

Successful Management of an Immature Necrotic Tooth via Intentional Replantation Following Regenerative Endodontic Procedure Failure: A Case Report

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AIM: To present the successful management of an immature necrotic tooth through intentional replantation (IR) following the failure of a regenerative endodontic procedure (REP), highlighting IR as a viable alternative in complex cases.

CASE PRESENTATION: A 9-year-old patient presented with necrotic tooth 45 complicated by right mandibular cellulitis. After initial infection management, REP was attempted following European Society of Endodontology (ESE) guidelines. Despite adherence to protocol, REP failed, as evidenced by persistent symptoms and a recurring fistula. IR was chosen given the unfavourable conditions for apexification and the patient's young age. During atraumatic extraction, the root fractured at a pre-existing defect, necessitating a modified reimplantation approach. The canal was treated *ex vivo* and sealed with calcium silicate-based cement (CSBC) before reimplantation.

RESULTS: At a 36-month follow-up, the tooth remained functional and symptom-free, with no signs of reinfection.

CONCLUSIONS: While REPs are promising for managing necrotic immature teeth, failures necessitate alternative strategies. This case highlights IR as a viable treatment, preserving function and aesthetics when regenerative efforts are unsuccessful. Careful case selection, meticulous execution, and long-term follow-up are crucial for optimizing outcomes.

Keywords: regenerative endodontics; immature tooth; necrotic pulp; intentional reimplantation; endodontic failure; therapeutic alternative options; case report

Introduction

The root development of permanent teeth continues within three years of their eruption in the oral cavity [1], which depends on the vitality of the pulp. However, root development can be discontinued if the pulp necrotises for infectious or traumatic reasons, resulting in a tooth with a shorter root, thin walls and an open apex. In these cases, the possible therapies aim to control the infection as early as possible to halt the infection process and achieve bone regeneration. Conventional non-surgical root canal treatment (NSRCT) is often contraindicated in immature teeth due to anatomical limitations, such as open apices and fragile canal walls, which compromise the ability to achieve an effective apical

seal and increase the risk of procedural complications. Consequently, obtaining a filling that perfectly seals the foramen is difficult, and the hazard of extrusion of the filling material in such cases is high.

Possible treatment options include regenerative endodontic procedures (REPs) [2], apexification treatments [3], or intentional replantation (IR), which is most often considered a last resort.

IR is frequently not considered among the initial treatment options due to its perceived risks, despite evidence supporting its success in selected cases. The choice between REP and apexification is primarily based on the Cvek stage of root development [4]. REP is typically recommended when root development is between stages 1 and 3. In stage 4, both REP and apexification are considered viable, while in stage 5, provided there is sufficient dentinal thickness, orthograde root canal treatment is generally preferred. However, even at this stage, REP has recently been proposed as a potential option.

The clinical conditions where apexification and REPs are required to perform the procedure must involve eliminating intracanal microorganisms or significantly lowering their load so that the tooth shows no clinical signs of inflammation. However, for necrotic immature teeth, REPs are an attractive option from a biological and mechanical point of

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view compared to apexification treatments. The primary aim of REPs is to promote the continued development of the root and restore vitality to the tooth [2,5,6] by stimulating the patient's own stem cells and healing processes. Moreover, as the periodontal ligament (PDL) is preserved, REPs may also halt possible processes of ankylosis and replacement resorption [7–9].

While REPs have shown promise in preserving immature teeth that would otherwise be compromised due to necrosis, typically resulting from trauma or infection at a young age, it is important to note that their success rate is estimated between 90% and 96% [10,11]. Nevertheless, despite this, clinical outcomes can be inconsistent, and there are cases where REP may not lead to successful regeneration or functional recovery [12]. When regenerative efforts fail, the prognosis for the immature necrotic tooth becomes unsure. However, this uncertainty does not mean the end, as it is crucial to consider alternative approaches. The first alternative is undoubtedly apexification treatments. For instance, another option can be extraction followed by reimplantation, which, despite being a more invasive option, can offer a viable solution to preserve the tooth's function and aesthetics in selected cases.

Extraction and reimplantation, though less commonly employed than REPs, have been documented as effective in specific clinical scenarios where maintaining the natural tooth is a priority. This approach allows for the intentional removal of the tooth, its treatment in *ex vivo*, and subsequent reimplantation into the socket, potentially maintaining alveolar bone integrity and occlusal function [13,14]. While root resorption or ankylosis risks exist, careful case selection and appropriate procedural steps can help mitigate these complications [15].

