***Case report***

**Clinical effectiveness of magnification in managing calcified canals and immediate definitive restoration: a case report**

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**ABSTRACT**

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| Pulp canal calcification represents a significant challenge in endodontics, marked by progressive obliteration of the canal lumen that complicates localization, negotiation, and effective disinfection. This case report presents a clinical protocol applied to a maxillary molar with severe calcification in the orifice portion of the mesiobuccal canal. Using high-magnification operating microscopy and ultrasonic instrumentation, the canal orifice was successfully located and instrumented. An immediate definitive restoration was performed to optimize the coronal seal and reduce the risk of microleakage and reinfection. The treatment followed a structured, stepwise approach incorporating current technological resources and evidence-based procedures, including selective dentin removal, glide path creation, and adhesive restorative techniques. Treatment involved three clinical sessions, with initial preparation of the distobuccal and palatal canals using manual and rotary instruments, followed by location and negotiation of the calcified mesiobuccal canal using ultrasonic tips and C-Pilot files under magnification, intracanal medication with calcium hydroxide, and final obturation by lateral condensation. Restoration included hybrid adhesive protocols and cusp reconstruction to ensure long-term seal and mechanical stability. This approach allowed for preservation of tooth structure and favorable prognosis in a complex anatomical scenario. The case emphasizes the importance of clinician expertise, customized access design, and timely restoration to reduce the risk of procedural complications. It highlights the need for adaptable, case-specific strategies in managing calcified canals to support predictable outcomes and long-term clinical success.  **Keywords:** Case Reports; Clinical Protocols; Dental Restoration, Permanent; Pulp Canal Obliteration; Ultrasonics |

**1. INTRODUCTION**

Pulp canal calcification is a condition characterized by progressive deposition of hard tissue within the root canal space in response to irritative stimuli, which may lead to partial or complete obliteration of the canal path [1]. In severe cases, no trace of the canal lumen is detectable in periapical radiographs [2].

This phenomenon is also described as dystrophic calcification, diffuse calcification, or calcific degeneration, depending on the trauma's severity and the root’s developmental stage [1]. Once established, this condition poses a frequent clinical challenge, complicating the location, instrumentation, and proper disinfection of the obliterated canals.

Chaniotis and Ordinola-Zapata [3] proposed a protocol involving thorough preoperative assessment, customized access design, and careful exploration of the chamber using magnification and coaxial illumination. Their approach includes ultrasonic tips and long-shank burs for calcification removal, glide path creation, and shaping with flexible, fatigue-resistant files. However, pulp chamber anatomy is dynamic and changes with age [4], making these steps more technically demanding.

This anatomical variability hinders the development of rigid clinical protocols, given the broad spectrum of presentation. Therefore, reporting clinical cases and techniques that illustrate the use of available tools in complex scenarios is essential, as it highlights both their advantages and limitations.

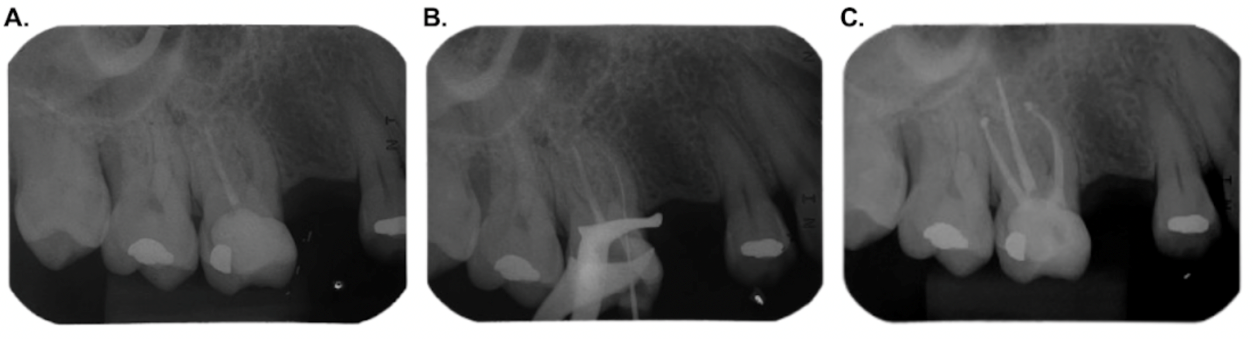
Thus, this case report presents the management of a maxillary molar with calcified canal orifices, outlining the clinical strategy employed and the outcomes achieved.

