

From Whole-Tooth to Root-Specific Vitality Preservation: Partial Pulpotomy, Full Pulpotomy, and Selective Endodontic Treatment in Mature Permanent Teeth with Symptomatic Irreversible Pulpitis – A Case Series with 12–24 Month Follow-up

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Case Report

Keywords: Vital pulp therapy, Partial pulpotomy, Full pulpotomy, Selective endodontic treatment, Root-specific management, Irreversible pulpitis, Bioceramic materials

Posted Date: October 11th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-10694731/v1>

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Additional Declarations: No competing interests reported.

Abstract

Background

Preservation of pulp vitality remains a central objective in contemporary conservative dentistry. Advances in pulp biology indicate that pulpal inflammation associated with caries is frequently a spatially graded process rather than a uniform one, raising the possibility that vitality-preserving treatment can be matched not only to the whole tooth but, in multirooted teeth, to the biological status of each individual root. This case series presents a graded spectrum of such decisions in three mature permanent molars with symptomatic irreversible pulpitis.

Case Presentation:

Three systemically healthy patients (aged 23–55 years; two female, one male) presented with symptomatic irreversible pulpitis in mature mandibular molars. Management progressed from partial pulpotomy (Case 1) to full pulpotomy (Case 2) to selective endodontic treatment, in which pulpectomy of the mesial root was combined with vital pulp therapy of the distal root within the same tooth (Case 3), the approach in each root guided intraoperatively by the character and duration of pulpal bleeding. Mineral trioxide aggregate was used for all vital-pulp procedures, and a bioceramic sealer with single-cone obturation for the pulpectomised root, under rubber dam isolation and magnification.

Results

At final follow-up (24, 12, and 12 months for Cases 1 through 3 respectively), all three teeth were asymptomatic, functional, and free of percussion or palpation tenderness. Sensibility testing was normal in all vitally managed roots. Radiographic examination confirmed periapical health (Periapical Index score of 1) in every case at final review, with progressive calcific bridge formation observed beneath the vital pulp-capped tissue. In Case 3, the pulpectomised mesial root and the vitally managed distal root each healed independently and predictably within the same tooth.

Conclusion

Partial pulpotomy, full pulpotomy, and selective root-specific endodontic treatment represent a graded, biologically coherent spectrum of vitality-preserving options. Extending minimally invasive decision-making from the whole tooth to the level of the individual root may broaden the scope of pulp preservation achievable in multirooted teeth with heterogeneous pulpal involvement.

Introduction

Despite considerable progress in preventive and restorative dental care, dental caries remains among the most widespread chronic diseases globally, cutting across every age group [1]. As a carious lesion deepens, bacterial by-products diffuse through the dentinal tubules and trigger inflammatory changes in the pulp well before it is physically exposed. If the lesion is left to advance, the degree and spread of pulpal inflammation worsen, and delayed treatment can lead to irreversible pulp damage and eventual necrosis [2, 3].

Teeth diagnosed with symptomatic irreversible pulpitis have conventionally been treated by pulpectomy and root canal therapy. More recent histological and microbiological research, however, indicates that pulpitis arising from caries is often a localized process, with the irreversible component largely restricted to the coronal pulp. This evolving view of pulp pathophysiology, together with newer bioactive pulp-capping materials, has driven a shift away from complete pulp removal toward more conservative, vitality-preserving treatment strategies [4].

Vital pulp therapy covers a range of techniques, from indirect and direct pulp capping to partial and full pulpotomy [5]. Current protocols place strong emphasis on strict asepsis, magnification, careful control of bleeding, and biocompatible dressing materials that encourage pulpal healing and dentin bridge formation. A growing body of clinical trials and systematic reviews has reported favorable outcomes with pulpotomy in mature permanent teeth, calling into question the older assumption that pulpectomy is the only reliable option for managing irreversible pulpitis [6].