This case report of an immature (Cvek's stage 2) necrotic mandibular premolar is not just a documentation of a clinical scenario of REP, followed by successful management using the alternative approach of extraction and reimplantation. It is a testament to the challenges associated with REPs and the importance of having alternative strategies in the clinician's toolkit when regenerative efforts do not yield favourable outcomes. This report is a call to action, urging us to explore and understand these challenges, be prepared with alternative strategies, and instil a sense of preparedness and proactivity in the audience.

Case Report

Anamnesis

In January 2022, a nine-year-old girl was urgently referred to the Dental Urgencies Department of the University of Strasbourg Hospitals due to right mandibular cellulitis linked to the necrosis of tooth 45. The cellulitis had been previously drained through endodontic and vestibular methods, accompanied by a 7-day course of amoxicillin (2 g per day). The tooth underwent root canal debridement and calcium hydroxide placement. The patient ar-

rived with a panoramic radiograph taken eight months prior (Fig. 1A). She had no significant medical or dental history and reported no maxillofacial trauma. The pain and facial swelling had resolved upon presentation, but a vestibular fistula remained (Fig. 1B). Although the cause of the necrosis was unclear, it was suspected that a developmental anomaly, such as dens evaginatus, a relatively frequent finding in premolars, may have contributed to pulp necrosis without preceding caries or trauma.

This case has been reported in line with the case report guidelines: Case Report (CARE) Guidelines to ensure the accuracy and completeness of the report (**Supplementary Material**).

Clinical Findings and Additional Examination

Oral hygiene was optimal; no plaque was visible to the naked eye. The condition of the mucous membranes was unremarkable. However, a fistulated abscess was noted at the mucogingival junction between teeth 45 and 46. The patient was in young adult dentition, and the teeth showed no carious lesions. Concerning orthodontic condition, class I canine right and left was detected.

Regarding orthodontic conditions, Class I canine relationships were noted on both the right and left sides. Additionally, there was no evidence of dental-dental or dental-arch disharmony that would necessitate treatment for tooth avulsion. The patient has a symmetrical face, falls within skeletal Class I, and presents an ortho-frontal profile with a cross-frontal tendency related to ethnic origin. Therefore, orthodontic treatment is not currently indicated.

During the first consultation at the Conservative Odontology and Endodontics Department, a periapical examination revealed an immature tooth number 45 with root interruption communicating with the endodontium. This interruption is located on the distal surface of the root in the middle third and is associated with an inflammatory periapical lesion involving the alveolar bone (Fig. 1C).

Next, a three-dimensional radiographic examination was performed (Fig. 1D) to enhance the visualisation of the root anatomy, following the guidelines of the European Society of Endodontology (ESE). The Cone Beam Computed Tomography (CBCT) scan (N°67480060 01, Newtom VGi EVO, Bologna, Italy) revealed a circumscribed hypodense cavity centered on the distal side of the root of tooth 45 at the junction of the middle third and apical third. This cavity measured approximately $3.2 \times 5.9 \times 4.2$ mm. The endodontic canal in this area was exceptionally wide, occupying most of the root. The dentin was interrupted distal to this region, measuring approximately 3.6 mm in the buccal-lingual axis and 3.1 mm in height. Additionally, bone resorption adjacent to the area of cortical bone loss was visible.



Fig. 1. Initial situation. (A) Orthopantomogram performed 6 months prior to referral; the red arrow indicates the concerned tooth. (B) In the intraoral photograph of 45, the red circle indicates the fistula. (C) Periapical radiograph of 45. (D) Sagittal Cone Beam Computed Tomography (CBCT) sections of 45.

Diagnosis

A diagnosis of pulpal necrosis in the immature 45, associated with disorderly further root development, was made. Analysing previous radiographs, the treating dentist revealed a differential diagnosis of inflammatory external root resorption on a mature tooth. The aetiology of this necrosis is undetermined.

First Therapeutic Approach and Failure

This case report was conducted in accordance with the strict ethical standards set by the Institutional Review Board (IRB). Ethics approval was obtained under reference number CE-2024-102 from the Ethics Committee of University of Strasbourg, ensuring all human participant procedures adhered to ethical guidelines and regulatory requirements. Given the root's maturity stage, comparable to Cvek's stage 2, it was determined that regenerative therapy would be pursued, although the root continued to develop mesially. Several REP protocols have been described in the literature [16–19]. For this case report, the treatment plan was meticulously designed, with regenerative endodontic therapy performed under a microscope (Zumax Medical Co., Suzhou, China) as the primary treatment choice, following ESE recommendations [16].

