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Efficacy of Biodentine as an Intraorifice Barrier in a Cracked Tooth with Endo-periodontal Lesions: A Case Report

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This case report highlights the innovative application of Biodentine as an intraorifice barrier in the management of cracked teeth with radicular extension associated with endo-periodontal lesions. A 37-year-old female patient reported pain during chewing on tooth #36. Significant periodontal attachment loss was noted around the mesial root. The tooth was diagnosed with pulp necrosis. Upon endodontic access, a vertical crack extending into the mesial canal walls was observed. Root canals were identified and shaped using rotary instruments. Calcium hydroxide was placed as an intracanal dressing. After one week, the patient returned without inflammatory signs. The root canals were filled with gutta-percha and bioceramic cement. Biodentine repair cement was applied 2.0 mm beyond the orifice to seal and reinforce the area. The endodontic access cavity was restored with composite resin. Clinical and radiographic follow-ups at 12 months revealed significant periapical healing and the absence of inflammatory signs. A radiographic and computed tomography scan at 48 months confirmed substantial bone repair and continued tooth functionality. The intraorifice barrier with Biodentine demonstrated notable effectiveness, aligning with literature on its benefits. The protocol, integrating modern techniques and timely restoration, shows promise in managing cracked teeth with root extension, enhancing tooth preservation in complex cases.

Keywords: Biodentine; Biomaterial; Case Report; Cracked Tooth Syndrome; Root Canal Therapy

Introduction

Cracked teeth (CT) are often not identified until the pain becomes unbearable. They are characterized by the presence of crack lines with uncertain direction, which can cross the tooth structure, ultimately reaching the pulp cavity and/or the periodontal space [1]. In dental practice, this condition has presented a significant challenge [2, 3]. Although the definition of CT remains unclear, the treatment of these cases still lacks consensus in the dental community [4], especially when the cracks extend into the root and are associated with periodontal pockets [5]. Current protocols suggest that early and appropriate intervention can result in satisfactory survival and success rates [3-5].

The choice of intervention for the treatment of CT usually depends on the location and extent of the fractures, the pulp condition, and the factors that directly influence the prognosis [2, 4]. However, the presence of crack lines with root extension, associated with periodontal pockets, significantly increases the risk of tooth loss [5]. This negative impact may be related to the biofilm colonization of the cracks [6], which can lead to the development of endo-periodontal lesions [7]. Therefore, the unpredictability of these cases has led to disagreements regarding the best therapeutic approach [5, 8].

However, to increase treatment predictability, new protocols have been proposed [9-12]. Recently, the use of Biodentine hydraulic restorative cement has been suggested as an alternative for the management of CT extending to the root [13]. Although the evidence is still preliminary, treatment using an intraorifice barrier based on Biodentine has shown promise for the prognosis of these teeth [13].

