WHIOCE PUBLISHING PTE. LTD.
PROVIDING
FIRST-CLASS SCIENTIFIC INFORMATION
FOR TOP SCHOLARS

2026 Volume 11, Issue 2
Advances in Precision Medicine
ISSN: 2424-9106 (Online)
ISSN: 2424-8592 (Print)

Exploration of the Improvement of the Technique of Calced Root Canal Dilation in the Treatment of Root Canal

Kai Shi*
School of Stomatology, North China University of Science and Technology, Tangshan 063000, Hebei, China

**Author to whom correspondence should be addressed.*

Abstract: Root canal calcification is a common and challenging issue in the clinical diagnosis and treatment of dental pulp diseases, closely associated with factors such as age, chronic inflammation, and trauma. This leads to narrowing or obstruction of the root canal, making the procedure more difficult to perform and increasing the risk of complications, thereby reducing the success rate of treatment. Based on clinical practice, this study aims to improve traditional techniques for calcified root canal treatment by addressing limitations such as restricted visibility and rough manipulation. The improvements are made in four dimensions: instrument selection, operational techniques, auxiliary technologies, and process optimization. By refining operational protocols and technical details, the study seeks to reduce the risks of root canal treatment, enhance the success rate, and provide practical references for managing complex calcified root canals, thereby contributing to the overall quality of root canal therapy.

Keywords: root canal therapy; calcified root canal; debridement techniques; microendodontic root canal; modified application

Online publication: February 26, 2026

1. Introduction

Dental pulp disease is one of the common conditions in dentistry, significantly impairing patients' oral function and quality of life. If left untreated, pulp infection may progress to periapical disease, leading to pain, occlusal dysfunction, and even premature tooth loss, resulting in substantial physiological and psychological burdens. Epidemiological studies indicate a high prevalence of pulp-periapical lesions, with the need for re-treatment related to chronic periapical periodontitis increasing annually. In clinical practice, chronic pulp damage, reparative dentin accumulation, and mineral deposition within the root canal can easily cause partial or complete calcification of the root canal, manifesting as concealed root canal orifices, narrowed canal passages, and closed apical foramina. Conventional root canal preparation methods often fail to accurately determine the root canal course or establish a patent pathway, prolonging treatment time and increasing the risk of complications such as excessive tooth structure removal and root canal perforation.

2. Clinical characteristics of calcified root canals and limitations of traditional canal preparation techniques

2.1. Clinical classification and core diagnostic challenges of calcified root canals

In clinical practice, calcified root canals are typically classified into three types based on the degree and location of calcification: root canal orifice calcification, mid-canal calcification, and apical calcification. Each classification presents distinct clinical manifestations and diagnostic challenges[1]. Root canal orifice calcification is commonly observed in elderly patients or those with chronic pulpitis, where the calcified layer at the pulp base thickens, completely obscuring the root canal orifice. Conventional probe examination often fails to locate the orifice, posing the primary challenge in canal preparation. Mid-canal calcification typically manifests as intermittent narrowing of the root canal lumen, with a tortuous pathway and highly rigid calcified tissue that obstructs instrument access. Forced preparation may deviate from the original canal course. Apical calcification frequently leads to apical foramen occlusion, making precise measurement of working length difficult. During preparation, it may form a root canal step, potentially damaging periapical tissues.

2.2. Core limitations of traditional calcified root canal treatment

Traditional calcified root canal treatment heavily relies on the physician's experience. Conventional manual file exploration has significant drawbacks, making it inadequate for complex cases. Without microscopic equipment during the procedure, the visual field is limited, and it is difficult to distinguish calcified tissue from dentin with the naked eye, leading to blind cutting or even perforation of the root canal wall. Physicians often use only standard K files and H files, lacking specialized instruments, resulting in suboptimal cutting performance and low efficiency. The rough manipulation techniques, such as forced advancement and repeated lifting, contradict the minimally invasive principle, often causing step formation and lateral perforation, which damage the root canal structure. The absence of auxiliary softening techniques further complicates the treatment, as mechanical methods alone cannot effectively address calcified tissue, leading to a low success rate in root canal treatment.

3. Core principles and instrument optimization for improved calciumized root canal access techniques

3.1. Core principles and practical approach of the improved technique

The improvement of calciumized root canal access techniques adheres to the core principles of "minimally invasive precision, step-by-step progression, and multi-technique combination," moving away from the traditional extensive operational model. The primary objectives are to preserve the original anatomical structure of the root canal, reduce the incidence of complications, and enhance the efficiency of access. In practice, the procedure follows the approach of "first localization, then softening, followed by access." Imaging and microscopic equipment are utilized to precisely determine the course and extent of the calcified root canal, clarifying the access pathway. Chemical agents are employed to soften the calcified tissue, reducing resistance to instrument access. Subsequently, appropriate instruments are selected for meticulous access, with strict control over the force and depth of operation throughout to prevent excessive cutting[2]. Personalized plans are developed based on the degree of calcification, curvature of the root canal, and dental position characteristics. Operational details are adjusted according to different types of calcified root canals to achieve precise and individualized access techniques, ensuring both safety and efficacy of the procedure. This approach makes the entire process of calciumized root canal access more scientific and rational.