This change in approach is supported by evidence that caries-related pulpitis tends to remain confined to specific regions of the pulp rather than affecting it uniformly [7, 8, 9]. Preserving pulp vitality is a core goal of operative dentistry, reflecting a biologically oriented philosophy that limits intervention while protecting the pulp's roles in tooth development, defense, and sensory feedback. Minimally invasive principles are widely advocated for the same reason, since they reduce the risk of overtreatment, break the cycle of repeated restorations, and help conserve tooth structure while improving the cost-effectiveness of care [10, 11].

This reasoning has largely reshaped decision-making at the level of the whole tooth. Permanent molars, however, are multirooted, and there is no biological reason to assume that pulpal inflammation, once it reaches the radicular pulp, must involve every root of a tooth to an equal degree. Diagnostic and treatment-planning frameworks are increasingly recognising that the extent of pulp tissue removed or retained should be individualised according to the vitality of the pulp as reassessed intraoperatively, rather than fixed in advance for the whole tooth [22]. Consistent with this, combining non-surgical endodontic treatment in one root with vital pulp therapy in another has been reported to achieve outcomes comparable with conventional full endodontic treatment in mature mandibular molars with symptomatic irreversible pulpitis and apical periodontitis [21].

This case series reports the clinical management and follow-up of three mature permanent molars with a diagnosis of symptomatic irreversible pulpitis, illustrating a graded spectrum of vitality-preserving

decisions – from partial pulpotomy, to full pulpotomy, to selective endodontic treatment applied independently to each root of the same tooth – followed for periods of 12 to 24 months.

Case Series

This case series was prepared in accordance with the CARE (CAsE REport) guidelines and informed by the PRICE 2020 reporting guidelines for endodontic case reports (Fig. 1). Written informed consent was obtained from the all the patients for publication of this case report and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.. All patients were systemically healthy, with no contributory medical history.

Patient Information

The demographic and clinical characteristics of the three participants are summarised in Table 1.

Table 1
Demographic and clinical characteristics of participants.

Case	Tooth	Age / Gender	Chief Complaint	Diagnosis
1	36	25 / Male	Sharp, lingering pain to thermal and sweet stimuli	Symptomatic irreversible pulpitis, normal periapical tissue
2	46	23 / Female	Severe nocturnal pain aggravated by sweet, hot and cold stimuli	Symptomatic irreversible pulpitis, normal periapical tissue
3	46	55 / Female	Severe nocturnal pain aggravated by sweet, hot and cold stimuli	Symptomatic irreversible pulpitis, normal periapical tissue (root-specific management; see Case 3)

Clinical and Radiographic Findings

Every patient presented with pain occurring both spontaneously and on stimulation. Cold sensibility testing produced a sharp, lingering response in all three cases, with an early response also recorded on electric pulp testing. Percussion tenderness was absent in Case 1, while Cases 2 and 3 each showed mild discomfort on vertical percussion; palpation was unremarkable in all three. Periapical radiographs demonstrated deep caries approximating or extending to the pulp horn in each tooth, with completely formed roots and no radiographic evidence of periapical pathology (Periapical Index score of 1 in every root). In Case 3, a pre-existing restoration was additionally noted in close radiographic proximity to the mesial pulp horn, raising suspicion of more advanced, longstanding pulpal involvement localised to the mesial root – a suspicion that was subsequently confirmed intraoperatively (see Case 3, below).

Treatment Planning

In Cases 1 and 2, the treatment options – conventional root canal therapy versus vital pulp therapy – were discussed in detail, and each patient elected to proceed with pulpotomy. In Case 3, given the anatomical and clinical suspicion of differential pulpal involvement between the mesial and distal roots, the treatment plan anticipated the possibility of a root-specific approach, to be finalised intraoperatively according to the character of pulpal bleeding observed in each canal. Written informed consent was obtained from all patients before treatment began.

Common Procedural Elements

In all three cases, local anaesthesia was achieved using 2% lignocaine with 1:100,000 epinephrine, and the tooth was isolated with a rubber dam to maintain an aseptic field, further disinfected using 2% povidone-iodine. All procedures were performed under a dental operating microscope at 18x magnification. A non-selective caries excavation technique, guided by a caries-detecting dye (Kuraray Noritake Dental Inc., Tokyo, Japan), was used to remove infected dentin with a large sterile round carbide bur (RA – Prima Dental Group, Gloucester, UK) under high-speed water irrigation, working from the periphery inward. Following complete caries removal, a fresh sterile carbide bur was used to gain pulpal access, and the access cavity was refined with an ultrasonic tip (E4 – Woodpecker Medical Instrument Co., Guilin, China). Bleeding on exposure confirmed pulpal vitality in every case.