The REP was initiated 21 days after the initial drainage and antibiotic therapy, at the time of referral to the Department of Conservative Dentistry and Endodontics, once the acute symptoms had resolved and clinical conditions allowed for a conservative approach.

During that appointment, after achieving proper isolation using a dental dam (Medium dental dam 6"×6", Nic Tone, Zapopan, México) and administering local anaesthesia (Septanest 40 mg/mL with adrenaline 1:200,000, Septodont, Saint-Maur-des-Fossés, France), the root canal was disinfected according to the ESE guidelines [16]. This step involved the use of 20 mL of 2.5% sodium hypochlo-

rite (CanalPro NaOCl, Coltene, Langenau, Germany) over a 5-minute period, followed by 5 mL of sterile physiological saline (Laboratoires Gilbert, Hérouville Saint-Clair, France) and 20 mL of 17% ethylenediaminetetraacetic acid (EDTA) (CanalPro EDTA, Coltene, Langenau, Germany) over another 5 minutes.

Next, the canal was then dried, medicated with calcium hydroxide (MM-Paste, Micromega, Mülheim an der Ruhr, Germany), and sealed coronally with temporary filling material (Cavit, 3M ESPE, Cergy Pontoise, France). Two weeks later, all signs of inflammation and infection had resolved clinically. The disappearance of the fistula confirmed this result: negative responses to percussion and palpation tests, no tooth mobility, and no reported pain during mastication.

Consequently, a second session followed ESE guidelines [16]. Local anaesthesia without adrenaline (Scandonest 30 mg/mL, Septodont, Saint-Maur-des-Fossés, France) was administered, and dental dam isolation was set up again. The temporary filling was removed, and the canal was irrigated with 20 mL of 17% EDTA (CanalPro EDTA, Coltene, Langenau, Germany) and 5 mL of sterile physiological saline (Laboratoires Gilbert, Hérouville Saint-Clair, France) once more (Fig. 2A). The canal was then dried using sterile paper points. Intra-canal bleeding was induced by mechanically irritating the periapical tissue with a #50 K file (Dentsply Maillefer, Ballaigues, Switzerland). At this stage, the canal filled with blood until it was 2 mm below the gingival margin. (Fig. 2B).

Haemostasis was achieved, and a collagen membrane (Pangen, Symatase, Chaponost, France) was placed in contact with the blood clot (Fig. 2C,D). A calcium silicate-based cement (CSBC) (Well Root, Vericom, Gangwon-Do, Korea) was applied over 2 mm in contact with the blood-soaked collagen membrane (Fig. 2E,F). The access opening was sealed with a flowable micro-filled composite (Dentsply, Milford, DE, USA) (Fig. 2G–I).

