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Conservative Management of a Molar with Separated Instrument and Periapical Lesion: A Two-Year Clinical Follow-Up and Review of Regenerative Strategies

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Abstract: ***This case report presents the nonsurgical retreatment of a mandibular molar with a periapical lesion and a retained instrument in the mesiolingual canal. Despite the complexity of the case, a conservative, multi-step protocol including pre-endodontic build-up, advanced instrumentation, ultrasonic irrigation, and bioactive obturation was successfully employed. Over a two-year follow-up period, clinical and radiographic assessments showed significant healing and stable outcomes. The report underscores the regenerative potential of periapical tissues, the value of contemporary bio ceramic sealers, and the necessity of structured monitoring in managing difficult endodontic cases.***

Keywords: periapical healing, endodontic retreatment, separated instrument, tricalcium silicate sealer, conservative dentistry

1. Introduction

The treatment of endodontically treated teeth presenting with apical periodontitis continues to represent a considerable challenge in daily clinical practice [[1]]. Although endodontic therapy is generally associated with high success rates, the presence of a periapical lesion significantly reduces the likelihood of favourable outcomes, with success rates reported to decrease to approximately 78% [[2]]. Various complicating factors may further compromise the prognosis, including the persistence of microorganisms within the root canal system, inadequate previous root canal filling materials, procedural mishaps such as fractured or separated instruments, and the extent of the periapical lesion [[3]]. In such situations, the clinician must not only focus on eliminating the intraradicular infection but also establish conditions that promote periapical tissue repair and regeneration [[4]].

Current endodontic retreatment strategies emphasise thorough debridement and disinfection of the root canal system, as well as the careful management of obstacles, such as separated instruments, by either bypassing or removing them [1], [3]. Following these steps, the choice of obturation material and technique is critical for achieving a hermetic seal and preventing reinfection [[5]]. In recent years, tricalcium silicate–based sealers have emerged as valuable materials due to their proven bioactivity, biocompatibility, and ability to stimulate periapical bone regeneration [[4]],[6]. Their favourable biological interactions and sealing capacity support healing, offering clinicians new opportunities for predictable outcomes, even in complex retreatment cases [[7]]. This case report aims to illustrate the conservative management and regenerative outcome of a mandibular molar with asymptomatic apical periodontitis and a separated instrument, using a bioactive endodontic protocol.

2. Case Presentation

This clinical case presents a 30-year-old man who reports no complaints in the region of tooth #46. The patient reported mild discomfort during biting. The patient is systemically healthy. One physiological condition that may influence clinical management and procedural planning is a pronounced gag reflex. Extraoral examination revealed no abnormalities or facial asymmetry. An intraoral preoperative periapical radiograph of tooth #46 (Fig.1) demonstrated a previously endodontically treated tooth, exhibiting a periapical radiolucency associated with the mesial root, suggestive of a lesion of endodontic origin. A separated instrument was identified within the mesiolingual canal. Additionally, a disto-occlusal overcontoured restoration and a primary carious lesion on the mesial surface were observed. There is no tenderness to either vertical or horizontal percussion, and upon digital palpation, there is no abnormal tooth mobility.

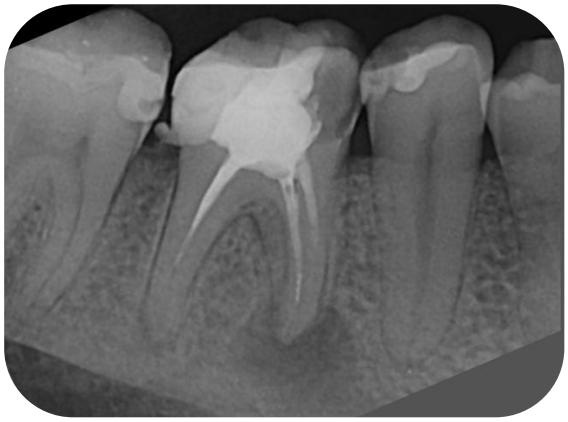

Figure 1: An intraoral parallel periapical preoperative radiograph of tooth #46 - PAI (Periapical index) score 5

According to the AAE consensus from 2013, the diagnoses of tooth #46 are [[1]]:
1) Pulpal Diagnosis: Previously treated
2) Apical Diagnosis: Asymptomatic apical periodontitis

According to Ørstavik's classification, the PAI of the tooth before the start of the treatment is 4 [[2]].

