GUIDED ENDODONTIC ACCESS IN A CALCIFIED DOUBLE-ROOTED MAXILLARY PREMOLAR: A CASE REPORT

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ABSTRACT: Root canal treatment in teeth with severe pulp calcification represents a clinical challenge due to the difficulty in locating the canal lumen and the possibility of surgical accidents. This clinical case report aims to describe and discuss a guided endodontic access protocol in a double-rooted tooth with two calcified canals diagnosed with pulp necrosis. Radiographic and cone-beam computed tomography examinations revealed a hypodense image involving the coronal region and cervical root third, severely calcified root canals, and regular apical tissues. Surgical planning software was used to design and 3D-print two guides that directed a #103.395 access bur to the root canal lumen up to the pre-planned depth in the apical third, allowing minimal removal of tooth structure. The endodontic treatment included a single session using ProTaper Ultimate rotary instruments and 2.5% sodium hypochlorite. Passive ultrasonic irrigation with 17% EDTA and saline was performed before obturation. The access cavity was restored. After four months, the tooth was asymptomatic and functioning regularly. The study concluded that guided endodontic access may improves the effectiveness of treating calcified root canals, preserves healthy dental structure, and may reduces surgery time.
KEYWORDS: Dental Pulp Calcification; Cone-Beam Computed Tomography; Endodontics; Printing; Three-Dimensional; Root Canal Therapy.

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ACESSO ENDODÔNTICO GUIADO EM PRÉ-MOLAR MAXILAR BIRRADICULAR CALCIFICADO: RELATO DE CASO

RESUMO: O tratamento endodôntico em dentes com calcificação pulpar severa representa um desafio clínico devido à dificuldade de localização do lúmen do canal e à possibilidade de acidentes cirúrgicos. Este relato de caso clínico tem como objetivo descrever e discutir um protocolo de acesso endodôntico guiado em um dente birradicular com dois canais calcificados e diagnóstico de necrose pulpar. Exames radiográficos e de tomografia computadorizada de feixe cônico revelaram uma imagem hipodensa envolvendo a região coronal e o terço cervical da raiz, canais radiculares severamente calcificados e tecidos apicais regulares. Um software de planejamento cirúrgico foi utilizado para projetar e imprimir em 3D dois guias que direcionaram uma broca de acesso #103.395 para o lúmen do canal radicular até a profundidade pré-planejada no terço apical, permitindo a remoção mínima de estrutura dentária. O tratamento endodôntico incluiu uma única sessão com instrumentos rotatórios ProTaper Ultimate e hipoclorito de sódio a 2,5%. Irrigação ultrassônica passiva com EDTA a 17% e solução salina foi realizada antes da obturação. A cavidade de acesso foi restaurada. Após quatro meses, o dente estava assintomático e funcionando normalmente. O estudo concluiu que o acesso endodôntico guiado pode aumentar a eficácia do tratamento de canais radiculares calcificados, preservar a estrutura dentária saudável e reduzir o tempo cirúrgico.
PALAVRAS-CHAVE: Calcificações da Polpa Dentária; Tomografia Computadorizada de Feixe Cônico; Endodontia; Impressão Tridimensional; Tratamento do canal radicular.

ACCESO ENDODÓNTICO GUIADO EN PREMOLAR MAXILAR BIRADICULAR CALCIFICADO: REPORTE DE CASO

RESUMEN: El tratamiento de conductos radiculares en dientes con calcificación pulpar severa representa un desafío clínico debido a la dificultad para localizar la luz del conducto y la posibilidad de accidentes quirúrgicos. Este reporte de caso clínico tiene como objetivo describir y discutir un protocolo de acceso endodóncico guiado en un diente bicardicular con dos conductos calcificados, diagnosticado con necrosis pulpar. Los exámenes radiográficos y de tomografía computarizada de haz cónico revelaron una imagen hipodensa que involucraba la región coronal y el tercio radicular cervical, conductos radiculares severamente calcificados y tejidos apicales regulares. Se utilizó un software de planificación quirúrgica para diseñar e imprimir en 3D dos guías que dirigieron una fresa de acceso n.° 103.395 hacia la luz del conducto radicular hasta la profundidad preplanificada en el tercio apical, lo que permitió una remoción mínima de la estructura dental. El tratamiento endodóncico incluyó una sola sesión con instrumental rotatorio ProTaper Ultimate e hipoclorito de sodio al 2,5%. Se realizó irrigación ultrasónica pasiva con EDTA al 17 % y solución salina antes de la obturación. Se restauró la cavidad de acceso. Después de cuatro meses, el diente estaba asintomático y funcionaba con regularidad. El estudio concluyó que el acceso endodóntico guiado puede mejorar la eficacia del tratamiento de conductos radiculares calcificados, preservar la estructura dental sana y reducir la duración de la cirugía.
PALABRAS CLAVE: Calcificaciones de la Pulpa Dental; Tomografía Computarizada de Haz Cónico; Endodoncia; Impresión Tridimensional; Tratamiento del Conducto Radicular.