**2. PRESENTATION OF CASE**

***Case description***

A 44-year-old male patient, normosystemic, on-smoker, and non-drinker, presented to the dental clinic at the University of Fortaleza seeking treatment. During the anamnesis, he reported a family history of cancer and no comorbidities. Clinical examination revealed missing teeth, the need for extractions, periodontal treatment, restorations, and prosthetic rehabilitation. The patient was referred to the university’s Integrated Clinical Care Program within the undergraduate curriculum to address these needs.

At the subsequent appointment, following full-mouth periodontal scaling, the panoramic radiograph was re-evaluated, revealing incomplete endodontic treatment in tooth #16. Given the complexity of the case, the patient was referred to the clinical discipline of the Master's Program in Dentistry at University of Fortaleza. Pulp vitality tests, as well as vertical and horizontal percussion tests, yielded negative results, confirming pulp necrosis. No other clinical signs, such as associated abscess or sinus tract, were observed. A periapical radiograph focused on tooth #16 was then obtained (**Figure 1A**).



**Figure 1.** Periapical radiographs obtained throughout the endodontic treatment using Kodak F-speed periapical radiographic film (Carestream, Rochester, USA). A. Baseline radiograph taken during the re-evaluation appointment. B. Working radiograph used to confirm the location of the mesiobuccal canal. C. Immediate postoperative radiograph following root canal obturation.

Radiographic assessment of tooth #16 revealed an extensive coronal restoration. The palatal canal had been previously obturated, while the mesiobuccal (MB) and distobuccal (DB) canals exhibited narrowing, with no signs of instrumentation or obturation. Their radiographic appearance was consistent with partial calcification. The periodontal ligament and lamina dura appeared intact, with no evidence of periapical radiolucency, corroborating the absence of clinical signs of inflammation.

***Session I***

Following clinical and radiographic re-evaluation, partial removal of the existing restoration was performed using a #1014 round bur (Microdont, São Paulo, Brazil), enabling access to the pulp chamber. Rubber dam isolation was then applied, and canal exploration was initiated. The palatal and DB canals were initially located. Due to resistance encountered during negotiation of the DB canal with a 21 mm #10 K-file (Dentsply Maillefer, Ballaigues, Switzerland), #08 and #10 C-Pilot files (VDW, Munich, Germany) were employed. Working length (WL) was determined to be 19 mm.

Canal preparation was initiated with manual Flexofile instruments (#15, #20, #25; 25 mm, Dentsply Maillefer), and completed with a conventional R25 file (25 mm, VDW, Munich, Germany) attached to the Sensory endodontic motor (Schuster, Santa Maria, Brazil). The canal was irrigated thoroughly with 2.5% sodium hypochlorite (NaOCl), filled with UltraCal XS (Ultradent Products Inc., South Jordan, USA), and sealed with a temporary restoration of Bioplic (Biodinâmica, Ibiporã, Brazil).

***Session II***

At the following appointment, the temporary restoration and intracanal medication were removed through copious irrigation with 2.5% sodium hypochlorite (NaOCl). Rubber dam isolation was then applied, and exploration of the MB canal was initiated. Residual resin material was removed using round burs to improve access. Due to difficulty in locating the canal, enhanced visualization was achieved using an operating microscope (Unique, Alliance Comercial de São Carlos Ltda., São Carlos, Brazil), which improved assessment of the internal anatomy.