The possible treatment options are:
1) Monitoring – clinical and radiographic
2) Nonsurgical root canal retreatment
3) Endodontic microsurgery
4) Tooth extraction

Based on the patient's information consent and following clinical decision-making criteria, a nonsurgical root canal retreatment of tooth #46 was performed:
1) Pathology - presence of infection
2) Clinical - radiological assessment:
   - Coronal seal - poor
   - Crown to root ratio - good
   - Periodontal condition- healthy periodontium
   - Remaining tooth structure - presence of ferule
3) Access to the root canal system – feasible

Written informed consent was obtained from the patient to treat the tooth and to publish the results in this paper. The study was conducted in accordance with the Declaration of Helsinki.

According to the AAE case difficulty assessment form, the retreatment of tooth #46 is rated as a treatment with high difficulty [[3]]. The treatment plan includes:
1) Multiple visit root canal retreatment
2) 6 months and 1 year follow-up
3) Temporary crown
4) Long term crown
5) Micro-endodontic surgery - indicated in cases where periapical healing doesn't occur or when clinical symptoms persist.

3. Clinical Retreatment Protocol

The clinical protocol implemented in the management of the presented case requires the following steps:

3.1 Isolation and pre-endodontic build-up:

A clamp W4 (Hu Friedy Group- Chicago, USA) was secured on tooth #47, and after that, a heavy latex sheet (Nic Tone, MDC Dental/Reko Dental, USA) was placed- technique "clamp first". To restore the approximal contacts with the pre-endodontic build-up after the removal of the old restoration and primary and secondary caries, the operative field includes teeth #47, #46 and #45. Due to the patient's pronounced gag reflex, the appropriate isolation was troubled. The condition was managed by spreading a topical anesthetic gel on the back side of the rubber dam and by spraying a topical anesthetic- Lidocaine spray 10 % intraoral. A Palodent V3 sectional matrix system (Dentsply Sirona, Charlotte, NC, USA) was used to reestablish the proximal contacts, ensuring optimal contour and tight interproximal adaptation after the proper isolation. The pre-endodontic build-up was performed using a combination of flowable composite resin (Essentia LoFlo, GC, Tokyo, Japan) and packable composite resin (Essentia Universal, GC, Tokyo, Japan). The use of a flowable material facilitated adaptation to the cavity floor and minimized void formation. The packable composite provided sufficient strength and durability for coronal reinforcement. This composite layering approach is well-documented in the literature for achieving effective cavity sealing and mechanical stability prior to endodontic treatment, particularly in structurally compromised posterior teeth [[4]],[5]. After the pre-endodontic build-up was facilitated and the endodontic access was ready, the application of solvents was possible, and the instrumentation was more efficient [31],[32].

3.2 Endodontic access cavity:

It is a result of the removal of the old composite restoration, all the infected tissues, and the pre-endodontic buildup (Fig.2A).

Figure 2: (a) The access cavity and pre-endodontic build-up; **(b)** The presence of a third mesial root canal in the mesial root.

3.3 Preparation of the root canals:

The old filling in the canals was identified as a so-called "*Russian red cement*". Resorcinol-formaldehyde (*RF*) cement or resin is a material used in endodontic therapy in many countries for years. It contains two potentially toxic components, formaldehyde (liquid) and resorcinol (powder). When 10% sodium hydroxide is added to the mixture, polymerization occurs, which can form a brick-hard brownish-red material that has no known solvent and which discolorates the remaining root dentin. The changes in color from pink to brown and darker are the signs of RF endodontic therapy. The resin in this case was infected and not so hard, and it has been removed from the coronal one-third of the root canals with the X3 file of ProTaper Next System. The separated instrument was in the ML root canal. Initially, the aim was to bypass it with a small number of K files (*ISO# 0.10 - #0.06*) and then, if possible, to remove it. After the bypassing the removal of the separated instrument was obtained by the activation of NaOCl 5,25 % with a U-file number #25 (*MANI Inc., Utsunomiya, Japan*), attached to the

