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Endodontic Management of Lower Premolar with Dens Evaginatus and Open apex using Strontium Silicate C-Root BP as Bioactive Material: A Case Report

Abstract

Background: Management of non-vital permanent teeth with dens evaginatus and open apex remains challenging because of thin dentinal walls, a wide apical foramen, and the absence of a physiological apical constriction. Strontium silicate-based bioceramic materials have been increasingly used as apical barriers because of their favorable sealing and excellent biological properties. C-Root BP is a bioactive strontium silicate-based material that may provide an alternative approach for the management of immature teeth; however, clinical evidence regarding its use in non-vital immature permanent teeth remains limited.

Case Presentation: A 15-year-old male patient presented with a dens evaginatus of mandibular right second premolar (#45). Clinical examination and pulp sensibility testing were consistent with pulp necrosis. Preoperative periapical radiography demonstrated an immature root with thin dentinal walls, a wide-open apical foramen, and a periapical radiolucency. The tooth was diagnosed with pulp necrosis and asymptomatic apical periodontitis. Following conservative chemomechanical preparation and canal disinfection, C-Root BP was placed in the entire root as root filling material, followed by fluid tight seal coronal restoration. At 8 months follow-up, the tooth remained asymptomatic and functional, and the previously observed periapical radiolucency had completely resolved and root length increased

Discussion: The favorable clinical and radiographic outcome observed in this case is consistent with the reported effectiveness of bioceramic apical barriers in the management of non-vital immature teeth. The bioactivity, sealing ability, and biocompatibility associated with calcium silicate-based materials may contribute to favorable periapical healing. The favorable outcome observed in this case should be interpreted as preliminary clinical evidence rather than definitive evidence of the material's long-term effectiveness.

Conclusion: Within the limitations of this case report, C-Root BP demonstrated a favorable clinical and radiographic outcome when used as a root filling material in a non-vital immature permanent tooth with dens evaginatus and open apex. Complete resolution of the periapical lesion, absence of clinical symptoms and continuation of root growth were observed at follow-up. Further clinical studies with larger samples and longer follow-up periods are required to establish the long-term effectiveness and predictability of C-Root BP.

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Introduction

The management of non-vital immature permanent teeth remains a clinical challenge because pulpal necrosis occurring before completion of root development results in an open apex, thin dentinal walls, and a root with limited structural strength. Dens evaginatus (DE) is a dental anomaly with a supernumerary tubercle projection that typically contains dentin and pulp tissue. However, the tubercle projection can fracture, exposing the dentin and potentially the dental pulp, which induces pulpal diseases. These anatomical characteristics complicate conventional root canal treatment and obturation because the absence of an apical constriction makes adequate control of the filling material difficult and may increase the risk of overextension into the periapical tissues. Consequently, treatment strategies for immature necrotic teeth aim not only to eliminate infection but also to establish an effective apical seal while preserving the structural integrity of the developing tooth. [1,2]

Apexification has traditionally been used for the management of immature permanent teeth with pulp necrosis. The procedure aims to create an apical barrier that permits controlled obturation of the root canal system. Contemporary apexification protocols commonly employ calcium silicate-based materials as apical barriers because these materials can provide favorable sealing, biocompatibility, and biological activity. Clinical evidence has demonstrated favorable outcomes following apexification of non-vital immature teeth, including high tooth survival and satisfactory periapical healing. A long-term case series reported a tooth survival rate of 93.8% following apexification and corono-radicular adhesive restoration, with follow-up periods ranging from 5 to 22 years. [3] Similarly, a retrospective study of non-vital immature incisors treated with bioceramic apical plugs reported complete healing or signs of healing in 86.3% of treated teeth, supporting the clinical effectiveness of bioceramic materials for apical barrier formation. [4]