Selective dentin removal was performed at the suspected MB canal orifice using an E2 ultrasonic tip (Helse, Santa Rosa de Viterbo, Brazil) coupled to the Sonic Evo LED unit (Schuster, Santa Maria, Brazil). After careful refinement of the pulp chamber floor, a distinct drop was noted, consistent with canal entry. Canal location was confirmed radiographically using a #10 C-Pilot file (21 mm; VDW, Munich, Germany) **(Figure 1B**).

WL was established at 20 mm. Instrumentation followed the same protocol as in the previous session. After abundant irrigation, the canals were medicated with UltraCal XS (Ultradent Products Inc., South Jordan, USA), and the access cavity was sealed with Bioplic (Biodinâmica, Ibiporã, Brazil).

***Session III***

At the final appointment, rubber dam isolation was established. After removal of the temporary restoration and intracanal medication, copious irrigation with 2.5% sodium hypochlorite (NaOCl) was performed. The canals were dried with #25 paper points (MK Life, Porto Alegre, Brazil). The MB and DB canals were obturated using lateral condensation technique with Paiva spreaders numbers 2 and 4 (Golgran, São Paulo, Brazil), single Medium gutta-percha cones (Odous de Deus, Belo Horizonte, Brazil), and AH Plus resin-based sealer (Dentsply Sirona, Bensheim, Germany) (**Figure 1C**). To minimize reinfection and reduce the risk of coronal fracture, immediate definitive restoration was performed with a direct technique, as the sealer was compatible with adhesive procedures.

The access cavity was cleaned with pumice paste and distilled water, followed by alcohol-soaked cotton. A small increment of Riva Light Cure glass ionomer restorative (SDI Limited, Bayswater, Australia) was applied exclusively over the canal orifices. After spatulation on a glass plate, the material was placed using a #2 Precision Straight Needle tip (Maquira Dental Group, Maringá, Brazil) attached to a Centrix syringe (Nova DFL, Rio de Janeiro, Brazil) and light-cured for 40 seconds with a Radii-Cal CX curing unit (SDI Limited, Bayswater, Australia).

Phosphoric acid etching (37%) (FGM Dental Group, Joinville, Brazil) was applied for 30 seconds on the remaining enamel, and for 20 seconds on the ionomer base, residual resin, and internal cavity walls. It was then rinsed thoroughly with air-water spray for 30 seconds and gently air-dried for 10 seconds. Silane coupling agent (Silano Prosil, FGM Dental Group, Joinville, Brazil) was applied to the residual restoration surfaces and left to act for 1 minute. Hybridization was performed by active scrubbing with 3M™ Single Bond Universal adhesive (Solventum Corporation, Maplewood, USA), followed by 40 seconds of light curing.

The 3M™ Filtek™ Bulk Fill Flowable Restorative resin (Solventum Corporation, Maplewood, USA) was injected into the cavity to reinforce the seal and regularize the cavity floor, then light-cured for 40 seconds after a single 4 mm increment. The cusps were reconstructed with Empress Direct dentin A3 (Ivoclar Vivadent, Zurich, Switzerland) and enamel A3 (Ivoclar Vivadent, Zurich, Switzerland) resins. Shade selection was performed prior to the endodontic procedure. Each increment was light-cured for 20 seconds, with a final curing for 40 seconds. Occlusal adjustment was completed by selective wear guided with carbon paper using FF and KG Sorensen diamond burs (Cotia, São Paulo, Brazil), followed by polishing with Enhance flame and disc-shaped polishers (Dentsply Sirona, Charlotte, USA).

The patient received oral hygiene instructions and was informed about the need for follow-up and re-evaluation of the endodontic treatment after six months. The patient was then referred back to the original clinic to continue the remaining treatment plan, including restoration reassessment and adjustment.

***Follow-Up***

Treatment sessions were scheduled at an average interval of seven days. The patient was contacted by phone the day after each intervention; no discomfort or symptoms were reported at any time. After seven months, clinical re-evaluation revealed no adverse events and confirmed clinical success.