1. INTRODUCTION

Among the key challenges in endodontics is the treatment of calcified canals, as they present a high probability of iatrogenic surgical errors and the development of complications during treatment. According to Lima *et al*., 2024, The American Association of Endodontists (AAE) reports that endodontic treatment of obliterated root canals presents a high level of difficulty during localization and chemical-mechanical canal preparation.

Root canal calcification is a response of the vital pulp against aggression. However, up to one-third of calcified teeth may develop long-term apical pathology, and conventional endodontic treatment might be challenging and associated with high failure rates. Even with a surgical microscope, endodontic access may remove excessive tooth structure, reducing prognosis (Connert *et al*., 2017).

Root canals obliterate mainly after traumatic injuries. A repair process develops in response to a neurovascular supply disruption, promoting marked dentin precipitation in the root canal. Calcification occurs as a response of the pulp to carious lesions or restorations. It may result from the adverse effects of orthodontic forces, particularly in elderly patients. These effects are primarily due to the deposition of secondary dentin over a lifetime (Llaquet Pujol *et al*., 2021).

An obliterated canal may experience iatrogenesis, such as overpreparation of the access cavity, which may lead to crown or root perforation. Moreover, locating the canal is difficult, which may cause a deviation from the original path and form ledges on the inner walls of the root. All these factors may prevent dental professionals from working the entire canal length, keeping dentin infected and causing treatment failure (Llaquet Pujol *et al*., 2021).

Given this problem and the technological advancements in endodontics, guided endodontic access system emerged as static-guided endodontics for accessing calcified root canals. It assists in accurately locating the canal lumen, providing predictable treatment outcomes with a lower likelihood of reduced working time and intraoperative iatrogenesis, such as excess wear of healthy dental structures (Torres *et al*., 2021).

Guided endodontic access is planned virtually by overlapping cone-beam computed tomography (CBCT) images with intraoral scan images. The determination of the working limit and proper angulation of the endodontic access bur occurs during guide preparation, based on root canal location. The designed guide is three-dimensionally printed and includes an access hole fitted with a metal sleeve, allowing for accurate bur direction (Lima *et al*., 2024).

The access cavities performed with ® are minimally invasive, as they preserve as much healthy dentin as possible due to the small bur diameter that removes a narrow cylinder of dentin along the planned path, preserving pericervical dentin. This feature benefits from increased fracture strength by insignificantly compromising the tooth's biomechanical behavior, contributing to treatment success (Connert *et al.*, 2019).

Guided endodontics is a contemporary topic with its pioneering literature cited in 2016 (Krastl *et al.*, 2016). This research line demonstrated increasing interest in recent years due to its numerous benefits in canal treatment and digital flow incorporation by endodontists (Lima *et al.*, 2024). This clinical case report, conducted in an academic environment by a dental student, aims to describe and discuss a guided endodontic access protocol in a double-rooted tooth with two calcified canals.

2. CASE REPORT

The reported clinical case was submitted to and approved by the Research Ethics Committee of the Federal University of Campina Grande CAAE #81971324.0.0000.5182. The patient provided written informed consent for publication of the data and images from this case.

This case report followed the PRICE 2020 guidelines (Nagendrababu *et al*., 2020). A 53-year-old male patient was referred for endodontic treatment at the Dental School Clinic of the Federal University of Campina Grande (UFCG), Brazil, with a history of therapy initiated in the first right upper premolar. A detailed review of the patient's medical and dental history did not find systemic illnesses or allergies. The patient did not present spontaneous or provoked pain, and the clinical examination was negative in the pulp sensitivity test, establishing pulp necrosis. The tooth also responded negatively to vertical percussion, lateral percussion, and apical palpation tests. Periodontal probing depths were within normal limits, and there was no pathological mobility. Radiographic and CBCT examinations revealed a hypodense image involving the coronal region and the cervical third of the root, suggesting endodontic instrumentation with excessive dentin destruction, severely calcified root canals, and regular apical tissues (Figure 1). Treatment options and sequence were discussed with the patient, who agreed to initiate primary endodontic treatment of tooth 14 using guided endodontic access.

