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Intraoperative Identification of Vital Radicular Pulp in a Tooth Diagnosed with Pulp Necrosis: Four-Year Outcome of Tampon Pulpotomy

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Abstract

Teeth diagnosed clinically with pulp necrosis and apical periodontitis may occasionally retain vital radicular pulp tissue despite negative sensibility test responses. Such diagnostic discrepancies highlight the limitations of conventional pulp testing and may create opportunities for biologically based treatment approaches. This case report describes the successful management of a mature permanent molar initially diagnosed as necrotic but found intraoperatively to contain vital radicular pulp tissue. A 36-year-old healthy patient presented with pain on chewing and tenderness to percussion in the left mandibular second molar. Clinical and radiographic examination revealed severe coronal destruction, a periapical radiolucency, and a negative response to cold testing, leading to a preoperative diagnosis of pulp necrosis with apical periodontitis and a treatment plan for root canal therapy. However, during access cavity preparation, profuse bright-red bleeding from the canal orifices indicated retained vital radicular pulp tissue. Consequently, treatment was changed to full pulpotomy. Because hemostasis could not be achieved after 5 minutes using 2.5% sodium hypochlorite-soaked cotton pellets, a tampon technique was performed with calcium-enriched mixture cement placed over the radicular pulp stumps, followed by definitive restoration. The patient became symptom-free within one week and remained asymptomatic throughout the 4-year follow-up period. Radiographic examination demonstrated complete resolution of the periapical lesion, re-establishment of the lamina dura, and normalization of the periodontal ligament space. This case demonstrates that teeth initially diagnosed as necrotic may still harbor maintainable vital radicular pulp tissue. Careful intraoperative assessment can alter both diagnosis and treatment strategy. Full pulpotomy using an endodontic biomaterial and a tampon technique resulted in complete clinical and radiographic healing over four years.

Keywords: Calcium Silicate Cement; Calcium-Enriched Mixture; Dental Pulp; Irreversible Pulpitis; Endodontics; Mineral Trioxide Aggregate; Pulpotomy; Tampon Pulpotomy; Vital pulp therapy

Introduction

Management of pulpal and periapical diseases, including irreversible pulpitis and apical periodontitis in mature permanent teeth, has undergone a paradigm shift from a traditional extirpation-based philosophy toward biologically oriented minimally invasive approaches [1, 2]. Conventional dogma has long considered symptomatic irreversible pulpitis with apical periodontitis as an indication for complete pulpectomy and root canal treatment (RCT); however, increasing evidence suggests that pulpal inflammation may be reversible or spatially limited, particularly in teeth with deep carious exposure and localized coronal inflammation [3].

Vital pulp therapy (VPT; including its subcategories of stepwise excavation, indirect pulp capping, direct pulp capping, miniature pulpotomy, partial pulpotomy, full pulpotomy, and partial pulpectomy) has emerged as a predictable treatment modality for both immature teeth and mature permanent teeth with irreversible pulpitis [4, 5]. The biological rationale of VPT is based on preservation of radicular pulp vitality, which

maintains proprioception, immune defense, and long-term tooth survival while allowing continued healing of the dentin–pulp complex [6].

The clinical success of VPT is strongly dependent on accurate case selection, strict aseptic technique, effective hemostasis, and the use of bioactive pulp-capping materials. Mineral trioxide aggregate (MTA) and calcium silicate-based cements have demonstrated superior outcomes compared to calcium hydroxide, particularly in terms of hard tissue barrier formation and sealing ability [7-9]. Among newer biomaterials, calcium-enriched mixture (CEM) cement has demonstrated comparable outcomes to MTA, with advantages including improved handling, faster setting time, and enhanced sealing ability [10].

Recent studies have reported high success rates of full pulpotomy in mature permanent teeth diagnosed with symptomatic irreversible pulpitis, challenging the conventional necessity of RCT in all such cases [11-13]. However, emerging evidence also highlights a critical limitation in diagnostic pathways: clinical symptoms and sensibility tests may not reliably reflect the true histopathological status of the radicular pulp, and negative sensibility responses do not necessarily indicate complete pulp necrosis [14].

In particular, discrepancies between sensibility testing and actual pulpal vitality have been reported, especially in teeth with advanced carious lesions and periapical radiolucencies, where residual vital radicular pulp tissue may persist despite negative preoperative testing. These limitations underscore the importance of intraoperative assessment in determining true pulpal status.