Case 1: Partial Pulpotomy (Tooth 36, Fig. 2)

The portion of coronal pulp judged to be irreversibly inflamed was removed to a depth of 3–4 mm using a large sterile round diamond bur (BR-46 – MANI, Inc., Tochigi, Japan) under continuous water cooling, continuing until well-vascularised, actively bleeding tissue was reached. Haemostasis was achieved within 3 minutes using a cotton pellet moistened with 3% sodium hypochlorite. Mineral trioxide aggregate (MTA – Angelus, Londrina, Paraná, Brazil) was placed as the pulp-capping agent per manufacturer instructions, followed by a 1 mm layer of resin-modified glass ionomer cement (GC Fuji Plus – GC Corporation, Tokyo, Japan) and a bonding agent (Clearfil SE Bond – Kuraray Noritake Dental Inc., Tokyo, Japan). Lost dentin was rebuilt in 2 mm increments using short fibre-reinforced composite (EverX Posterior – GC Corporation, Tokyo, Japan), and the enamel was restored with a high-strength posterior composite (Filtek Bulk Fill – 3M, St. Paul, MN, USA). The restoration was finished and polished, and occlusion verified with 40 µm articulating paper.

At the 18-month recall the tooth remained asymptomatic, with a normal sensibility response and no percussion or palpation tenderness; the periapex was radiographically healthy (PAI 1). These findings were maintained at the 24-month recall, by which time radiographic evidence of calcific bridge formation beneath the capping material was evident, and the restoration remained intact.

Case 2: Full Pulpotomy (Tooth 46, Fig. 3)

Because the coronal pulp bled profusely on exposure, a full pulpotomy extending to the root canal orifices was performed, with haemostasis achieved using chilled saline under 3 minutes. MTA was placed as the pulp-capping agent, and the tooth was restored using the same layered restorative sequence described for Case 1 (resin-modified glass ionomer liner, bonding agent, fibre-reinforced composite core, and posterior composite enamel replacement).

The immediate postoperative radiograph showed mild widening of the periodontal ligament space at the mesial root apex (PAI 2), which persisted essentially unchanged at the 6-month recall – at which point the tooth remained asymptomatic, with normal sensibility and no percussion or palpation tenderness – before resolving to a normal periapical appearance (PAI 1) by the 12-month recall. Radiographic evidence of calcific bridge formation was noted at 12 months, the restoration was intact, and the tooth remained asymptomatic and fully functional throughout follow-up.

Case 3: Selective Endodontic Treatment (Tooth 46, Fig. 4)

On access, the mesial canals bled profusely, with blood of a bright, deep-red colour; haemostasis could not be achieved even after resecting the pulp 3 mm below the canal orifices – an appearance and behaviour interpreted as advanced, irreversible pulpal involvement of the mesial root, consistent with the preoperative radiographic finding of a restoration in close proximity to the mesial pulp horn. The distal canal, in contrast, required resection of only 2 mm of tissue below its orifice before haemostasis was achieved, within 3 minutes and with no necrotic islands observed – findings consistent with a lesser degree of inflammatory involvement in that root.

Based on this intraoperative, root-specific assessment, a differential treatment plan was adopted: pulpectomy for the mesial root and vital pulp therapy for the distal root, reflecting a compartmentalised, biology-based approach in which visually and behaviourally confirmed infected tissue was removed while healthy pulp tissue was preserved. The distal orifice was first capped with MTA and a thin layer of resin-modified glass ionomer cement, while mesial orifice being sealed temporarily, after which pulpectomy was carried out in the mesial root. The mesiobuccal and mesiolingual canals were instrumented with nickel-titanium rotary files to a master apical size of 25/04, using 5% sodium hypochlorite as the working irrigant, followed by final rinse of 17% EDTA, 5% sodium hypochlorite and normal saline. The canals were obturated with gutta-percha using a bioceramic sealer (CeraSeal – Meta Biomed, Cheongju, South Korea) using single-cone technique.