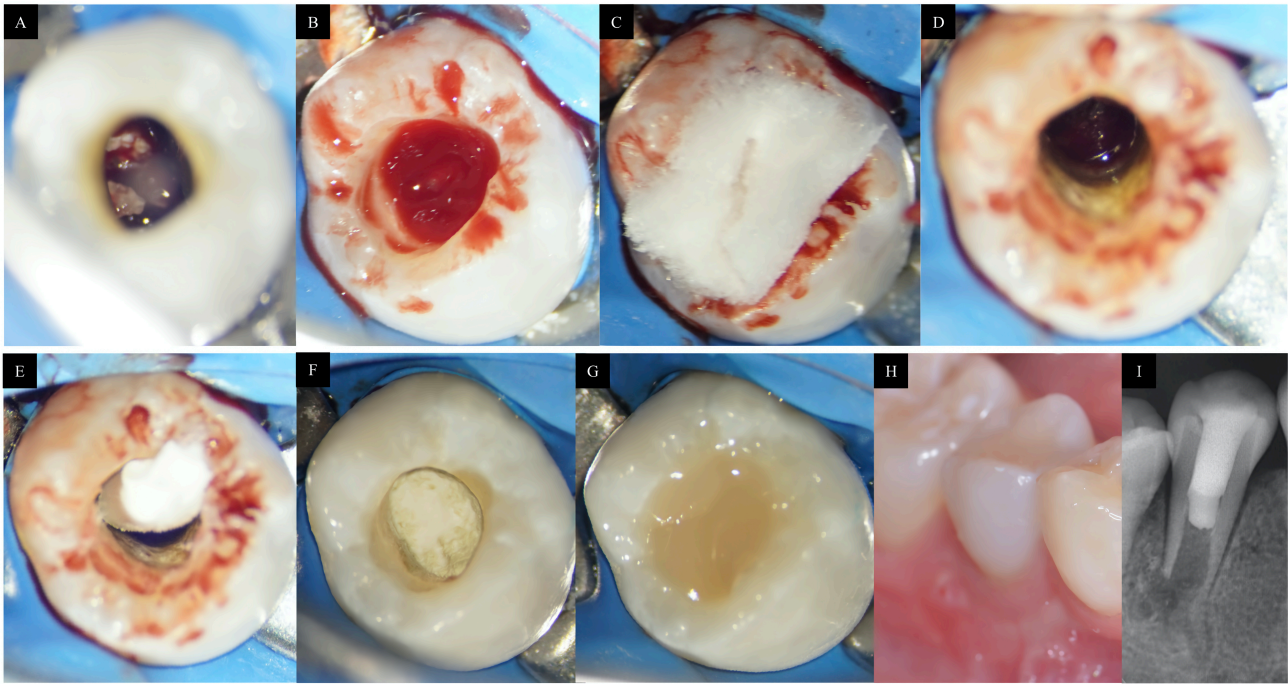


Fig. 2. First therapeutic approach: regenerative endodontic therapy and follow-up. (A) Root canal disinfection. (B) Induction of intracanal bleeding. (C) Placement of a collagen membrane. (D) Hemostasis. (E,F) Application of calcium silicate-based cement (CBSC) in contact with the clot. (G) Coronal seal. (H,I) Clinical and radiographical follow-up at 3 months: persistent fistula.

One month later, the patient showed no clinical signs or symptoms during the first follow-up visit. However, at the three-month follow-up, the patient exhibited a positive response to percussion and palpation, along with the reappearance of a fistula. These clinical signs indicated a resurgence of infection and were deemed sufficient to define the failure of the REPs.

Therapeutic Alternative Options

After REPs failed, an alternative treatment approach was considered to preserve the function and aesthetics of the affected tooth. The options evaluated included apexification, dental implants, and periapical surgery.

Apexification, while historically used in the case of immature necrotic teeth, presents an equal success rate than REPs [11]. However, it is contraindicated for teeth in Cvek stage 2 of root development [4]. Moreover, in the present case, the persistence of a sinus tract despite extensive intracanal medication made this option unfavourable. Similarly, implant placement, while associated with high long-term survival rates (above 97% [20]), is generally contraindicated in growing patients due to risks of infra occlusion and alveolar development issues [21,22]. Periapical surgery was also excluded, primarily due to the patient's age and the anatomical complexity of the area, specifically the proximity to the mental foramen, a key anatomical structure whose involvement increases surgical risk and morbidity.

Subsequently, tooth extraction or IR were the only viable options. Although IR involves similar procedural discom-

fort to extraction, it avoids the psychological, aesthetic, functional, and orthodontic consequences of early tooth loss in a growing child. IR has shown promising success rates between 90% and 96% [10,11], especially when atraumatic techniques and strict aseptic protocols are followed. Additionally, IR can potentially preserve proprioception and aesthetics, thus maintaining the child's psychological and functional oral well-being. Therefore, IR remained the only comprehensive and age-appropriate option from a medical perspective.

The decision was not unilateral but collaborative, involving the patient and her legal guardian. They were fully informed of the risks and benefits, including potential complications such as root fractures or ankylosis. Their consent was obtained, ensuring a patient-centred approach.

The treatment was carried out strictly according to the recommendations of the ESE, which instilled confidence in the chosen approach [23].

Two dentists performed the procedure using a 4-handed technique under a microscope. The surgical site was locally debrided and disinfected with 0.2% chlorhexidine (Eludrilperio, Pierre Fabre, Laval, France). The extraction of the tooth was performed under local anaesthesia (Septanest 40 mg/mL with adrenaline 1:200,000, Septodont, Saint-Maur-des-Fossés, France) in an atraumatic manner using a premolar forceps (Aesculap, Chaumont, France) (Fig. 3A,B). The tooth fractured at the level of the distal root discontinuity, and the apex, which did not luxate, was left in place. A sterile gauze pad was placed over the sur-