Endodontic 120° Angle Holder (*E11, NSK,Yurakucho, Tokyo, Japan*). In RF retreatment cases and in management of calcified root canals hand files with higher carbon content are recommended to use. Such type of files are C + files (*Dentsply Sirona, Ballaigues, Switzerland*). Their distinctive features are: made from heat treated stainless steel which makes the stainless steel more rigid than K files which allows the operator to exert 143% more pressure during insertion into a canal that would deform a K-File of corresponding size, an active pyramidal shape tip so they cut dentin, greater than 2% taper in the apical 3 mm: size 6- 5 % taper, size 8 - 4,5 % taper, size 10 – 4 % taper, size 15 – 4 % taper . The active tip helps to penetrate the brick hard RF paste but could be dangerous for via falsa or ledge producing. The working length (*WL*) was established with the Propex Pixi apex locator (*Dentsply Sirona, Ballaigues, Switzerland*). (Table 1).

Table 1: Representation of the reference point and WL of each root canal on tooth #46. The initial and final file of treatment are described

Tooth #46	Reference Point	WL	Initial Apical File (IAF)	Master Apical File (MAF)
MV	MV tubercle	19 mm	08 K file	X2 + 30
ML	M ridge	18 mm	10 K file	X2 + 25
MM	M ridge	19 mm	06 K file	X2 + 30
D	DV tubercle	20 mm	08 K file	X2 + 35

The presence of a third mesial root canal in the mesial root merging with the mesio-buccal root canal was established (Fig. 2B). The irrigation protocol was as follows: NaOCl - 5,25 %, citric acid - 40 % and saline solution 0.9% as the final irrigation solution [42],[43]. In this case, root canal instrumentation was carried out using the ProTaper Next rotary file system (*Dentsply Sirona, Bensheim, Germany*). An intraoperative flare-up occurred, characterised by purulent exudate from the mesial root canals, necessitating the prescription of systemic antibiotics for seven days prior to root canal obturation. Calcium hydroxide $Ca(OH)_2$ paste was placed in the root canals as an intracanal medicament between appointments [3],[21].

3.4 Obturation of the root canals:

Definitive root canal obturation was planned after a negative microbiological sample [[42]]. Cold hydraulic condensation with gutta-percha master cones and tricalcium silicate sealer Neosealer Flo by Avalone Biomed (*Avalon Biomed Inc., Bradenton, FL, USA*) was selected as an obturation method. It is well known that the type of sealer must be reconsidered when selecting the obturation technique. In this case, the properties of contemporary tricalcium silicate sealers - biocompatibility and bioactivity - enhance the good healing result in the periapical area. Following a one-year period of clinical and radiographic monitoring confirming satisfactory periapical healing, the tooth was definitively restored with a long-term metal-fused-to-ceramic crown (Fig.3).

Figure 3: Radiographic monitoring of periapical healing of tooth #46: **a/** postoperative radiograph after the obturation- PAI score 5; **b/** radiograph - 6 months follow up – PAI score 1; **c/** 1 year follow up with definitive crown.

4. Discussion

In the presented clinical case there are two main challenges as a tooth with high difficulties according to AAE [[3]]. The first problem was to remove the total resorcinol-formaldehyde cement from the endodontic space. At the same time to bypass or remove the separated instrument from the apical part of the ML canal. The second challenge was to create conditions for periapical regeneration processes. To realize this the retreatment started with the removal of the old filling paste, secondary and primary caries lesions and making of a pre-endodontic build-up in order to eliminate the risk of a microleakage and of reinfection due to bacteria in the oral cavity [6],[7],[8]. The primary aim of pre-endodontic build-up is to re-establish the structural integrity and stability of teeth undergoing root canal therapy. Such teeth are often significantly compromised as a result of extensive carious destruction or the failure of previous restorations. Without adequate coronal reinforcement, these teeth are more susceptible to mechanical stresses during endodontic procedures, thereby increasing the likelihood of fracture or procedural complications [9],[10],[11],[12]. According to the classification of pre-endodontic build-ups of Khanvilkar and Pawar, the presented pre-endodontic build-up corresponds to class II type II-2: missing both proximal walls and supragingival margin.

The other challenge is the patient's gag reflex, which made isolation difficult. The situation could be managed in some of the following ways or with a combination of them: prescription of antiemetic medication (*per os*), nerve block, spray of topic anesthetic, spreading of a topical anesthetic in form of gel on the back side of the rubber dam.