In the distal root, vital pulp therapy was carried out to a depth of 2 mm below the canal orifice. Haemostasis was achieved within 3 minutes using a cotton pellet soaked in 3% sodium hypochlorite, following which MTA (MTA-Angelus, Londrina, Paraná, Brazil) was placed as the capping material. A layer of resin-modified glass ionomer cement (GC Fuji Plus – GC Corporation, Tokyo, Japan) was placed over both the pulpectomised and vitally treated roots, and the tooth was restored using heated short fibre-reinforced composite (EverX Posterior – GC Corporation, Tokyo, Japan) as a dentin substitute and a high-strength posterior composite (Filtek Bulk Fill – 3M, St. Paul, MN, USA) for the enamel layer.

Figure 4: Case 3. A – Preoperative radiograph, B – Intraoperative photograph showing inflamed state of mesiobuccal and mesiolingual canals with uncontrolled bleeding and healthy tissue in distal canal with controlled bleeding after resection, C – Vital distal canal capped with MTA, D – Immediate postoperative radiograph showing root canal treated mesial canals and MTA capped distal canal with permanent restoration, E – 6 month recall radiograph, F – 12 month recall radiograph

Follow-up and Outcomes

Patients were recalled at periodic intervals for clinical and radiographic evaluation, including pulp sensibility testing, percussion and palpation assessment, and intraoral periapical radiography. A summary of treatment and final outcomes is presented in Table 2.

Table 2
Treatment and follow-up outcomes.

Case	Treatment	Follow-up	Outcome
1	Partial pulpotomy (tooth 36)	24 months	Asymptomatic; normal sensibility; healthy periapex (PAI 1); calcific bridge noted
2	Full pulpotomy (tooth 46)	12 months	Asymptomatic; at 12 months; calcific bridge noted
3	Selective endodontic treatment: mesial pulpectomy + distal VPT (tooth 46)	12 months	Both roots asymptomatic and radiographically healthy (PAI 1); mesial root well-obtured, distal root vital with progressive calcific bridge (none → mild → marked)

Discussion

Management of deep carious lesions affecting the dental pulp has changed substantially in recent decades. Pulpectomy was once taught as the standard treatment for symptomatic irreversible pulpitis, but advances in the understanding of pulp biology have shown that pulpal inflammation is frequently localised, allowing healthy radicular pulp to be preserved through conservative surgical management [12, 13].

Bioceramic materials, such as mineral trioxide aggregate, offer strong sealing capability, high biocompatibility, and bioactivity, which together support pulpal healing and the formation of a hard-tissue barrier. These characteristics make them well suited to vital pulp procedures and are associated with better clinical results than those obtained with traditional calcium hydroxide [14].

The improved clinical success seen with vital pulp therapy has been linked to rigorous aseptic technique, the use of magnification, and the use of bioceramic cements [15, 16]. Calcium hydroxide has long served as the standard pulp-capping material [17], but current evidence points to bioceramic materials as offering better performance owing to their lower solubility, superior sealing, and greater capacity to encourage pulpal cell proliferation, mineralisation, and reparative hard-tissue formation [17].

Clinical data continue to support pulpotomy as a dependable treatment option for permanent teeth affected by symptomatic irreversible pulpitis. Good outcomes have consistently been linked to careful case selection, accurate diagnosis, and close adherence to established protocols, especially when modern bioceramic cements are used as the pulpal dressing [18–20].