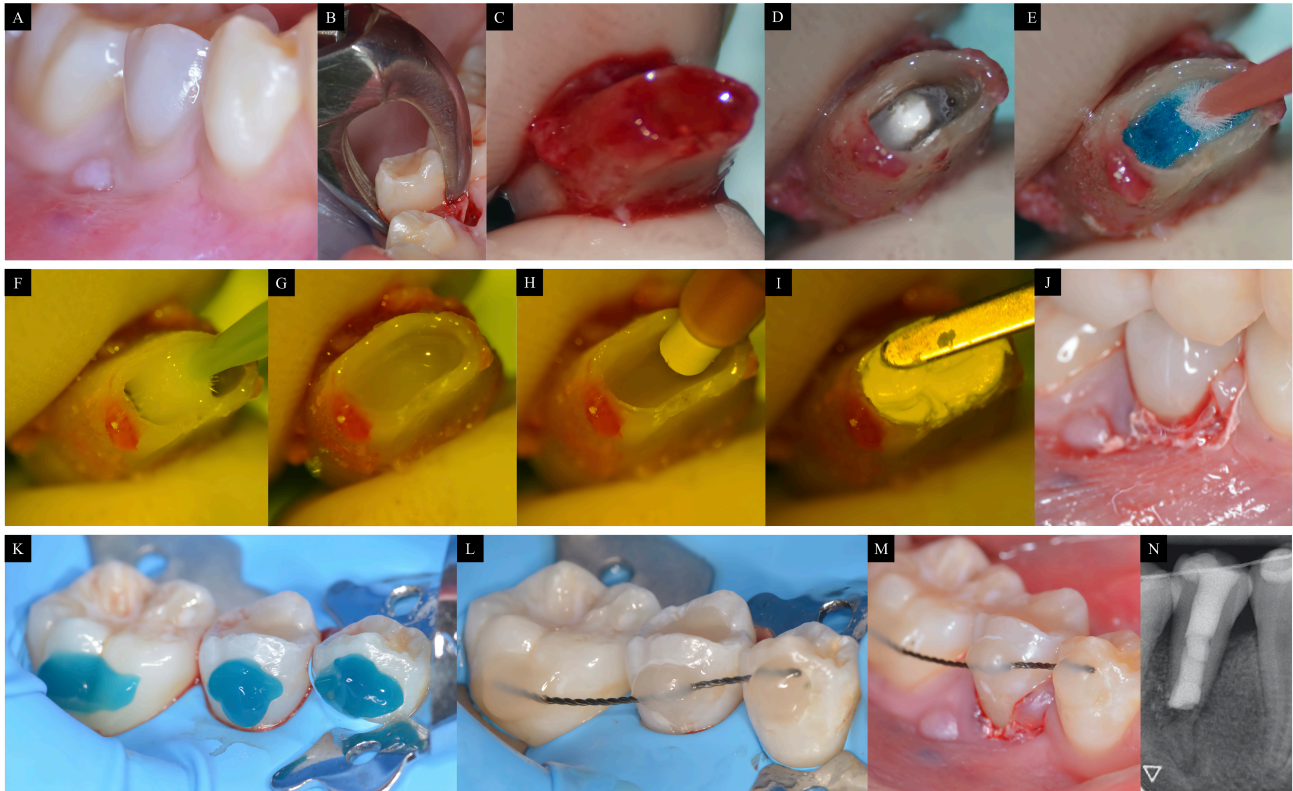


Fig. 3. Therapeutic alternative: intentional reimplantation, protocol and follow-up. (A) Initial situation. (B) Atraumatic extraction. (C,D) Extra-oral retrocleaning. (E–G) Adhesive steps to fill the first coronal part of the canal with a micro-filled composite. (H,I) Sealing the apical portion with CBSC. (J) Tooth repositioning and occlusion control. (K,L) Adhesive steps to place the dental splint. (M,N) Post-operative clinical and radiographical situation.

gical site to protect it. The canal was cleaned retrogradely, and a portion of the CSBC placed during the REP was removed (Fig. 3C,D). This step allowed for the placement of 3 mm of micro-filled composite in the coronal part of the root for mechanical reasons (Fig. 3E–G), and then the most apical portion of the tooth was sealed using a CSBC on 2 mm (Fig. 3H,I). This approach allowed for the preservation of alveolar bone integrity and provided an opportunity to restore the tooth's function despite the failure of previous regenerative efforts [24]. The tooth was reimplanted after 5'47" extra-oral time, and a non-rigid splint (Supra-FlexTM, RMO Europe, Illkirch, France) was placed under sectional dam isolation (Fig. 3J–L). Finally, the occlusion was checked with articulating paper (Bausch, Nashua, NH, USA) and adjusted with a polishing burr (Fig. 3M,N). Postoperatively, the patient was prescribed paracetamol for pain management, demonstrating a comprehensive approach to patient care that extends beyond the procedure itself.

Follow-up and Outcomes

Regular follow-up was carried out at 1 month, 1.5 months, 3 months, 6 months (Fig. 4A) and then every 6 months for 3 years.

At the first follow-up appointment, which took place after 1 month, the tooth exhibited no clinical symptoms; however, significant mobility remained. A mucosal examination revealed a scarred area at the site of a previous gingival abscess. The dental splint was removed at the 1.5-month mark.