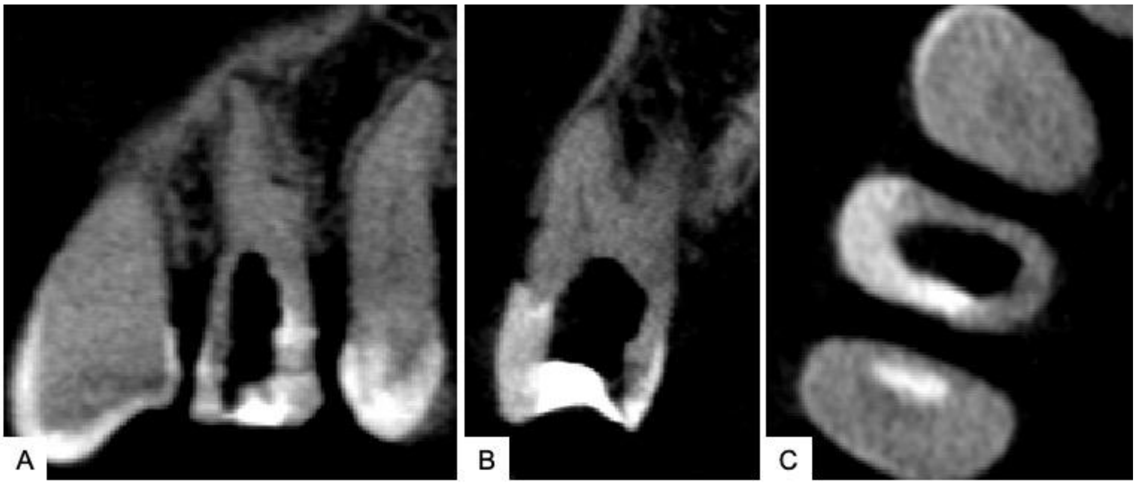

Figure 1. Preoperative cone-beam computed tomography (CBCT) images. A- Sagittal section; B- Coronal section; C- Axial section.

The patient's intraoral scanning was possible with an intraoral scanner (CEREC Omnicam, Dentsply Sirona, York, Pennsylvania, USA). CBCT and intraoral scan images were aligned and processed using surgical planning software (NemoStudio, Nemotec, Madrid, Spain). A virtual copy of a 103.395 access bur with a diameter of 1.3 mm and length of 20 mm (Neodent, Curitiba, Paraná, Brazil) overlapped the scans in a position that allowed access to the lumen of root canals in the tooth's apical third (Figure 2A). Subsequently, the 3D model was exported as a Standard Tessellation Language (STL) file to a 3D printer (P30, Straumann, Basel, Switzerland). Two 3D guides for guided access to the buccal and palatal canals were printed using biocompatible fused deposition (FDM) or stereolithography (SLA) modeling resins (Figure 2B). Model adjustment and bur position were verified in the mouth (Figure 2C). The bur was coupled to a low-speed handpiece set to 10,000 rpm. After satisfactory fit and stability evaluations, local anesthesia was performed with 2% mepivacaine with 1:100,000 epinephrine. The guide was positioned in the tooth, and dentinal drilling was performed in each root with pecking movements to penetrate the calcified part of the root canal using the 103.395 access bur (Figure 2D). At each 2mm apical advance, the cavity was rinsed with saline, and the active part of the bur was cleaned. Absolute isolation with a rubber dam was performed when the bur's penetration depth reached the safety stop (Figure 2E) (i.e., contacting the lumen of both root canals) with radiographic confirmation (Figure 2F). A #15 K-file (Dentsply Maillefer) was introduced into each canal, and the working length (WL) was determined electronically (Finepex®, Schuster, Santa Maria, RS, Brazil) and confirmed radiographically, providing 17 mm in the buccal canal and 15 mm in the palatal canal (Figure 2F).

