 3D CBCT, an accurate diagnosis was achieved, allowing for the planning of a minimally invasive and effective treatment.

The treatment of tooth 1.2, aided by the operating microscope, advanced rotary files, and modern 3D cleaning and filling protocols, was performed without complications. Clinical and radiographic follow-ups at one year showed successful healing of both gingival and periapical tissues.

Availability of Data and Materials

All experimental data included in this study can be obtained by contacting the corresponding author if needed.

Author Contributions

Methodology: AI, DA; Software: DA, DM; Validation: DA, AI, DM; Formal analysis: MP, EE; Investigation: DM, AI; Resources: AI, EE; Data curation; DA, AI; Writing—original draft: AI, DM; Writing—review and editing: AI, DA; Visualization: AI, MP, EE; Project administration: AI, DA, DM. All authors contributed to important editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

This case report was conducted following the principles outlined in the Declaration of Helsinki. The rights, safety, and well-being of the patient were prioritized throughout the preparation of this article. Approval was obtained from the institutional ethical committee (AOU Federico II, Protocol Number 00008975-03/2023), and informed consent was obtained from the patient before the treatment and for publication.

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Conflict of Interest

The authors declare no conflict of interest. Alfredo Iandolo is serving as one of the Guest editors/Editorial Board of this journal. We declare that Alfredo Iandolo had no involvement in the peer review of this article and has no access to information regarding its peer review.

Supplementary Material

Supplementary material associated with this article can be found, in the online version, at https://doi.org/10.62713/aic.3776.

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