Three months after the initial treatment, the tooth showed no clinical symptoms, and the gingival abscess between teeth 45 and 46 had healed. The patient reported no discomfort upon mastication and was able to eat normally.

At the one-year check-up, the tooth demonstrated fragility, with multiple cracks on the vestibular surface. Therefore, an indirect bonded restoration was applied to protect the tooth and provide better mechanical resistance to the various occlusal forces exerted on it (Fig. 4B,C).

At the subsequent follow-ups, the tooth showed neither clinical nor radiological signs of infection, ankylosis, or post-reimplantation resorption (Fig. 4D). The legal guardian and the patient also expressed satisfaction with the tooth's function and appearance.

Discussion

This case demonstrates the challenges and complexities associated with treating necrotic immature teeth. Initially, it was decided to perform REPs. This choice was made as

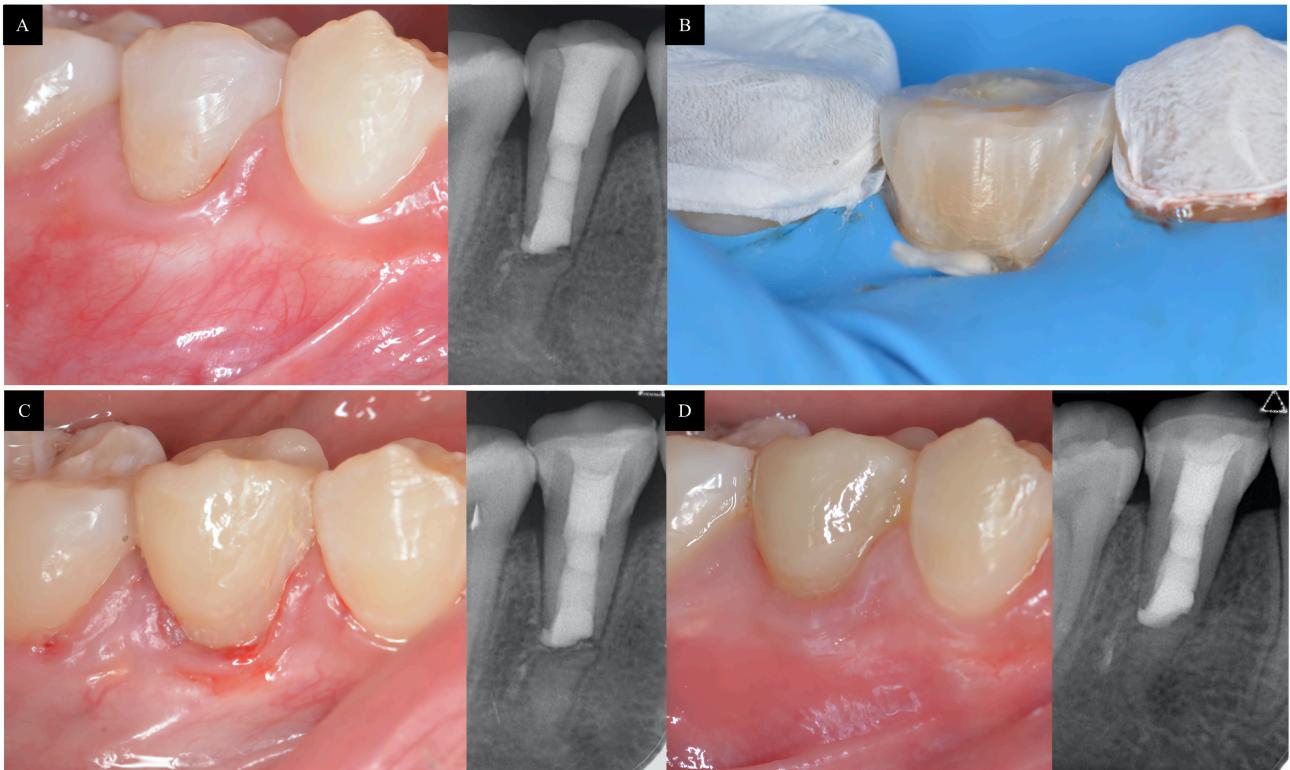


Fig. 4. Clinical and radiographical follow-ups. (A) At 6 months. (B,C) At 1 year: applying of a bonded indirect occluso-buccal restoration. (D) At 3 years.

the first option to promote further root growth, canal wall thickening and disto-apical closure [2,5,6]. The resulting intra-canal tissue is a reparative tissue combining fibrous connective tissue (similar in structure to the periodontal ligament) and cement-bone tissue [25–27]. Furthermore, this therapy is therefore of considerable interest in improving the mechanical strength of immature teeth.