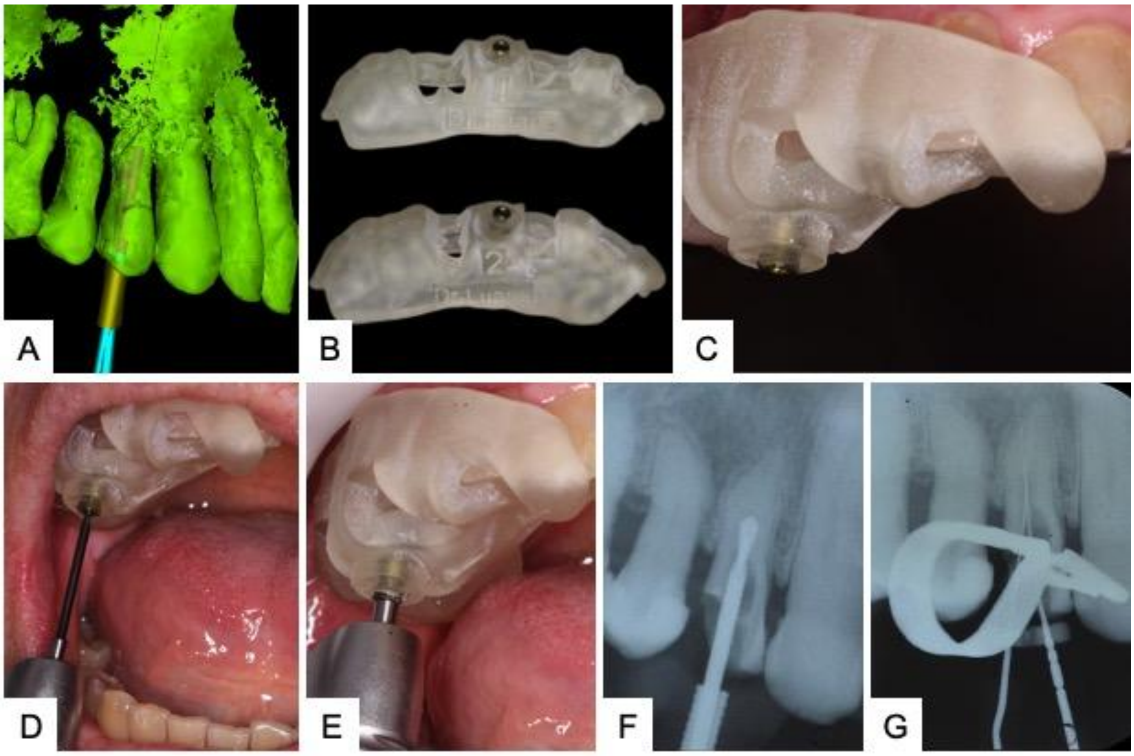

Figure 2. A – Digital planning with a bur overlapping scan and tomography images; B – 3D-printed guides; C – Guided endodontic access positioned and adapted in the patient's dental arch; D – 103.395 access bur in a working position; E – Burs on the pre-established working limit in digital planning; F – Periapical X-ray showing bur length after touching the guide metal sleeve; G – Periapical X-ray showing exploratory files within the canals for working length determination.

The chemical-mechanical preparation used 2.5% sodium hypochlorite (NaOCl) and ProTaper Ultimate rotary instruments (Dentsply Sirona, Ballaigues, Switzerland) up to a minimum size of #30.09 (Figure 3A). The final irrigation employed 2.5% NaOCl, 17% ethylenediaminetetraacetic acid (EDTA), and saline under passive ultrasonic agitation with the E1-Irrisonic® insert (Helse Ultrasonic, Santa Rosa de Viterbo, SP, Brazil) in three 20-second cycles, replacing the irrigant each cycle (Figure 3B). Next, the canals were aspirated with a 0.14" Capillary Tip® (Ultradent) (Figure 3C), dried with absorbent paper cones (Dentsply Maillefer) positioned up to the WL (Figure 3D), and filled with gutta-percha and Sealer 26 cement (Dentsply Maillefer, Petrópolis, RJ, Brazil) using the single-cone technique (Figure 3E). The access cavity was restored with Master Fill® composite resin (Biodynamic, Ibiporã, PR, Brazil) on a base of approximately 3 mm of Master Flow® composite resin (Biodynamic, Ibiporã, PR, Brazil) (Figure 3F), and occlusion was verified and adjusted (Figure 3G). Finally, orthoradial and mesioradial periapical radiographs were obtained to confirm the quality of root filling (Figure 3H). An undergraduate dental student trained by an experienced professor conducted all endodontic treatment procedures in a single session. The present clinical case had straight roots with two calcified root canals, which enabled to overcome calcification aided by the guided endodontic access. After twelve months, the tooth was asymptomatic and radiographically, there were no pathological changes (Figura 4).