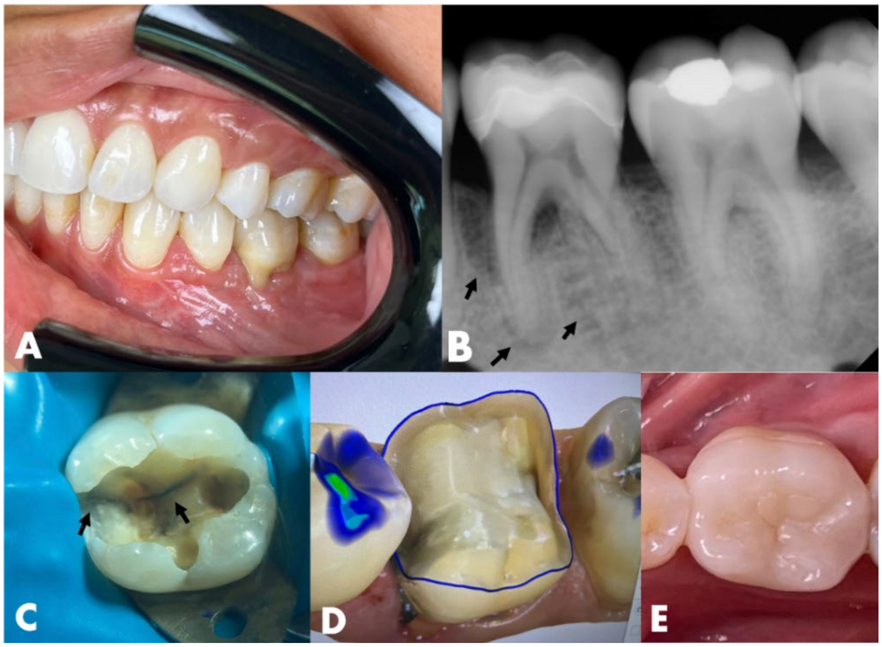

Figure 1. Initial appointment: *A)* A ceramic onlay restoration was noted for its excellent marginal fit and esthetic adaptation; *B)* The periapical radiograph indicated the presence of three roots, suggesting a Radix Entomolaris and apical hypodensity in the mesial root, including a discreet radiolucent area in the furcation region; *Past History: C)* Clinical images revealed mesio-distal crack originating at the mesial marginal ridge and extending distally; *D & E)* The tooth received an adhesive onlay restoration which was fabricated using CAD-CAM System (computer-aided design/computer-aided manufacturing technology)

Biodentine, composed mainly of calcium trisilicate, is widely employed in vital pulp therapies, retrograde filling, resorptions, perforations, incomplete root development, and as a dentine substitute [14]. Its effectiveness is due to the release of calcium ions, which interact with the dentinal tubules and promote the formation of a dentine bridge [15]. Thus, the use of Biodentine reparative cement as an intraorifice barrier represents a promising alternative for the management of CT with radicular extension and associated endo-periodontal lesions.

This case report details the successful treatment of a cracked mandibular molar, emphasizing the clinical procedures employed that may enhance treatment outcomes. By combining this innovative material with modern techniques such as operative magnification and timely restoration, dental practitioners can improve the predictability and success rates of treatments for complex cases.

Case Report

A 37-year-old, white female patient with no history of comorbidities or significant family history was referred to the endodontics clinic for evaluation, diagnosis, and treatment planning of tooth #36, according to the Federation Dentaire Internationale (FDI) notation.

During the consultation, the patient reported pain when chewing and visual loss of the conjunctival insertion in the buccal region of the mesial root (Figure 1A). Horizontal and vertical percussion tests indicated pain, and pulp sensibility tests using the Frigi-Dent thermal device (Ellman International, Hicksville, USA) and the Digitest electric device (Parkell, Edgewood, USA) revealed negative responses to the stimuli, indicating the possibility of pulp necrosis. Additionally, periodontal mapping revealed a probing depth of more than 5 mm on the mesial and buccal surfaces. On clinical inspection, tooth #36 had an adhesive restoration with good adaptation and excellent aesthetics. Three roots were observed in radiographic examination, suggesting a radix entomolaris and apical hypodensity in the mesial root, including a discreet radiolucent area in the furcation region (Figure 1B).

The patient's dental history was contributory. According to the patient, her general dentist had previously noted the presence of a crack originating at the mesial marginal ridge and extending distally (Figure 1C). During that time, tooth #36 had no spontaneous symptoms and a positive response to pulp sensibility tests. Given this scenario, the general dentist decided to protect the pulp with Riva self-cure glass ionomer cement (SDI, Melbourne, Australia) and temporarily seal the cavity. After a week, in the absence of pain, the tooth was prepared (Figure 1D) and received an adhesive onlay restoration to ensure crack stabilization and protect the tooth from occlusal forces.