An additional influential factor in the success of VPT is achieving predictable hemostasis before placement of the pulp-capping material. The quality and time required for bleeding control have been proposed as indirect indicators of pulpal inflammation severity and prognosis [15]. The use of controlled pressure techniques (tampon technique) facilitates stabilization of the clot and improves the interface between pulp tissue and bioactive materials, potentially enhancing healing outcomes [16, 17].

Despite growing evidence supporting VPT in cases diagnosed as irreversible pulpitis with apical lesions, long-term clinical documentation of cases involving diagnostic discordance, where teeth initially diagnosed as necrotic are later found to contain vital radicular pulp tissue, remains limited. Furthermore, evidence regarding long-term outcomes of CEM cement full pulpotomy using a tampon-assisted technique is still emerging.

This case report presents a four-year follow-up of a mature permanent tooth initially diagnosed with pulp necrosis and apical periodontitis based on clinical and radiographic findings. Intraoperatively, the tooth was found to contain vital radicular pulp and was successfully managed with a CEM full pulpotomy using the tampon technique, resulting in complete clinical and radiographic healing.

Case Presentation

A 36-year-old systemically healthy male patient presented to the dental clinic with a chief complaint of spontaneous pain exacerbated by mastication and pronounced tenderness to percussion in the left mandibular posterior region. The patient reported a progressive increase in pain intensity over several days, which had begun to interfere with sleep and normal daily function. No relevant medical conditions, medications, or allergies were reported.

Clinical examination revealed an extremely deep carious lesion affecting the left mandibular second molar. The tooth was tender to vertical percussion, while palpation of the adjacent mucosa was unremarkable. Periodontal probing depths were within physiological limits, and there was no evidence of mobility, swelling, sinus tract formation, or soft tissue discoloration. Pulp sensibility testing using EPT and cold stimulus demonstrated no response.

Radiographic assessment using periapical and panoramic imaging confirmed severe coronal structural loss and a periapical radiolucent lesion associated with the apical region of the tooth, suggestive of established apical pathosis (Figs. 1A-1B); these findings were interpreted as consistent with pulp necrosis and symptomatic apical periodontitis. Accordingly, a treatment plan for nonsurgical RCT was established, and informed consent was obtained.

After tooth isolation and complete caries removal, access cavity preparation was initiated. Upon entering the pulp chamber, the coronal pulp tissue appeared necrotic and disorganized, consistent with advanced pulpal breakdown. However, after removal of the necrotic coronal tissue and exposure of the canal orifices, profuse bright-red bleeding was observed from all canal entrances. The color and intensity of bleeding indicated the presence of vascularized vital radicular pulp tissue, contradicting the preoperative diagnosis of complete pulp necrosis.

This intraoperative finding prompted an immediate reassessment of the pulpal status. Following discussion with the patient and based on the newly observed biological condition of the pulp tissue, the treatment plan was modified from root canal therapy to full pulpotomy.