REPs are designed to stimulate the continued development of immature roots by promoting the body's healing mechanisms through the recruitment of stem cells, the formation of new dentin, and the revascularisation of the pulp [5]. In the present case report, although the two-visit protocol recommended by the ESE was strictly followed [16,19,23], using the same suggested irrigation protocol and putting a calcium silicate-based cement (CBSC) in contact with the blood clot due to its bioactive properties [28,29], the signs of inflammation and infection reappeared after three months.

While REPs have shown promising results with success rates ranging between 90% and 96% [10,11], failures, like in the present case report, are not uncommon, particularly in cases of severe infection or complex root canal anatomies [30]. Several factors can influence the success or failure of REPs [31–33]. Persistent infection, insufficient disinfection, and anatomical complexities such as wide or curved canals may limit the regenerative potential [30]. Although the initial regenerative attempt seemed to show early signs

of success, with the disappearance of the fistula, the eventual recurrence of symptoms, as in the present case, evidenced by a positive response to percussion and palpation, along with the reappearance of a fistula, suggested incomplete eradication of the infection.

Additionally, the large and open apex of the immature tooth likely contributed to difficulties in achieving complete disinfection and creating an appropriate environment for revascularisation [34]. In this case, the lack of long-term success highlights a critical limitation of REPs: the procedure's reliance on the body's intrinsic healing mechanisms. However, no systemic pathology was reported in this case.

The failure of REPs necessitated the consideration of alternative therapeutic strategies. Apexification, implant option, periapical surgery, IR, and extraction were considered. However, each of these options presented specific limitations in the present clinical scenario.

Apexification, although historically used for immature necrotic teeth, was contraindicated in this case due to the Cvek stage 2 of root development and the persistence of a sinus tract despite extended intracanal medication, indicating a poor response to this conservative approach. Moreover, apexification often results in a tooth with an incomplete root structure that remains susceptible to fracture [35].

Implant placement, while associated with long-term survival rates [20], is generally not recommended in growing patients due to the risk of infra occlusion and disruption of

alveolar bone development. Similarly, periapical surgery was excluded primarily because of the patient's age and the anatomical complexity of the area, particularly the proximity to the mental foramen, whose involvement significantly increases surgical risk and postoperative morbidity [36]. Another alternative therapeutic strategy was the IR option, which, despite being more invasive, can offer a viable solution to preserve the tooth's function and aesthetics in selected cases, even though it is traditionally considered a last-resort therapy. The procedure involves the controlled extraction of the tooth, *ex vivo* treatment, and subsequent reimplantation. Despite its invasiveness, IR allows for direct treatment of the root canal system without damaging adjacent periodontal tissues and an opportunity to resolve periapical pathology under more controlled conditions. Additionally, reimplantation maintains the tooth within its original socket, preserving both alveolar bone and occlusal function. This step is particularly important in young patients where tooth extraction might result in long-term aesthetic and functional complications [13,14]. IR treatment is, therefore, a real therapeutic alternative [23,37–40]. Within this context, IR emerged as the only feasible and comprehensive treatment option aligned with the patient's clinical, functional, and psychological needs. While IR involves a level of procedural discomfort similar to extraction, it offers significant advantages by preserving the natural tooth and its proprioceptive function. Moreover, it prevents the psychological, aesthetic, orthodontic, and functional consequences that would have inevitably followed tooth extraction in a growing child, representing a critical concern in pediatric dentistry.

Recent studies support the efficacy of IR in selected cases, reporting success rates ranging from 90% to 96% [10,11, 37–40], particularly when atraumatic techniques and strict aseptic protocols are applied. The preservation of the natural tooth, even via IR, contributes positively to occlusal stability and the patient's psychological well-being, reinforcing the functional and emotional value of tooth conservation in the pediatric population.

Therefore, in the present case, IR not only represented an effective therapeutic solution but also constituted the only age-appropriate and biologically respectful strategy capable of addressing the multifaceted needs of a growing patient.

In the present case, the tooth was considered at high risk of fracture due to the extremely thin root walls and the absence of continuity at the distal aspect. During extraction, the apical fragment fractured at the site of root discontinuity. Given that this fragment had likely developed after the coronal necrosis, it was presumed to be vital. It was intentionally left *in situ* as a less invasive and biologically favourable approach [41].