3.2. Selection, improvement, and appropriate use of instruments for canal preparation

The choice of instruments significantly impacts the efficiency and quality of calcified root canal preparation, thereby altering the outcomes of canal preparation and improvement. Instead of continuing with the traditional single-instrument approach, it is advisable to establish a "tiered adaptation and specialized priority" instrument selection system. During

the root canal orifice localization phase, the DG16 probe and ultrasonic working tip (P5, ET20) are used to precisely remove superficial calcified tissues, exposing the hidden root canal orifice. In the initial canal preparation phase, 6# and 8# small prebent C+ files and D files are prioritized. These instruments feature sharp tips and good flexibility, allowing gentle exploration along the root canal course and penetration of superficial calcified tissues. For the middle calcified canal preparation phase, alternating use of nickel-titanium files and manual K files is recommended. The superelasticity of nickel-titanium instruments adapts to curved root canals, reducing canal deviation. In the apical calcified canal preparation phase, small files with dulled tips are selected, combined with an apical locator, to precisely control the depth of preparation and avoid damage to periapical tissues.

3.3. Integration of auxiliary technologies and standardized practical techniques:

The improved root canal preparation technique eliminates the single mechanical approach by combining three auxiliary technologies—microscopic visualization, chemical softening, and ultrasonic vibration—to establish a comprehensive preparation system. This addresses the limitations of traditional methods in visual field and resistance. The dental microscope, as the core auxiliary device, is adjusted to 10-25x magnification to clearly visualize the intricate root canal structures, resolving issues such as occlusion of the root canal or unclear preparation pathways. Chemical assistance involves alternating rinsing with 17% EDTA gel and 2.5% sodium hypochlorite solution. EDTA gel chelates calcium ions in calcified tissues to soften hard mineralized layers, while sodium hypochlorite dissolves residual pulp tissue to reduce preparation resistance. Ultrasonic assistance employs low-power pulsed vibration, with power controlled below 30%, intermittently loosening calcified tissues to prevent continuous heat generation that may damage dental structures. These three auxiliary technologies work synergistically throughout the preparation process, creating optimal conditions for mechanical preparation and enhancing efficiency.

4. Precision modification and dilation procedures for different types of calcified root canals

4.1. Modified dilation procedure for calcified root canal orifices

The core of calcified root canal orifice dilation lies in precise localization and minimally invasive exposure, performed under dental microscopy. During the procedure, strict control of the cutting range is maintained to avoid damaging normal pulp tissue. Preoperative CBCT 3D reconstruction is used to accurately determine the position, depth, and direction of the root canal orifice, marking the target for dilation to prevent blind probing. Intraoperatively, a small ultrasonic working tip is employed to remove the superficial calcified tissue of the pulp floor layer by layer using a “spot grinding, intermittent, and minimally invasive” technique, with the cutting depth controlled within 0.5 mm. The procedure is paused every 3-5 seconds for irrigation to remove debris and prevent root canal occlusion. If a suspected root canal orifice is identified, a DG16 probe is used for gentle probing. After confirming the root canal orifice, EDTA gel is applied to soften the calcified tissue around the orifice, followed by gentle rotation with a 6# prebent C+ file to establish the initial pathway. Throughout the process, violent puncture is avoided to prevent pulp floor perforation, completing the exposure and preliminary dilation of the root canal orifice.

4.2. Modified canalization procedure for middle segment calcification

Middle segment calcification in root canals is often accompanied by canal stenosis and tortuosity. The modified canalization must follow the natural course of the root canal, with gradual expansion to avoid forced advancement, which may lead to canal displacement or step formation. Prior to the procedure, CBCT should be used to accurately measure the length and curvature angle of the calcified segment, predict resistance points, and customize the pre-bending of the canalization instrument to match the curvature of the root canal. During the procedure, inject EDTA gel into the calcified segment and allow it to soften for 1-2 minutes. Employ the “twist + gentle pull” technique: gently insert a small pre-bending file into the root canal, stopping immediately upon encountering resistance. Retract the file by 1-2 mm, then twist and advance it slightly, repeating the process to penetrate the calcified segment. For every 1 mm penetration, switch to a

slightly larger file to expand the pathway. Alternate between sodium hypochlorite and EDTA irrigation to remove calcified debris and prevent further obstruction. For severe calcification, combine ultrasound-assisted intermittent oscillation with manual file advancement to ensure smooth passage and alignment with the original root canal course.

4.3. Modified procedures for calcareous apical segmentation

The core of apical calcification management lies in precise control of working length and gentle instrumentation to avoid periapical tissue damage, preventing calcified debris from being expelled through the apical foramen and triggering inflammatory responses. Preoperative measurement of working length using an apical locator combined with CBCT data is essential to mark the termination point, rather than relying on empirical judgment, which ensures greater precision than arbitrary manipulation. During instrumentation, use a 8# or 10# small file with a blunt tip, dipped in EDTA gel, to slowly enter the root canal. Employ the technique of "small-range twisting and pressure-free advancement," stopping immediately upon encountering resistance. Repeat the process of lifting and loosening calcified tissue before gradually advancing toward the apex to minimize unnecessary root canal damage. Real-time monitoring of apical locator data is critical during the procedure, strictly prohibiting instrument overextension beyond the working length. Rinse the canal every 0.5 mm of advancement, clear debris, and lubricate the root canal. For completely occluded apical calcification, avoid forced instrumentation and instead employ a combined approach of ultrasonic minimally invasive release and chemical softening to gradually establish an apical pathway. Adjust the termination point as needed to ensure effective and safe instrumentation, with safety always being the top priority[3].