Control of haemorrhage during pulpotomy continues to serve as a key indicator of likely treatment success. Although the ideal duration for achieving haemostasis remains a matter of debate, current evidence favours controlling bleeding within a clinically reasonable timeframe through gentle tissue handling and antimicrobial irrigation. Lin et al. proposed that haemostasis achieved within 8–15 minutes is acceptable, and that bleeding persisting beyond this period may warrant pulpectomy instead [4]. Ricucci et al., by contrast, applied a stricter cut-off, suggesting that bleeding lasting longer than roughly 2 minutes may call for a change in approach, such as moving from partial to complete pulpotomy or from pulpotomy to pulpectomy [4]. More recent in vivo histological findings from an animal study by Santos et al. found that the duration of haemostasis may not meaningfully influence pulpotomy outcomes in permanent teeth [9]. Koli et al. used a similarly rapid, root-specific criterion in their combined NSET–VPT protocol, confirming vitality at the root orifice by the arrest of pulpal bleeding following application of a sodium hypochlorite pressure pack [21]. These varying thresholds point to a lack of consensus on how clinically important haemostasis time really is, underscoring the need for further well-designed clinical research to establish evidence-based cut-offs. In the cases presented here, haemostasis was achieved within a consistent, narrow window in every root judged suitable for vital pulp therapy, allowing predictable placement of materials and favourable healing; the one root in which haemostasis could not be controlled (the mesial root in Case 3) was managed instead by pulpectomy, illustrating this criterion applied at root level rather than whole-tooth level.

The selective endodontic treatment illustrated in Case 3 extends this reasoning one step further, from the level of the whole tooth to the level of the individual root. Because pulpal inflammation is not obliged to progress at the same rate in every root of a multirrooted tooth, intraoperative assessment of bleeding at each canal orifice offers a direct, root-specific indicator of pulp status that whole-tooth sensibility testing cannot provide. Koli et al. reported that combining non-surgical endodontic treatment in one root with vital pulp therapy in another achieved outcomes comparable with conventional full endodontic treatment in mature mandibular molars with symptomatic irreversible pulpitis and apical periodontitis [21]. More recently, an international expert consensus statement reaffirmed that decisions on the extent of pulp tissue removal should be individualised according to the diagnosed vitality of the pulp and its reassessment during the operative procedure, rather than fixed in advance for the whole tooth [22]. The present case adds to this evolving picture, with independent and radiographically confirmed healing of both the pulpectomised and vitally managed roots of the same tooth over 12 months of follow-up, and with a plausible anatomical explanation — a restoration in close proximity to the mesial pulp horn — for why the two roots differed in their pulpal status at presentation.

The positive clinical and radiographic results seen across this case series are consistent with existing literature on partial and complete pulpotomy in mature permanent teeth with irreversible pulpitis, and, for Case 3, with the limited but growing literature on root-specific vitality preservation. Rigorous asepsis, the use of magnification, careful handling of tissue, and effective, root-specific control of coronal bleeding likely all contributed to the successful outcomes observed.

This case series has the inherent limitations of a small, single-centre sample: only three teeth are reported, follow-up duration varied between 12 and 24 months, and the patient cohort spanned a wide age range (23–55 years), which may itself be associated with differences in pulp reparative capacity. The threshold used to judge haemostasis as adequate was based on clinical judgement within the timeframes described above, and, as discussed, no universally agreed cut-off currently exists. Larger, prospective, multicentre studies with longer and more uniform follow-up are needed to confirm the durability of root-specific vitality-preserving treatment and to establish objective, reproducible criteria for root-by-root decision-making.

Conclusion

Partial pulpotomy, full pulpotomy, and selective endodontic treatment represent a graded spectrum of vitality-preserving options, unified by the same underlying principle: that treatment should be matched to the true extent of pulpal involvement rather than applied uniformly by default. The favourable outcomes observed across all three cases, including the independent healing of two differently managed roots within the same tooth in Case 3, support the feasibility of extending minimally invasive, biologically based decision-making to the level of the individual root in multirooted teeth with symptomatic irreversible pulpitis. Larger, prospective, longitudinal studies are needed to confirm these findings and to establish standardised criteria for root-specific treatment planning.

Declarations

Ethics and consent to participate:

The study involves standard clinical care and did not require institutional ethics approval. Written informed consent was obtained from the patients for both treatment and publication. Patient confidentiality has been maintained.

Informed Consent

Written informed consent was obtained from all the patients for publication of this case report and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

Availability of data and materials:

All data generated or analysed during this study are included in this published article

Competing interests:

The authors declare that they have no competing interests.