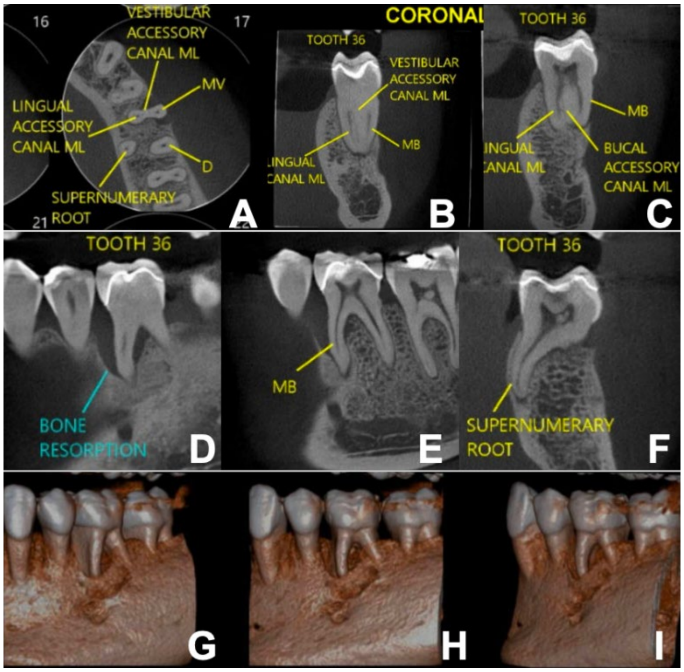

Figure 2- *A,B, C, F*) Tomographic sections confirmed that tooth#36 had three roots: one mesial with three root canals, one distal and one supernumerary on the lingual side ("radix entomolaris"); *D, E*) Alveolar bone resorption was observed adjacent to the mesiobuccal and distobuccal surfaces of the cervical and middle thirds of the mesial root; *G, H, I*) Digital reconstruction of the images.

Initially, a cone-beam computed tomography (CBCT) scan was requested for a more detailed assessment of the clinical and radiographic findings. The tomographic sections confirmed that tooth #36 had three roots, one of which was supernumerary in lingual ("radix entomolaris"), with a total of five root canals, two of which were located in its mesial root. Bifurcation of the mesiolingual canal was observed in the cervical third, with intercanals between the ramifications. The buccal branch of the mesiolingual canal ended in a mesial foramen. The mesiobuccal canal ended in a distal foramen. The presence of pulp stones inside the pulp chamber was observed, including a periapical lesion associated with the mesial and supernumerary roots. There was also alveolar bone resorption adjacent to the mesiobuccal and distobuccal faces of the cervical and middle thirds of the mesial root, associated with resorption of the buccal cortical bone in the area. No image compatible with root fracture was found (Figures 2A–2I).

The findings and the guarded prognosis were explained to the patient, and her informed consent for the procedures was obtained.

The endodontic treatment procedure was performed, maintaining an onlay restoration as suggested by de Toubes *et al.* [3]. All procedures were carried out under magnification using a clinical microscope (DF Vasconcelos, São Paulo, Brazil).

The patient was anesthetized with an inferior alveolar nerve block using 4% articaine with epinephrine, 1:200,000 (DFL, Rio de Janeiro, Brazil), followed by isolation of the operating field with a Hygenic rubber dam (Coltene, Altstätten, Switzerland). A Top Dam gingival barrier (FGM, Joinville, Brazil) was employed to better seal the access cavity. A minimally invasive access was made through the restoration using a high-speed 1019 diamond drill (KG Sorensen, Cotia, Brazil). After this stage, the presence of the crack on the floor of the pulp chamber was confirmed.

After abundant irrigation with 2.5% sodium hypochlorite (Lenza Pharma, Belo Horizonte, Brazil), the five root canal orifices were identified. Initial exploration up to the estimated root length was performed with a #10 C-Pilot file (VDW, Munich, Germany), followed by preparation of the initial two-thirds of the canal with the same file system selected for instrumentation (Race Evo 4%, Dentaire, La Chaux-de-Fonds, Switzerland). Patency length was achieved through catheterization movements, combined with copious irrigation with 2.5% sodium hypochlorite. The working length was established with the aid of a Root ZX2 electronic apex locator (J Morita, Osaka, Japan) and periapical radiographs (Figure 3A).

The chemomechanical preparation of the canals was conducted using the Race Evo 4% rotary system (FKG Dentaire, La Chaux-de-Fonds, Switzerland), along with irrigation by 25 mL of sodium hypochlorite and final irrigation with 3 mL of 17% ethylenediaminetetraacetic acid (Lenza Pharma, Belo Horizonte, Brazil). The irrigating solutions were activated with the Irrisonic insert (Helse, Santa Rosa do Viterbo, Brazil), applying three interspersed cycles of 30 sec for each solution, followed by a final irrigation with 2 mL of distilled water. The root canals were dried with cell pack absorbent paper tips (Tanari, Boa Vista, Brazil), and the root extension of the crack in the mesiobuccal canal was verified.