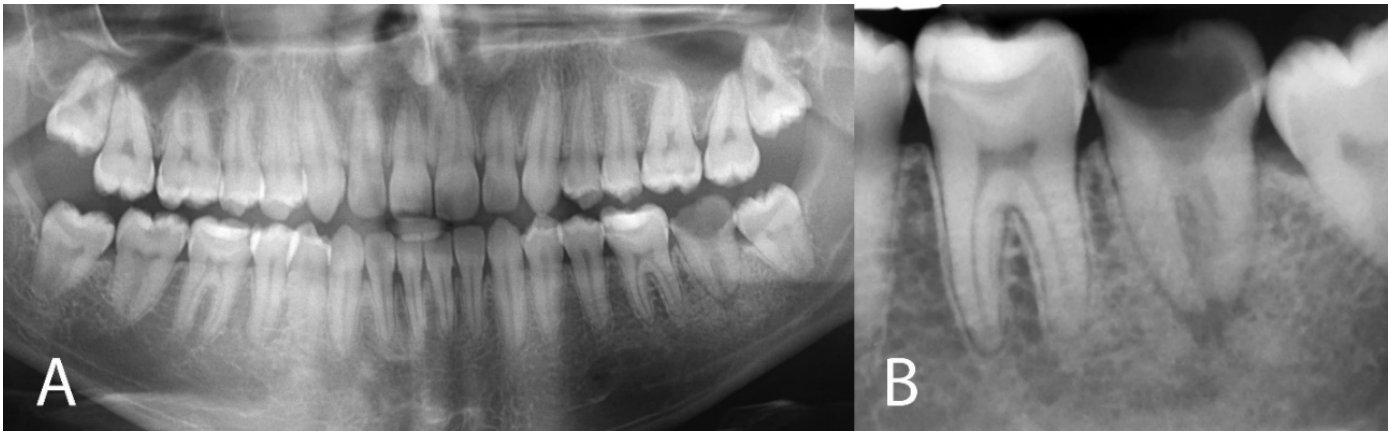

Figure 1. Preoperative radiographic assessment. (A) Panoramic and (B) periapical radiographs demonstrating a deep carious lesion in the left mandibular second molar with severe coronal destruction and an associated periapical radiolucency, indicative of apical pathosis.

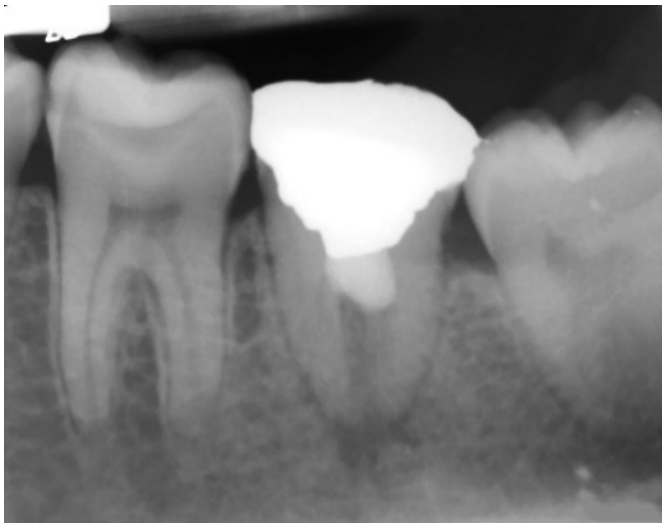

Figure 2. Immediate postoperative periapical radiograph showing completion of full pulpotomy and placement of CEM cement over the radicular pulp stumps, followed by definitive coronal restoration.

A full pulpotomy was performed; the remaining coronal pulp tissue was removed to the level of the canal orifices using sterile high-speed diamond burs under copious irrigation. Hemostasis was attempted using sterile cotton pellets soaked in 2.5% sodium hypochlorite with gentle pressure. However, bleeding persisted beyond 5 minutes, indicating persistent pulpal inflammation and difficulty in achieving conventional hemostasis.

Given the inability to achieve hemostasis within the expected timeframe, a tampon-assisted technique was employed. Calcium-enriched mixture (CEM) cement (BioniqueDent, Tehran, Iran) was prepared according to the manufacturer's instructions and gently adapted directly over the radicular pulp stumps, utilizing controlled pressure to achieve both hemostasis and an optimal interface between the biomaterial and vital pulp tissue. Following stabilization of bleeding, a moist cotton pellet was placed over the cement to facilitate initial setting.

The tooth was subsequently restored using amalgam in the same visit with a definitive coronal restoration to ensure a durable coronal seal and prevent microleakage (Fig. 2).

At the one-week follow-up, the patient reported complete resolution of symptoms and absence of spontaneous pain or tenderness. Clinical examination confirmed normal function and absence of percussion sensitivity.

Long-term follow-up over a period of 4 years demonstrated sustained clinical success. The tooth remained asymptomatic and fully functional throughout the observation period. Radiographic evaluation revealed complete resolution of the periapical radiolucency, re-establishment of lamina dura continuity, and normalization of the periodontal ligament space. No evidence of internal or external resorption, reinfection, or other pathological changes was observed (Figs. 3A-3B). The patient reported high satisfaction with the treatment outcome, particularly appreciating the preservation of his natural tooth and the absence of any discomfort throughout the follow-up period.

From a diagnostic perspective, this case highlighted a critical discrepancy between preoperative sensibility testing and actual pulpal status, as a tooth initially diagnosed as necrotic based on negative cold testing and periapical pathology was found intraoperatively to contain vital radicular pulp tissue capable of healing when managed with biologically based vital pulp therapy.