Funding:

The authors received no specific funding for this work.

Authors' contributions:

APP contributed to the clinical management of all three cases, acquisition and interpretation of clinical and radiographic data, and drafting of the manuscript. RR contributed to case selection, clinical data acquisition, and critical revision of the manuscript. SCM contributed to interpretation of radiographic findings and critical revision of the manuscript for important intellectual content. RRR contributed to conception and design of the case series and critical revision of the manuscript. PSVP contributed to overall supervision of clinical management, conception and design of the case series, and final approval of the manuscript for submission. All authors read and approved the final manuscript.

Patient Perspective

All patients reported complete relief from pain and expressed satisfaction with the preservation of their natural dentition.

Acknowledgement declaration

The authors would like to express their sincere gratitude to the faculty and fellow postgraduate residents of Amrita School of Dentistry, Kochi, Kerala, India, for their valuable guidance and encouragement throughout our academic journey.

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Figures

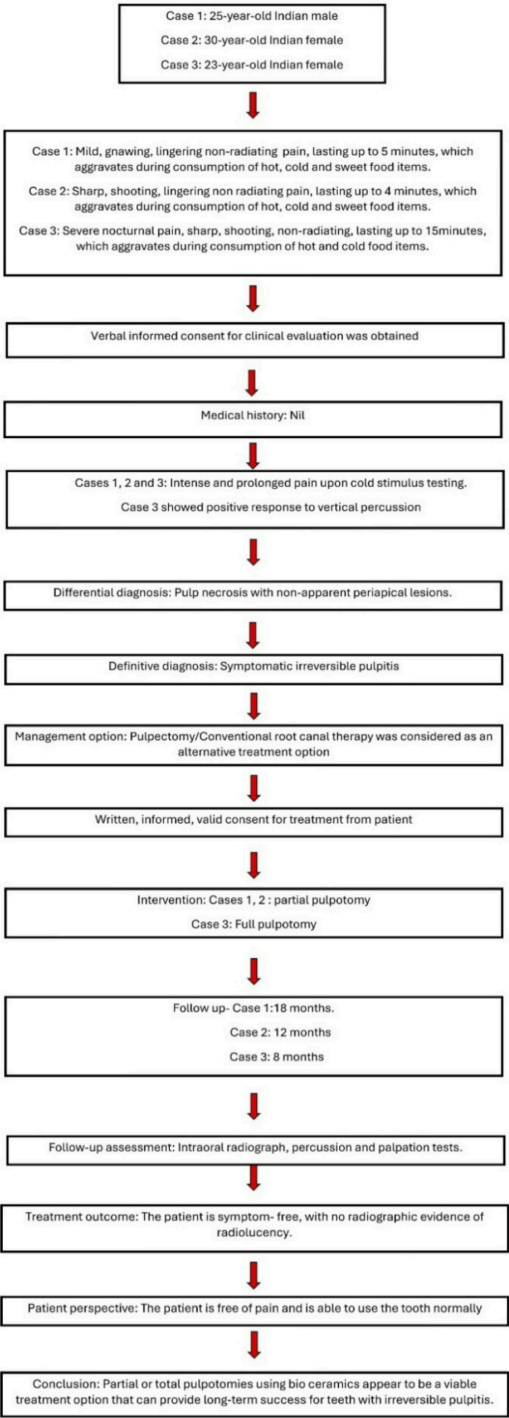


Figure 1

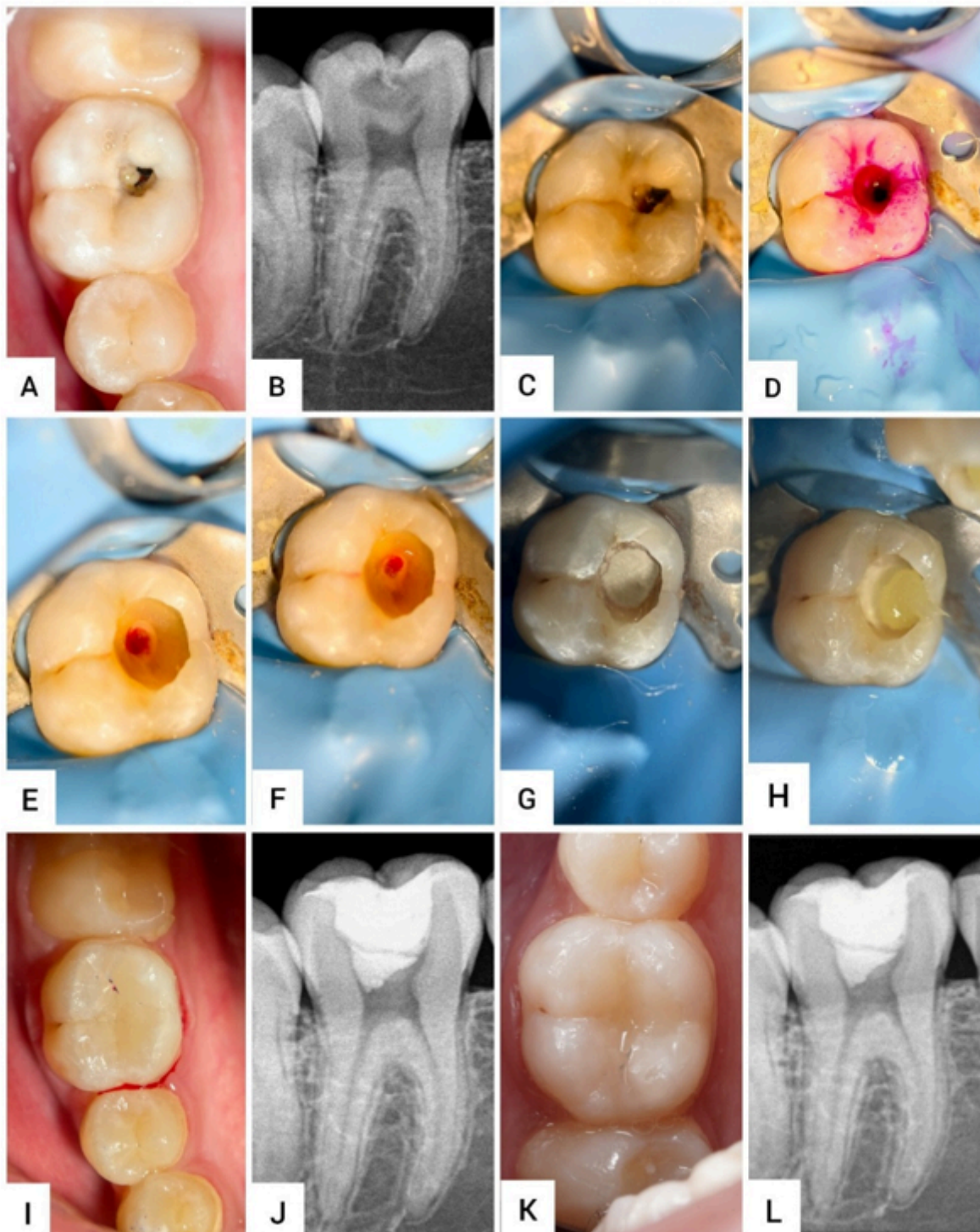


Figure 2

Case 1. A – Preoperative photograph, B – Preoperative radiograph, C – Isolation and asepsis, D – Complete caries removal with caries detection dye, E – Exposed unhealthy pulp, F – Healthy pulp after partial

pulpotomy, G – MTA capping, H – Short fibre-reinforced composite core, I – Final composite layer, J – Immediate post-operative radiograph, K & L – 18-month recall photograph and radiograph, respectively.



Figure 3

Case 2: A – Preoperative radiograph, B – Radiograph after full pulpotomy and MTA capping, C – 12-month recall radiograph.