Although apexification provides predictable apical closure and facilitates subsequent obturation, it does not necessarily promote continued physiological root development. Regenerative endodontic procedures have therefore emerged as an alternative approach for immature necrotic teeth, with the potential to promote further root maturation, increase root length and dentinal wall thickness, and achieve periapical healing. Comparative evidence indicates that both regenerative endodontic procedures and apexification can provide favorable clinical outcomes, although regenerative approaches may offer greater potential for continued root development. [5,6] Nevertheless, apexification remains an important treatment option, particularly when predictable apical barrier formation and effective root canal sealing are considered primary treatment objectives. The development of strontium silicate-based bioceramic materials has further improved the biological and physical properties of materials used in endodontic treatment. These materials exhibit favorable biocompatibility and bioactivity and may interact with tissue fluids to promote the formation of apatite-like deposits. Their biological activity, together with their sealing properties and ability to release calcium ions, provides a rationale for their use in procedures involving communication between the root canal system and periapical tissues. [7,8] Strontium silicate-based cements have consequently been applied in several endodontic procedures, including apexification, pulp therapy, perforation repair, root-end filling, and other root repair procedures. [9]

C-Root BP is a bioceramic root repair material developed for endodontic applications involving apical and root repair. It contains strontium silicate as its bioactive material which has better hard tissue inducing properties than calcium silicate based material. Its use as a bioactive material is of particular interest in immature teeth because the clinical management of an open apex requires a material capable of establishing an effective apical barrier while maintaining favorable biological interactions with the surrounding tissues. Recent in vitro evidence demonstrated that C-Root BP exhibited apical sealing and bacterial microleakage performance comparable with iRoot BP Plus, while demonstrating greater adhesion strength to dentin than the comparator material. [10] These findings provide a biological and material-science rationale for considering C-Root BP in the management of teeth with compromised apical anatomy.

Despite the increasing use of strontium silicate-based bioceramics in apexification, clinical evidence specifically evaluating C-Root BP in non-vital immature permanent teeth remains limited. Most available evidence concerning bioceramic apexification involves established materials such as mineral trioxide aggregate and Biodentine, while evidence directly addressing the clinical and radiographic outcomes of C-Root BP is still emerging. Therefore, documenting clinical cases involving the use of C-Root BP in immature teeth may contribute valuable preliminary clinical evidence regarding its application, apical sealing potential, and associated periapical healing. [3,4,9,10]

The present case report describes the clinical and radiographic outcome of a non-vital immature permanent tooth with an open apex managed using C-Root BP as a bioactive apical barrier material. Clinical symptoms, radiographic findings, and periapical healing during follow-up were evaluated to assess the short-term treatment outcome.

Case Presentation and Management

A 15-year-old female patient presented to the Dental Hospital for evaluation and treatment of the mandibular right second premolar (tooth #45) with dens evaginatus. The patient's medical history was non-contributory, and no relevant systemic conditions or medications were reported. Clinical examination revealed an intact tooth #45. The tooth was asymptomatic, with no history of spontaneous pain, swelling, or sinus tract formation. The tooth was not tender to percussion or palpation.

Pulp sensibility testing was performed using a cold stimulus and electric pulp test. Tooth #45 showed no response to the cold test and electric pulp test, whereas the adjacent control teeth responded normally. Based on the clinical findings and pulp sensibility testing, the pulpal diagnosis was pulp necrosis. The absence of clinical symptoms, combined with the radiographic evidence of periapical pathology, was consistent with a diagnosis of asymptomatic apical periodontitis.

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A preoperative periapical radiograph was obtained to assess the root morphology, degree of root development, and periapical status of tooth #45 (Figure 1). The radiograph demonstrated an immature permanent tooth with an incompletely developed and short root, relatively thin radicular dentinal walls, and a wide-open apical foramen. The apical anatomy lacked a clearly defined physiological apical constriction, confirming the presence of an immature open apex.