Overall, the clinical and radiographic outcomes support the concept that careful intraoperative reassessment may significantly alter the diagnosis and treatment strategy, allowing for the preservation of vital pulp tissue even in cases initially diagnosed as pulp necrosis with apical periodontitis.

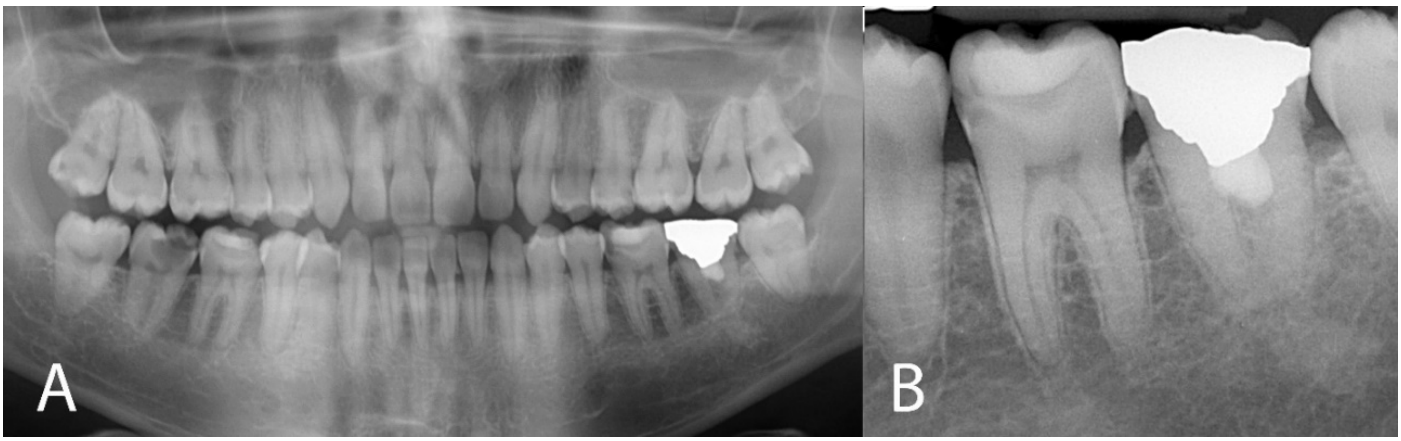

Figure 3. Four-year follow-up radiographic evaluation. (A) Panoramic and (B) periapical radiographs demonstrating complete periradicular healing with re-establishment of lamina dura, normalization of the periodontal ligament space, and complete resolution of the previous periapical lesion

Discussion

This case illustrates a successful long-term clinical and radiographic outcome following CEM cement full pulpotomy using a tampon technique in a mature permanent tooth initially diagnosed as pulp necrosis with apical periodontitis. The four-year follow-up demonstrated complete resolution of symptoms and periradicular healing, including re-establishment of lamina dura and normalization of the periodontal ligament space. These findings challenge the traditional treatment rationale that teeth diagnosed as necrotic with apical lesions in mature permanent dentition necessarily require RCT. A particularly important aspect of this case is the diagnostic discrepancy between preoperative findings and intraoperative observations. The tooth presented with a negative response to cold testing and radiographic evidence of apical periodontitis, both of which led to a diagnosis of pulp necrosis and an initial plan for root canal therapy. However, direct clinical access revealed profuse bleeding from the canal orifices, indicating the presence of vital radicular pulp tissue. This observation supports previous evidence that sensibility tests may not accurately reflect true pulpal histological status, particularly in teeth with advanced carious involvement and apical radiolucencies [14].

Traditionally, the presence of a periapical lesion has been interpreted as evidence of pulpal necrosis and bacterial contamination of the root canal system, mandating RCT [18]. However, the outcome observed in this case suggests that, in selected situations, periapical pathosis may be associated with teeth retaining vital radicular pulp tissue. The complete resolution of the apical lesion following pulpotomy further supports the concept that periapical healing is closely related to the biological status of the remaining pulp tissue and the establishment of an effective coronal seal [19, 20].