After extraction, necrotic tissue was observed within the enlarged root canal, in direct contact with the CSBC placed during the regenerative procedure, confirming the failure of the initial therapy [31]. The CSBC previously placed dur-

ing the REP was partially removed to allow for 3 mm of micro-filled composite placement in the coronal part of the root, minimising the risk of root fracture. The use of CSBC to seal the apical part of the root canal was justified by its antibacterial, anti-inflammatory and pro-healing properties [42–48]. Indeed, CBSCs offer superior healing potential in the presence of periapical lesions of endodontic origin [44,45].

The extra oral time the tooth spent outside the socket was minimised to avoid damage to the periodontal ligament, which is crucial in reducing the risk of ankylosis or resorption after reimplantation. Extra-alveolar time should be less than 15 minutes to avoid necrosis of fibroblastic cells in the alveolar ligament and prevent the risk of resorption [49]. In the present case report, the extra-alveolar time was less than 6 minutes, and the tooth was carefully handled to avoid damage to the fibroblast cells. Consequently, the risk of ankylosis and resorption-related complications is considered low. Although complications such as root resorption or ankylosis may occur following reimplantation, the patient's outcome has been positive, with preservation of both function and aesthetics of the tooth to date, more than three years after the procedure.

The appearance of cracks in the buccal surface one year post-reimplantation prompted the placement of an indirect bonded restoration to protect the tooth and enhance its mechanical resistance during function [49,50]. Such preventive measures are crucial in extending the longevity of reimplanted teeth, particularly in young patients where dental implants are not feasible due to ongoing craniofacial growth [35]. Due to the presence of cracks, especially at the buccal level, a veneer rather than a crown or overlay was preferred. This indirect bonded restoration is more conservative than a crown [51,52]. Furthermore, this choice ensures the aesthetic integration of the restoration in the patient, who has a wide smile line.

The long-term prognosis of the reimplanted tooth remains guarded due to the immature root structure, which remains vulnerable to fractures. The recommended period for follow-up should last at least three years to detect late-onset complications [53]. Given the unfavourable crown-root ratio and the thinness of the root walls, the tooth had a high risk of fracture [35,54]. As a result, the current proposed treatment aimed to delay implant insertion and maintain the space between 44 and 46 [55,56].

The success of this case emphasises the importance of extending the treatment plan with multiple treatment options available for managing necrotic immature teeth. While REPs remain the first line of treatment due to their biologically favourable outcomes, clinicians must be prepared to redirect to alternative approaches like IR when regenerative techniques fail. The use of REPs, a reversible procedure, remains a sound initial approach, as it allows clinicians to pursue alternative strategies, such as IR or apexification, should regeneration prove unsuccessful.

Successful healing following REPs might have been achieved in a different patient with a potentially more favourable local or systemic immune response. This observation underlines the biological variability of endodontic outcomes and reinforces the necessity of a flexible, case-by-case treatment planning approach.

The use of REPs, being a reversible procedure, remains a sound initial approach, as it provides the flexibility to pursue alternative treatments if necessary. However, we may have achieved healing in a different patient with a different immune response. This observation highlights the importance of always having multiple therapeutic options available, as each case may present unique challenges and outcomes.

Conclusions

This case report presents a necrotic immature tooth that fulfilled all current clinical indications for REPs, including patient age, root maturity stage, and the absence of systemic or local contraindications. Despite appropriate case selection and strict adherence to protocol, the treatment outcome was unfavourable, highlighting that even well-indicated REPs may not always achieve predictable success. In such instances, although more invasive, IR can serve as a valuable alternative to preserve both function and aesthetics. This case emphasises the importance of individualised treatment planning, reinforces the need for long-term follow-up, and underlines the necessity of developing strategies to improve the predictability of REPs.

Availability of Data and Materials

All experimental data included in this study are available upon reasonable request from the corresponding author.

Author Contributions

Methodology: DA, AI, DM; Software: DA, DM; Validation: DA, SDF, DM; Formal analysis: SDF; Investigation: DM, AI; Resources: SDF; Data curation: DA, DM; Writing—original draft: DM, SDF; Writing—review and editing: AI, SDF; Visualization: DM, SDF; Project administration: SDF, DA. 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 prioritised throughout the preparation of this article. Approval was obtained from the institutional Ethical Committee (University of Strasbourg, Protocol Number number CE-2024-102), and informed consent was obtained from the patient before the treatment and for publication.

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Conflict of Interest

Alfredo Iandolo is serving as one of the Editorial Board and Guest Editor members 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. Other authors declare no conflict of interest.

Supplementary Material

Supplementary material associated with this article can be found, in the online version, at <https://doi.org/10.62713/ai.c.4085>.

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