**3. DISCUSSION**

Calcified root canals remain a significant challenge in modern endodontics due to the difficulty in locating, instrumenting, and disinfecting obliterated pathways. In this case, the successful outcome was achieved by combining established principles with advanced techniques such as operating microscopy, ultrasonic tips, and reinforced dental materials, which contributed significantly to managing the anatomical complexity encountered. While cone beam computed tomography could have enhanced preoperative assessment, treatment was successfully completed without it due to limited patient access, illustrating feasibility in resource-constrained settings.

MB canals in maxillary molars are often hard to access, particularly when calcified near the orifice. Their identification necessitated magnification and the selective removal of dentin using ultrasonic tips. Research shows that operating microscopes enhance detection rates of additional canals [5–6]. When properly used, ultrasonic tips aid in selective dentin removal and reduce uninstrumented surfaces, though they require more time and carry a higher risk of cracks and roughness [7–8]. Identifying the appropriate site for dentin removal is important because errors can lead to canal deviation or perforation. Darker dentin generally marks the onset of calcification and the probable canal entry.

Optical magnification through loupes or microscopes represents a vital advancement in dentistry by improving diagnostic accuracy, procedural predictability, and ergonomics. However, its effectiveness relies heavily on operator experience; less experienced clinicians may face a higher risk of iatrogenic damage, especially with advanced techniques like guided endodontics. Therefore, adequate training is essential to ensure safety and maximize clinical benefits [9–10].

Coronal microleakage is well-known to compromise endodontic success, making coronal sealing paramount. Without a proper seal, microorganisms and metabolites can infiltrate the filled canal, leading to periapical pathology [11]. Thus, effective coronal sealing with suitable materials, both between appointments and immediately following obturation, is critical to prevent complications.

Composite resin is a safe and effective restorative option for endodontically treated teeth [12], closely mimicking the mechanical properties of dentin, which is often compromised in such treatments. Additionally, it requires less tooth reduction than ceramic restorations [13–15]. There is ongoing debate regarding whether definitive restoration should be placed immediately after obturation or postponed using temporary materials. Immediate restoration requires biocompatibility between the restorative material and the obturator, as demonstrated here with resin cement [16]. Adequate occlusal sealing is crucial because temporary restorations delay this and may endanger treatment integrity. However, the resinous temporary material used enhanced wall sealing and reduced fracture risk between sessions.

Timely post-endodontic restoration is essential to minimizing the risks of reinfection, structural cracks, and fractures. Sadaf [17] demonstrated that teeth restored within 14 days exhibited the highest survival rates over eight years. Delays of 15–59 days increased extraction risk by 25% (HR 0.25), and delays over 60 days by 73% (HR 0.73). Kaynar, Dincer, and Donmez [18] found that immediate restorations using bulk-fill and nanohybrid composites enhance fracture resistance, reinforcing the importance of rapid and effective sealing, as applied in this case.

Opting for immediate definitive restoration after obturation reflects a contemporary, evidence-based approach that minimizes contamination, preserves coronal seal integrity, and reduces structural risks. The restorative protocol applied here aligns with standards of excellence and supports long-term clinical success and patient-centered outcomes.

**4. Conclusion**

This case report demonstrates that meticulous clinical planning, precise execution, and modern technology can overcome challenging conditions such as calcified canals. This approach improves prognosis and preserves teeth previously considered untreatable, showcasing the capacity of contemporary endodontics to transform complex cases into predictable successes.

**Consent**

All authors declare that written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editorial office/Chief Editor/Editorial Board members of this journal.

**Ethical approval**

All authors hereby declare that all have been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki. This case report was submitted to the local ethics committee and received approval under protocol number 7.678.530.

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Author(s) hereby declare that generative AI technologies such as Large Language Models have been used exclusively for grammar correction during the writing or editing of this manuscript. The tool was not used to generate scientific content, data analysis, or interpretation.

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1. Name of the tool: ChatGPT
2. Version/model: GPT-4 (OpenAI)
3. Purpose of use: Grammar and language refinement only; no scientific content was generated or modified.

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