A well-defined radiolucent lesion was observed in the periapical region of tooth #45, associated with the apical portion of the immature root (Figure 1). The combination of pulp necrosis, an open apex, and a periapical radiolucency supported the diagnosis of pulp necrosis with asymptomatic apical periodontitis.

The immature root morphology and absence of an apical constriction represented a significant challenge for conventional root canal treatment. Therefore, C-Root BP, a strontium silicate-based bioactive material, was selected as root canal filling material.



Figure 1. Preoperative periapical radiograph of tooth #45. The radiograph demonstrates an immature permanent mandibular right second premolar with dens evaginatus and incompletely developed root, thin radicular dentinal walls, and a wide-open apical foramen. A periapical radiolucent lesion is evident at the apical region, consistent with asymptomatic apical periodontitis.

Following discussion of the treatment options, informed consent was obtained from the patient. Local anesthesia was administered, and tooth #45 was isolated using a rubber dam. An endodontic access cavity was prepared. The working length was established using an electronic apex locator and confirmed radiographically. Considering the immature root and relatively thin dentinal walls, instrumentation was performed conservatively to minimize unnecessary removal of radicular dentin and preserve the structural integrity of the root.

The root canal was irrigated using low concentration sodium hypochlorite, saline and 17% EDTA under controlled conditions. Particular care was taken during irrigation because of the wide-open apical foramen and the potential risk of irrigant extrusion into the periapical tissues. Following canal preparation and irrigation, the root canal was dried with sterile paper points.

Strontium silicate based C-Root BP was selected as the bioactive material for management of the open apex. The material was carefully introduced into the apical portion of the root canal and adapted to establish an apical barrier. The placement was performed under controlled conditions to achieve adequate adaptation to the apical walls while minimizing extrusion beyond the apical foramen.

Radiographic evaluation following treatment demonstrated the presence of the radiopaque root canal filling material extending to the apical region of tooth #45, with satisfactory radiographic adaptation and preservation of the treated root morphology (Figure 2). The remaining root canal space was fully obturated with C-Root BP, and the access cavity was restored to provide an adequate coronal seal.

The postoperative radiograph demonstrated satisfactory treatment of the immature root canal and adequate apical management of open apex (Figure 2).

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Figure 2. Postoperative periapical radiograph of tooth #45 following endodontic treatment. The radiograph demonstrates the treated root canal with radiopaque filling material extending to the apical region and management of the open apex using strontium silicate C-Root BP as a bioactive root canal filling material.

The patient was recalled for clinical and radiographic on 8 months follow-up. Clinical evaluation included assessment of pain, swelling, sinus tract formation, tenderness to percussion or palpation, and tooth function. At follow-up, the patient remained asymptomatic, with no clinical signs of recurrent infection. Tooth #45 remained functional and was not tender to percussion or palpation. Radiographic examination demonstrated satisfactory maintenance of the root canal filling and apical barrier, increase in root length and resolution of lamina dura and periodontal space. Importantly, the periapical radiolucency observed in the preoperative radiograph had resolved completely at follow-up, with restoration of the radiographic appearance of the periapical bone (Figure 3). No new periapical pathological changes were observed.



Figure 3. Follow-up periapical radiograph of tooth #45. The radiograph demonstrates satisfactory maintenance of the root canal treatment and complete resolution of the previously observed periapical radiolucency, indicating favorable periapical healing.

The clinical and radiographic findings indicated a favorable outcome following treatment of the non-vital immature tooth with an open apex using C-Root BP. The complete resolution of the preoperative periapical lesion and increase in root length, together with the absence of clinical symptoms at follow-up, indicated successful periapical healing.

Discussion

The management of non-vital permanent teeth with an open apex remains a challenging endodontic procedure because incomplete root development is associated with thin dentinal walls, a wide apical foramen, and the absence of a predictable apical constriction. These anatomical characteristics increase the difficulty of achieving an effective apical seal and may increase the risk of extrusion of obturation materials and weakening of the remaining root structure. In the present case, tooth #45

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exhibited an immature root with a wide-open apex and a periapical radiolucency associated with pulp necrosis and asymptomatic apical periodontitis. Therefore, treatment was directed toward elimination of intracanal infection and establishment of an effective apical barrier while minimizing additional structural loss.