Using magnification, the root extension of the crack was measured from the canal orifice to the most apical point. This measurement was carried out using a Hu-Friedy periodontal probe (Hu-Friedy, Chicago, USA) with transillumination placed externally to the clamp wing [10, 14].

Finally, the root canals were filled with UltraCal SX calcium hydroxide paste (Ultradent, Utah, USA) and the access cavity was temporarily restored with Filtek Z350 composite resin (3M ESPE, São Paulo, Brazil).

After 14 days, with the absence of clinical signs and symptoms, the tooth was accessed again. The intracanal dressing was removed using the ultrasonic agitation protocol of the irrigating solutions. The canals were obturated using AH-Plus Bioceramic endodontic cement (Dentsply Sirona, Charlotte, USA) and gutta-percha cones (Ultimate Dental, Tennessee, USA).

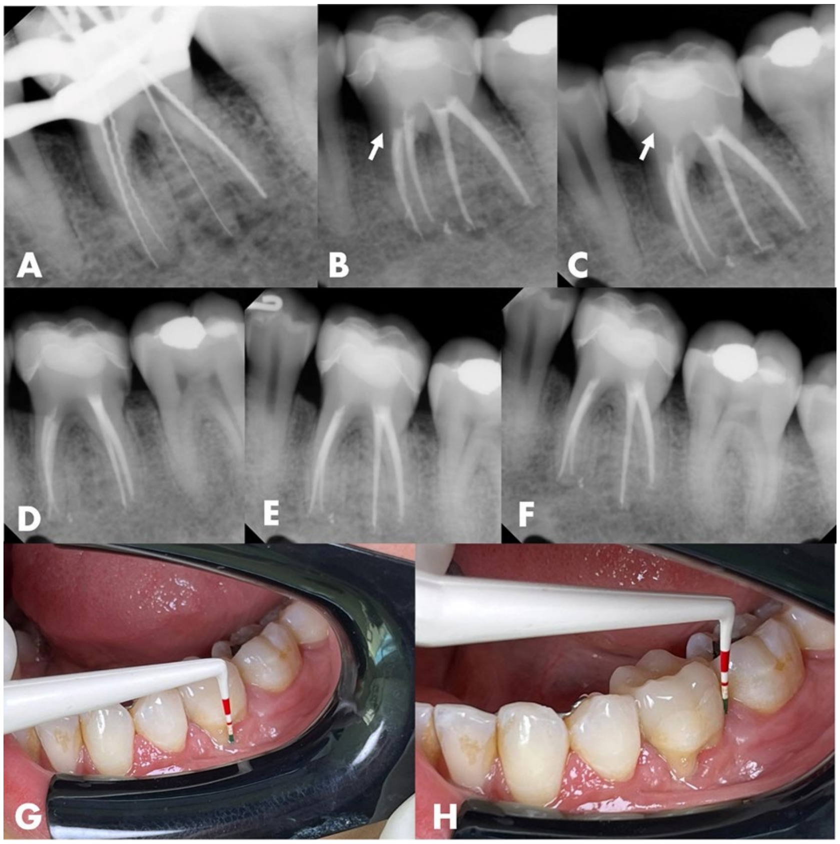

Figure 3. *A*) The working length was established; *B, C*) Post-treatment radiographs taken from various angles illustrate the adaptation of the intraorifice barrier (arrow) and the Biodentine core (arrow); *D-F*) After one year, the images reveal significant tissue repair in the alveolar bone and the integrity of periradicular tissues; *G, H*) Along with the resolution of the periodontal pocket during clinical evaluation

The filling material of the mesial canals was carefully removed 2 millimeters beyond the most apical point of the previously identified crack. The canal walls were cleaned with an ultrasonic insert, followed by drying with absorbent paper tips.