A major challenge in non-surgical endodontic retreatment is the effective removal of previously placed root canal filling materials, particularly when bioceramic or epoxy resin-based sealers are involved, and to realize the effective apical sealing [[21]]. Residual filling materials, especially within complex canal anatomies such as isthmuses, lateral canals, and apical ramifications, may compromise the disinfection process, which is essential for eliminating microorganisms, particularly in cases with chronic apical periodontitis, and impede subsequent sealing, ultimately affecting the outcome of retreatment [19], [25].

Studies have consistently demonstrated that no current technique is capable of completely eliminating root filling remnants from the canal system [25],[26],[27]. Rotary and reciprocating file systems-such as ProTaper Universal Retreatment, WaveOne Gold, and Reciproc Blue—have shown comparable efficacy, yet often leave residues, particularly in the apical third [[27]]. Adjunctive protocols such as the use of passive ultrasonic irrigation (PUI), XP-endo Finisher R, or solvents (e.g., Endosolv R, orange oil or chloroform) may enhance material removal, but their effectiveness remains technique-sensitive and operator-dependent [[26]]. The integration of advanced irrigation strategies and newer instrument designs continues to evolve, but the removal of obturation materials remains a critical and unresolved step in retreatment. Further research is needed to develop more predictable, minimally invasive protocols that ensure thorough debridement while preserving the integrity of the root structure [[25]].

The ProTaper Next (*PTN*) system, initially designed for primary root canal shaping, has been evaluated for its efficacy in removing filling materials during endodontic retreatment. Its off-centred rectangular cross-section and variable taper are intended to enhance debris removal and reduce torsional stress [[28]]. Hanafy et al. conducted an ex vivo study comparing PTN, ProTaper Universal Retreatment (*PTR*), and hybrid instrumentation (*HI*) systems. The study found that while PTR achieved the highest fracture resistance, PTN demonstrated a balance between efficient filling removal and preservation of root structure. Notably, PTN required more time for filling removal than PTR but less than HI, suggesting a moderate efficiency level [[29]]. In another study Vieira et al., was compared the effectiveness of PTN with WaveOne Gold and Reciproc Blue systems. The results indicated that all systems left residual filling materials, with no significant differences in removal efficacy. However, PTN showed a tendency for better performance in the apical third, which is critical for retreatment success [[30]]. Furthermore, a study by Özyürek and Özsezer-Demiryürek assessed PTN's ability to remove gutta-percha in curved root canals. The findings revealed that PTN effectively removed filling materials, though complete removal was not achieved, highlighting the need for supplementary techniques to enhance cleaning [[28]]. Collectively, these studies suggest that while PTN is effective in removing root canal filling materials during retreatment, it may not achieve complete cleanliness on its own. Therefore, combining PTN with adjunctive methods, such as ultrasonic activation or solvents, may improve outcomes.

Based on current evidence and the findings of recent studies, the ProTaper Next (*PTN*) system was selected in the present clinical case as the primary instrumentation method for root canal retreatment. PTN's advanced design has been shown to enhance shaping efficiency, debris removal, and flexibility in curved canals, while also reducing the risk of instrument fracture [28],[29],[30].

However, despite its favourable mechanical properties, existing literature consistently demonstrates that no rotary or reciprocating system is capable of completely removing residual filling materials from the root canal system [28],[29],[30].

Therefore, in accordance with contemporary endodontic protocols, ultrasonic activation of irrigants was incorporated into the retreatment procedure of presented case (*tooth #46*) to improve the removal of remaining sealer and debris from anatomical complexities such as isthmuses, lateral canals, and apical ramifications. This combined approach aims to maximise disinfection and optimise the conditions for three-dimensional sealing which leads to the periapical bone regeneration processes [20],[21],[23].

The use of ultrasonic instruments, rotary burs, endodontic solvents, nickel–titanium rotary files, and an operating microscope is advised for the efficient removal of hardened cementitious materials in cases involving root canals previously obturated with formalin–resorcinol paste [35],[36]. It must be noted that the described method is now rarely used due to the high toxicity of the paste and associated with tooth staining [35],[38].