Apexification remains an established treatment option for non-vital immature teeth because it enables the creation of an apical barrier against which the root canal can subsequently be obturated. The development of strontium silicate-based materials has improved the clinical management of open apices because these materials combine apical sealing ability with favorable biological properties. In the present case, the use of C-Root BP as an apical barrier resulted in a favorable clinical and radiographic outcome, with the patient remaining asymptomatic and complete resolution of the preoperative periapical radiolucency at follow-up. This finding is consistent with contemporary evidence supporting the effectiveness of bioceramic apexification in immature permanent teeth. Anjum et al. reported complete healing or signs of healing in 86.3% of 51 non-vital immature permanent incisors treated with bioceramic apical plugs, with a mean follow-up of 3.3 years. Importantly, their assessment incorporated both clinical symptoms and the Periapical Index (PAI), providing clinically relevant evidence for the use of bioceramic materials in immature teeth. [6]

The favorable periapical response observed in the present case is also consistent with the long-term findings reported by Santos et al. In their case series of non-vital immature permanent teeth treated with apexification using mineral trioxide aggregate, Biodentine, or β-tricalcium phosphate as apical barriers, 62.5% of the teeth fulfilled strict clinical and radiographic healing criteria at recall, while the overall tooth survival rate was 93.8% over a follow-up period of 5–22 years. [4] Although the present case has a substantially shorter follow-up period, the complete resolution of the periapical lesion and absence of clinical symptoms suggest a favorable initial healing response. However, longer-term follow-up is required before conclusions regarding the durability of treatment or long-term survival of the immature tooth can be made.

The clinical outcome observed in this case may be explained, at least in part, by the biological and sealing characteristics of calcium silicate-based materials. Strontium silicate-based cements are widely used in endodontic procedures involving hard-tissue repair and apical barrier formation because of their biocompatibility, bioactivity, strontium-ion release, alkalinizing activity, and ability to promote apatite formation. These characteristics may contribute to the interaction between the material and surrounding periapical tissues and provide a favorable environment for hard-tissue healing. [7-9] In particular, the ability of strontium silicate-based materials to form apatite-like deposits and maintain an alkaline environment has been proposed as an important component of their bioactive behavior. [9]

The resolution of the periapical lesion in the present case should, however, not be attributed solely to the bioactivity of C-Root BP. Successful endodontic treatment is multifactorial and depends on adequate microbial control, effective irrigation, appropriate management of the open apex, apical sealing, and prevention of coronal reinfection. The elimination of intracanal microorganisms is particularly important in necrotic immature teeth because persistent infection is a major determinant of treatment failure. Thus, the favorable outcome observed in this case most likely represents the combined effect of adequate canal disinfection, controlled management of the open apex, effective apical sealing, and an adequate coronal seal.

The selection of a bioceramic apical barrier is also supported by clinical studies comparing different calcium silicate-based materials. Tolibah et al. evaluated MTA and Biodentine as apical plugs in immature permanent molars with apical lesions and found no statistically significant difference in PAI scores between the materials at 6 and 12 months. Both materials were associated with favorable healing of apical lesions, while some Biodentine-treated cases demonstrated formation of an apical calcified barrier. [11] These findings support the concept that calcium silicate-based materials can provide clinically acceptable outcomes when used to establish an apical barrier in immature teeth. The present case extends this clinical concept to the use of C-Root BP, although direct clinical comparisons between C-Root BP and established materials such as MTA or Biodentine are not yet available. The material properties of C-Root BP provide additional support for its consideration as an apical barrier material. A recent in vitro study directly evaluating C-Root BP reported that its dye penetration and bacterial microleakage were not significantly different from those of iRoot BP Plus, while its adhesion strength to dentin was significantly higher than that of iRoot BP Plus. [10] These findings are relevant to the management of an open apex because the ability of an apical material to establish an effective seal and maintain adhesion to dentin is important for preventing communication between the root canal system and periapical tissues. Nevertheless, these findings originate from an in vitro experimental model and should not be interpreted as direct evidence of clinical superiority.