For the intraorifice barrier, the protocol described by Toubes *et al.* [13] was followed. A capsule of Biodentine™ (Septodont, Saint-Maur-des-Fossés, France) was mixed with five drops of liquid for 30 sec in an amalgamator operating at 4,200 revolutions per min. The material was transferred to a sterile glass plate and then inserted into the root canal using an MTA carrier (Angelus Odontologia, Londrina, Brazil) until it reached the most apical point of the crack. The Biodentine was adequately condensed to form a dense intraorifice barrier.

After an initial setting time of 15 min, the cavity was cleaned with distilled water, and the remaining walls were prepared with a multilaminate drill to qualify the dentin for receiving the adhesive system. Using a microbrush applicator (FGM, Joinville, Brazil), a layer of Clearfil SE Bond primer (Kuraray, Tokyo, Japan) was actively applied for 20 sec over the Biodentine. A gentle air drying was then applied. Next, a thin layer of Clearfil SE Bond (Kuraray, Tokyo, Japan) was applied. The excess material was removed with an endodontic suction tip, and it was light cured for 20 sec with a Valo light source (Ultradent, Utah, USA). Horizontal layers of Z 350 resin composite (3M ESPE, São Paulo, Brazil) were incrementally applied until the access cavity was completely sealed (Figures 3B-3C).

Occlusal contacts were adjusted in centric and lateral positions. The patient was provided additional guidance, including the recommendation to wear an occlusal plate at night to control possible parafunctions. During follow-up visits, clinical, radiographic, and tomographic evaluations of the tooth were done. The follow-up appointments were scheduled for 3, 6, and 12 months. At the 12-month appointment, clinical and radiographic examination revealed healing of the periapical tissues, with no clinical signs of inflammation (Figures 3D-3H).

After 48 months, radiographic and CBCT examinations were performed, which confirmed the repair of the alveolar bone adjacent to the mesial root, as well as complete healing of the periradicular tissues (Figures 4A-4F). In addition to the satisfactory images provided by the exam, the tooth was fully functional, with no reported complaints from the patient.

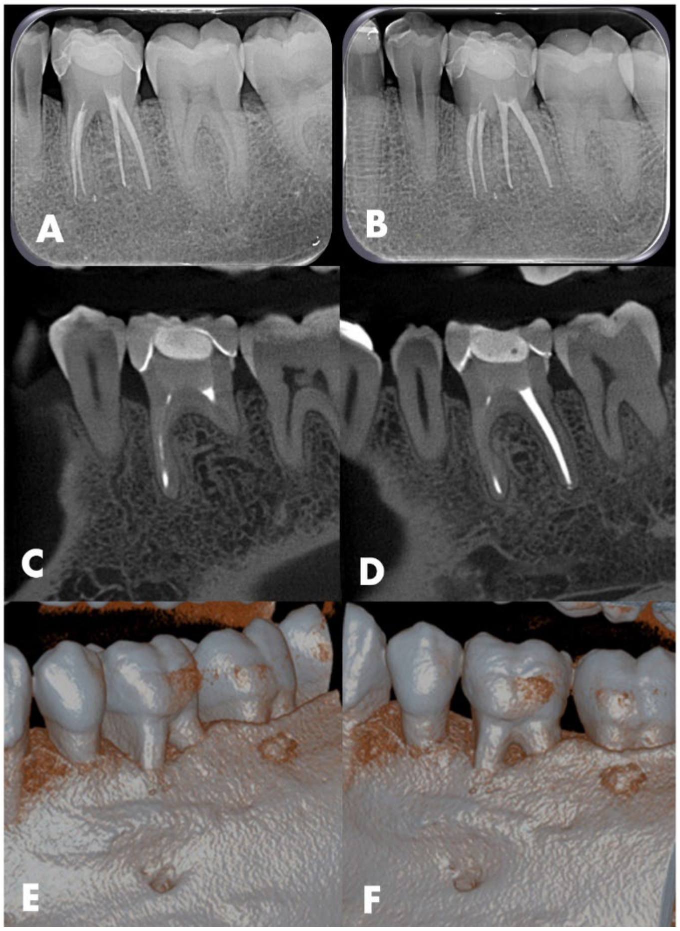

Figure 4. 48-month follow-up: *A, B*) Periapical images; *C, D*) Sagittal CBCT sections demonstrate substantial bone repair adjacent to the mesial root; *E, F*) The rendered images further illustrate the increase in alveolar bone following the healing process