In the European Union, formaldehyde is classified as a Category 1B carcinogen under the Classification, Labelling and Packaging (*CLP*) Regulation (*EC No 1272/2008*), and its use is limited by specific concentration thresholds. Furthermore, Regulation (EU) 2020/878 amending Annex II of the REACH Regulation (*EC No 1907/2006*) mandates stringent labelling, safety data sheets, and risk assessments for substances containing formaldehyde. Although some dental materials historically included formaldehyde derivatives (*e.g., paraformaldehyde in root canal sealers*), several of these products have been withdrawn or restricted across the EU in response to evolving toxicological evidence and updated regulatory frameworks (*EC No 1272/2008; EC No 1907/2006; EU 2020/878*) [13],[14],[15]. Formaldehyde is a highly cytotoxic agent that induces pronounced inflammatory responses in connective tissues. In the context of endodontic therapy, formaldehyde-based compounds have the potential to diffuse beyond the apical foramen and lateral canals, posing a risk of injury to the periodontal ligament and adjacent periapical structures [[16]].

The removal of separated instruments from the apical half of the root canal is always a challenge. In this case, it was necessary due to the presence of an infection and a lesion of endodontic origin around the medial root (Fig. 1). This provided the opportunity to prepare the endodontic space and radicular dentin mechano-chemically and achieve adequate sealing.

The usage of tricalcium silicate-based sealer NeoSealer Flo (Avalon Biomed Inc., Bradenton, FL, USA) was based on its advantageous properties in promoting periapical tissue regeneration. One of the principal benefits of these materials is their inherent bioactivity, which facilitates the formation of hydroxyapatite on their surface upon contact with tissue fluids. This mineralisation process plays a critical role in creating a favourable interface between the material and the surrounding dentine and periapical tissues. Additionally, tricalcium silicate sealers demonstrate excellent biocompatibility, exerting minimal cytotoxic effects and supporting the viability and proliferation of periradicular cells, such as periodontal ligament fibroblasts and stem cells. Their alkaline pH contributes to an antimicrobial environment, while also stimulating hard tissue deposition and modulating inflammatory responses. These properties make tricalcium silicate sealers particularly suitable for cases requiring enhanced healing potential, especially in the presence of periapical bone pathology [17],[18],[19].

After the shaping of the root canals and the removal of the instrument there was an exacerbation with profuse exudation from the root canals and extraoral swelling which required the prescription of systemic antibiotics.

The radiographic and clinical monitoring of endodontically treated teeth with pre-existing periapical bone lesions plays a crucial role in evaluating treatment success and guiding further management. Periapical healing is often a gradual process, particularly in retreatment cases where the initial infection may have persisted over an extended period. Radiographic and clinical assessment over time allows clinicians to determine whether the resolution of periapical

pathology is progressing or if persistent inflammation suggests treatment failure [39],[40].

Consistent monitoring during the post-obturation phase enables the swift identification of issues, such as inadequate healing, persistent symptoms, or the development of new pathology. This is especially important in retreatment cases, where the prognosis may be influenced by previous procedural complications, the extent of apical bone destruction, or the presence of resistant microorganisms [[41]]. Long-term observation - ideally extending to 12 months or more - supports informed clinical decision-making, including the consideration of surgical procedures in the absence of satisfactory healing.

Therefore, monitoring protocols are essential for verifying the biological success of root canal therapy and for ensuring that periapical health is ultimately restored. The study highlights the efficacy of bioactive sealers in retreatment scenarios previously considered candidates for surgery, reinforcing the role of nonsurgical protocols in preserving natural dentition.

5. Conclusion

The present case highlights the complexity of managing an endodontically treated tooth with a periapical lesion, a separated instrument, and remnants of resorcinol–formaldehyde paste. Successful retreatment required the sequential removal of compromised restorative and endodontic materials, the establishment of a stable pre-endodontic build-up, the negotiation to the apical zone and the application of a bioactive tricalcium silicate-based sealer. This comprehensive approach facilitated adequate disinfection, improved the mechanical stability of the tooth, and provided favourable biological conditions for periapical regeneration. The use of contemporary bioceramic sealers appears to enhance the healing potential of retreatment cases, particularly in situations where periapical tissues have been compromised for extended periods. At the six-month recall, satisfactory clinical and radiographic results were already achieved, thus avoiding surgical intervention. Nevertheless, predictable long-term outcomes can only be confirmed through structured follow-up, which will continue according to standard protocols for at least four years. Continuous monitoring remains indispensable for evaluating periapical healing, especially in lesions with a PAI 5 score, identifying complications at an early stage, and guiding further management if required.

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