In the present case, the intraoperative finding of vital radicular pulp tissue despite a negative sensibility test highlights the limitations of current diagnostic methods. Clinical tests alone, particularly cold testing, assess neural response rather than true vascular vitality and may yield false-negative results in cases of severe inflammation or altered pulpal physiology [14]. This diagnostic uncertainty emphasizes the importance of intraoperative reassessment as an integral part of treatment decision-making.

Bioactive materials play a central role in the success of VPT. CEM cement has demonstrated favorable biological and sealing properties, including the ability to induce hard tissue formation, support pulp cell viability, and provide an effective microbial barrier [10]. Comparative studies have reported that CEM cement performs similarly to MTA in terms of clinical and radiographic outcomes in pulpotomy procedures [21]. The favorable outcome observed in this case further supports its reliability in biologically based pulp therapy.

Another key technical aspect is the use of a tampon technique for hemostasis. Controlled pressure application stabilizes the fibrin clot and improves adaptation of the bioactive material to the pulp tissue interface [16, 17]. Although evidence regarding its long-term effect remains limited, effective hemostasis is widely recognized as a critical determinant of pulpotomy success [15].

The long-term success observed in this case, with complete radiographic healing at four years, indicates true biological regeneration rather than symptomatic masking of disease. This suggests that radicular pulp tissue, even when inflamed and initially misdiagnosed as necrotic, may retain significant healing potential under appropriate biological conditions.

This case also contributes to the ongoing debate regarding the diagnostic reliability of pulpal testing. The discrepancy

between preoperative diagnosis and intraoperative findings underscores the risk of overtreatment when decisions are based solely on sensibility tests and radiographic interpretation. Vital pulp therapy, when appropriately indicated and executed, may therefore represent a more conservative and biologically favorable alternative to root canal treatment [22, 23].

Nevertheless, careful case selection remains essential. Treatment outcome is critically predicted by symptom severity, the extent of carious destruction, coronal seal quality, and successful hemostasis. Furthermore, long-term coronal integrity is essential to prevent reinfection, which remains a primary cause of failure in pulpotomy cases [24].

Importantly, while this case highlights the potential limitations of conventional sensibility testing in accurately reflecting true pulpal status, it does not provide sufficient evidence to challenge the current diagnostic framework. Rather, it emphasizes the need for further investigation into the biological basis of diagnostic discrepancies observed in clinical practice. Future research integrating biomarkers of pulpal inflammation and vitality, together with advanced imaging and physiological assessment methods, may help refine diagnostic accuracy and improve treatment decision-making.

Although this case demonstrates favorable clinical and radiographic outcomes over a 4-year follow-up period, its limitations should be acknowledged. As a single case report, the findings cannot be generalized and should not be interpreted as evidence for broad modifications of current diagnostic/treatment frameworks. The discrepancy observed between the preoperative diagnosis and the intraoperative finding of vital radicular pulp tissue highlights a clinically relevant phenomenon; however, the present report cannot determine its prevalence or underlying biological mechanisms. Furthermore, no advanced vitality assessment methods, biomarkers, or novel imaging modalities were available to characterize the biological status of the pulp beyond conventional clinical/radiographic evaluation. Future prospective studies incorporating molecular biomarkers, advanced imaging techniques, and histobiological investigations are needed to improve understanding of diagnostic discordance between sensibility testing and true pulpal vitality and to identify factors associated with successful outcomes following VPT.

Conclusion

This case demonstrates that teeth diagnosed clinically as pulp necrosis with apical periodontitis may occasionally retain vital radicular pulp tissue despite negative sensibility testing. Intraoperative findings, particularly unexpected bleeding from canal orifices, can be crucial in revising the diagnosis and altering the treatment approach from RCT to VPT. Full pulpotomy using CEM cement combined with a tampon-assisted technique resulted in complete clinical and radiographic healing over a 4-year follow-up period, supporting the potential of biologically based VPT as a predictable and conservative alternative to RCT in carefully selected cases initially diagnosed as necrotic pulp with apical lesions. While no broad conclusions regarding current diagnostic/treatment frameworks can be drawn from a single case, the findings underscore the importance of careful intraoperative assessment and highlight the need for future studies investigating the biological basis of diagnostic discrepancies through biomarkers and other mechanistic approaches.

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Conflict of interest
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Author's contributions
SA is the sole author and is solely responsible for all aspects of the study, including conception, data collection, analysis, and manuscript preparation.

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