Discussion

The scientific literature provides evidence that root-extended fractures can be rehabilitated, with high success and survival rates [3, 8, 9]. However, recognizing that these teeth face a significantly higher risk of extraction compared to those with fractures restricted to the coronal region is crucial [5, 8]. Furthermore, the presence of periodontal pockets can aggravate this situation, further reducing the survival rates of the affected teeth [5]. Therefore, the search for innovative therapeutic approaches that maximize the chances of preserving these teeth is not only desirable but essential to guarantee the clinical success and longevity of the treatments.

Among the treatment options available, the intraorifice barrier stands out for its superior properties compared to conventional filling materials, especially concerning marginal sealing, fracture resistance, and bacterial infiltration [16]. In this context, bioceramic and composite cements have proved to be predictable options for clinical use [9, 11, 13]. In CT with root extension, the efficacy of the intraorifice barrier was shown in studies performed by Malentacca *et al.* [11] and Davis and Shariff [9], who used flowable resins and achieved impressive survival rates of 53% in 5 years and 96.6% in 4 years, respectively.

A recent systematic review with meta-analysis demonstrated that hydraulic repair cements offer additional advantages to composites [17]. Biodentine stands out among calcium silicate-based restorative cements for its superior mechanical properties, which is a result of its micromechanical bond with dentin [18]. With a hardness coefficient similar to that of dentin, it is effective in dentin replacement [16] and, when used as a core filling or in sandwich restorations, has a performance comparable to traditional materials [19].

In a preliminary prospective study, De Toubes *et al.* [13] implemented the intraorifice barrier technique using Biodentine hydraulic restorative cement in twelve root-extended CT. Clinical and radiographic follow-up, conducted over 1 to 3 years, revealed an impressive 100% survival rate. This study not only highlighted the effectiveness of the protocol but also emphasized the importance of carrying it out under strict conditions: all the interventions were carried out by a single experienced operator, using operative magnification and meticulous control by means of computed tomography scans. These factors give an extraordinary solidity to the results, reinforcing the adoption of this innovative approach in clinical practice.

A crucial factor that may have contributed to the success of the reported case was the haste with which the tooth received an adhesive restoration with cusp protection. Early bracing with a full crown or onlay is associated with a better survival rate [3]. Furthermore, the use of computer-aided design/computer-aided manufacturing technology contributes significantly to the maintenance of these teeth, as it speeds up the rehabilitation process [20].

The primary limitation of this study is its case report nature, which offers a lower level of scientific evidence. Nonetheless, it aligns with existing literature by employing an innovative protocol. Case reports are vital for generating hypotheses and research questions. Therefore, further studies are needed to assess the efficacy of Biodentine as an intraorifice barrier and develop robust methodologies that contribute to evidence-based dentistry. Additionally, exploring its long-term effectiveness in various clinical scenarios is essential for improving dental preservation strategies and patient care.

Conclusion

This case report highlights the significant potential of Biodentine restorative cement as an intraorifice barrier for managing root-extended cracked teeth associated with endo-periodontal lesions. The integration of advanced techniques, such as operative magnification and computer-aided design/computer-aided manufacturing technology, further optimized treatment outcomes. Comprehensive clinical, radiographic, and tomographic follow-ups demonstrated remarkable repair of periradicular tissues and sustained functionality of the tooth, underscoring the effectiveness and reliability of the adopted protocol. These findings not only validate the therapeutic approach but also pave the way for innovative strategies in the treatment of similar dental conditions in clinical practice.

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Conflict of interest

None.

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Authors' contributions

Conceptualization: KMPST/GHS/FFS, Case report: KMPST, Formal Analysis and Investigation: KMPST/GHS, Writing-Original draft preparation: KMPST /FFS/ALBA/GHS/PSR, Writing-review and editing: KMPST /FFS/GHS/ PSR, Supervision: KMPST /FFS. All authors read and approved the final manuscript.

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