The favorable outcome in the present case may therefore be considered clinically encouraging but should be interpreted cautiously. The complete disappearance of the periapical radiolucency at follow-up indicates a favorable radiographic healing response, but a single case cannot establish the effectiveness or superiority of C-Root BP compared with other bioceramic materials. The primary radiographic outcome demonstrated in this case was resolution of the periapical lesion and maintenance of the treated root canal.

An important consideration in immature teeth is the structural vulnerability of the remaining root. Although apexification can provide predictable apical management, it does not necessarily restore the lost dentinal thickness or promote continued physiological root development. Anjum et al. reported spontaneous root fractures in 9.8% of treated teeth, with all fractured teeth exhibiting very immature root development. [6] This finding emphasizes that successful periapical healing does not necessarily eliminate the long-term risk associated with thin dentinal walls. Consequently, conservative instrumentation and preservation of radicular dentin, as performed in the

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present case, remain important considerations in the treatment of immature teeth.

Regenerative endodontic procedures represent another treatment strategy for immature necrotic teeth and may provide the additional biological benefit of continued root maturation. Systematic evidence has demonstrated that successful regenerative procedures can result in periapical healing and, in a proportion of cases, continued root development. Alghamdi and Alsulaimani reported healing or absence of periapical lesions in 96% of successful regenerative endodontic cases, while 45% demonstrated advanced root maturation. [14] Nevertheless, apexification remains a clinically relevant approach when the primary objectives are infection control, predictable establishment of an apical barrier, and subsequent obturation of the root canal. The choice between regenerative treatment and apexification should therefore be individualized according to the developmental stage of the tooth, extent of infection, treatment objectives, operator expertise, and restorative considerations.

The present case has several limitations. First, this is a single case report and therefore cannot establish a causal relationship between C-Root BP and periapical healing. Second, the follow-up period should be considered when interpreting the outcome, particularly because immature teeth treated with apical barrier techniques may remain structurally vulnerable for many years. Third, the radiographic assessment was based on conventional periapical radiography, which provides two-dimensional information and may not detect subtle three-dimensional changes in periapical tissues. Finally, although the clinical outcome was favorable, the current evidence specifically evaluating C-Root BP in clinical endodontic applications remains limited. The available direct evidence for C-Root BP is currently primarily based on in vitro evaluation of sealing, bacterial microleakage, and adhesion properties. [10]

Despite these limitations, this case provides preliminary clinical evidence supporting the use of C-Root BP as a bioactive apical barrier in the management of a non-vital immature permanent tooth with an open apex and asymptomatic apical periodontitis. The complete resolution of the preoperative periapical lesion and absence of clinical symptoms at follow-up suggest a favorable short-term outcome. Further prospective clinical studies with larger sample sizes, standardized radiographic assessment, and longer follow-up periods are necessary to determine the long-term clinical effectiveness, biological behavior, and survival of immature teeth treated with C-Root BP.

Conclusion

Within the limitations of this case report, the use of strontium silicate containing C-Root BP as a bioactive apical barrier provided a favorable clinical and radiographic outcome in the management of a non-vital immature permanent mandibular second premolar with an open apex and asymptomatic apical periodontitis. The tooth remained asymptomatic and functional during follow-up, while complete resolution of the preoperative periapical radiolucency and increase in root length were observed radiographically. These findings suggest that C-Root BP may be a promising bioactive material for apical barrier formation in immature permanent teeth. However, further clinical studies with larger samples and longer follow-up periods are required to establish its long-term effectiveness and predictability.

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