5. Clinical quality control and complication prevention of modified root canal access techniques

5.1. Core clinical quality control of modified root canal access techniques

To ensure optimal clinical efficacy of modified root canal access techniques, strict quality control must be implemented throughout the entire process: preoperative, intraoperative, and postoperative. Standardized operational details should be followed to minimize human errors. Preoperative quality control focuses on precise evaluation, including comprehensive imaging examinations such as CBCT and apical radiographs. This involves clarifying calcification classification and root canal anatomy, identifying high-risk factors like root canal curvature or stenosis, and developing personalized access plans. Instrument sterilization and equipment calibration must be ensured to guarantee proper operation of microscopes and ultrasonic instruments. Intraoperative quality control emphasizes standardized procedures with full visualization of the access process, strict control of instrument force, depth, and cutting range, adhering to the principle of "stepwise, minimally invasive, and gentle" manipulation. Fragments should be promptly irrigated and cleaned during the procedure, with regular inspection of instrument morphology. Deformed or worn instruments must be replaced immediately. Postoperative quality control involves efficacy assessment, confirming root canal patency, absence of steps or lateral perforations via apical radiographs, and accurate measurement of working length to lay the foundation for subsequent root canal preparation and filling procedures.

5.2. Targeted preventive measures for common complications

During calcified root canal treatment, complications such as lateral canal perforation, step formation, instrument dislodgement, and periapical injury may occur, necessitating preventive measures to mitigate risks. To prevent lateral canal perforation, the root canal path should be clearly identified preoperatively, and the procedure should be performed under microscopic guidance. The depth of ultrasonic cutting should be controlled, and radiographic examination should be promptly conducted if abnormalities are detected. To avoid step formation, use a small-sized prebent instrument for exploration, and prohibit the forced insertion of large instruments. Any identified steps should be immediately repositioned and adjusted. To prevent instrument dislodgement, instruments should be used in a standardized manner, and violent

manipulation should be avoided. Instruments should be inspected preoperatively, and any dislodged instruments should be removed promptly. The working length should be precisely controlled to prevent overloading and debris expulsion through the apical foramen. Postoperative anti-inflammatory measures should be implemented promptly to ensure safe and effective treatment.

5.3. Clinical adaptation optimization for modified techniques

The modified techniques for calcified root canal preparation demonstrate strong practicality and universality. When implementing these techniques clinically, adjustments should be made according to specific clinical scenarios and the operator's proficiency to enhance their effectiveness. For primary dental institutions lacking advanced microscopes, simplified procedures can be adopted, focusing on optimized instrument selection and manual techniques. Utilizing apical radiographs for positioning, a basic modified approach with a small prebent file and EDTA-softened materials ensures effective initial root canal preparation[4]. In contrast, advanced dental facilities should fully implement refined modified techniques combining microscopic visualization, ultrasonography, and chemical agents. This comprehensive approach addresses complex calcified root canal cases, providing more effective solutions for intricate conditions and meeting diverse patient needs.

6. Conclusion

Calcified root canal preparation is a critical and challenging aspect of root canal therapy. Traditional preparation techniques have limitations, adversely affecting treatment success rates and safety. Therefore, targeted improvements to these techniques are of significant clinical importance. This revision integrates the clinical characteristics of calcified root canals and optimizes the preparation protocol from five dimensions: conceptual approach, instrument selection, auxiliary techniques, classification-based procedures, and quality control with risk management. It shifts from extensive manipulation to a minimally invasive, precise, and visualized refined preparation model, effectively overcoming issues such as poor visualization, high resistance, and elevated risks associated with conventional techniques.

Disclosure statement

The author declares no conflict of interest.

References

[1] Hao XF, Wang JP, Li LD, 2026, Factors Influencing the Efficacy of Root Canal Therapy in Patients with Pulpitis and Construction of a Line Graph Model. Journal of Xinjiang Medical University, 49(01): 100-106+112.

[2] Liu BB, Weng JL, Ma FF, et al., 2025, Application and Research Progress of Dynamic Navigation in Calcified Root Canals. Journal of Clinical Stomatology, 41(08): 507-510.

[3] Tian J, Wei X, Liu H, 2026, Case Evaluation and Clinical Decision-Making in Root Canal Re-Treatment. International Journal of Stomatology, 1-9.

[4] Sun PP, Mao TT, Zhang MW, et al., 2026, Effects of Polymerized Porcelain High Inlays on Masticatory Function and Gingival Status of the Second Premolar in the Mandible after Root Canal Treatment. Journal of Oral and Maxillofacial Prosthodontics, 27(01): 23-30.