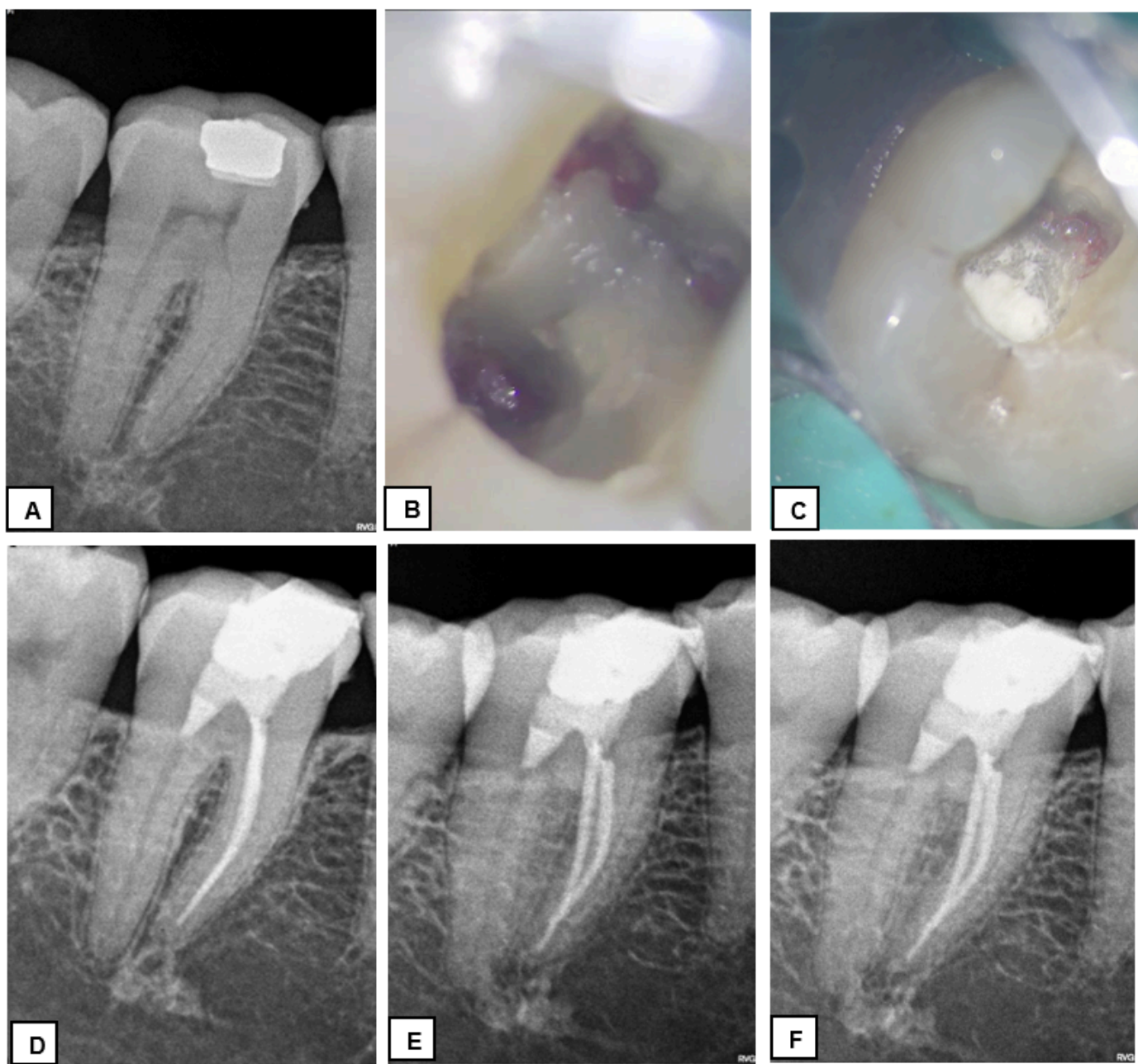


Figure 4

Case 3. A – Preoperative radiograph, B – Intraoperative photograph showing inflamed state of mesiobuccal and mesiolingual canals with uncontrolled bleeding and healthy tissue in distal canal with controlled bleeding after resection, C – Vital distal canal capped with MTA, D – Immediate postoperative radiograph showing root canal treated mesial canals and MTA capped distal canal with permanent restoration, E – 6 month recall radiograph, F – 12 month recall radiograph

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