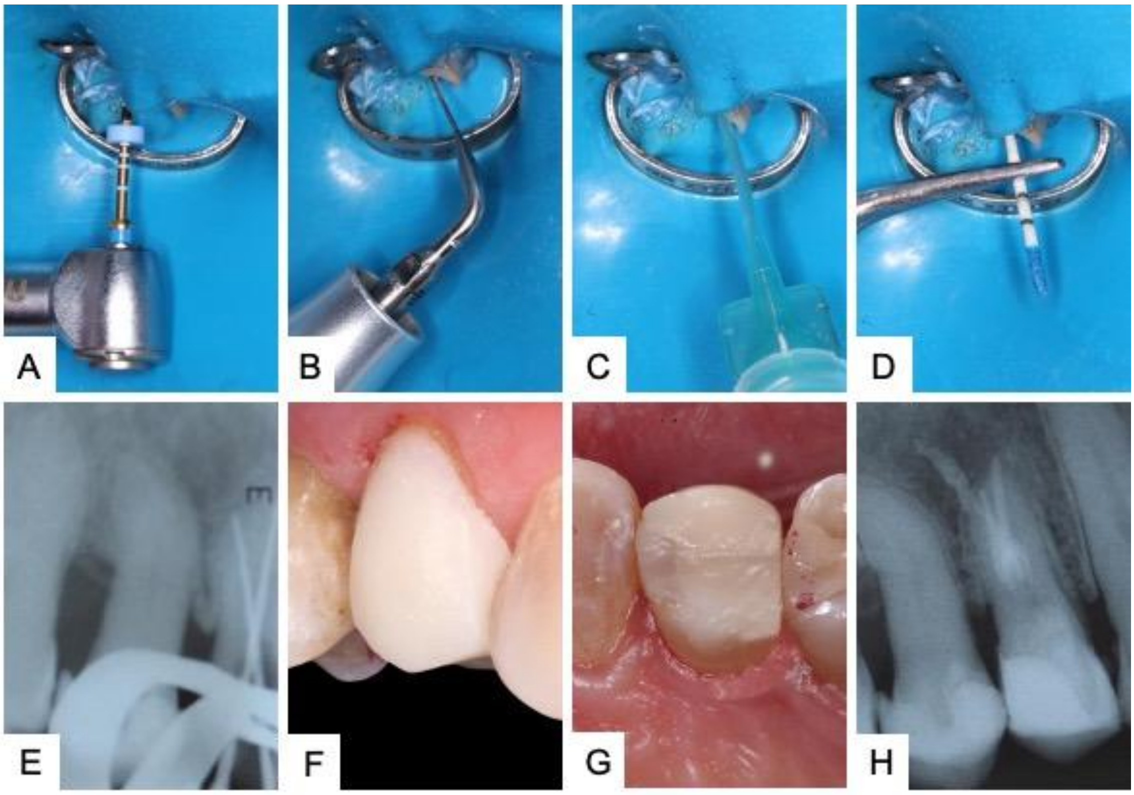

Figure 3. A - Root canal instrumentation up to file F3 #30.09; B - Final irrigation under passive ultrasonic agitation with the E1-Irrisonic® insert; C - Canal aspiration with 0.14" Capillary Tip®; D - Canal drying with absorbent paper cones; E - Periapical radiograph showing a single gutta-percha cone adapted to the working length; F - Crown restoration with composite resin; G - Occlusal adjustment; H - Periapical radiograph showing the quality of root fillings (displaying endodontic cement overflow) and crown restorations.

Figure 4. Control periapical radiograph after twelve months.

3. DISCUSSION

A tooth calcified by trauma, orthodontic treatment, caries, restoration, or the accumulation of reactionary dentin over age may or may not require endodontic treatment. This calcification is a vital pulp response to aggression as a tooth defense by stimulating tertiary dentin production. Calcified teeth with associated painful symptomatology or apical pathologies, such as periodontitis and abscess, require endodontic therapy to fight the infection and save the tooth. That occurs, on average, in about one-third of calcified teeth (Connert *et al.*, 2017). The patient in the present study had a calcified double-rooted tooth and was diagnosed with pulp necrosis, indicating the need for non-surgical root canal treatment.

Teeth with calcifications in the cervical and middle thirds of the root pose a challenge for endodontics during localization and in the chemical-mechanical preparation of canals. Even when using magnifying glasses and microscopes and having a high level of professional clinical experience, these cases present a risk of iatrogenesis, including excessive wear of healthy dentin, crown and root perforation, deviation from the original canal path, and the formation of ledges on the inner walls of the canal (Llaquet Pujol *et al.*, 2021). The patient in the present case had sought another professional when experiencing tooth pain but was unsuccessful in locating the canal, which promoted excessive wear of pericervical dentin and reduced the tooth's fracture strength.

Guided endodontic therapy has emerged due to these circumstances to minimize transoperative iatrogenic errors and assist in canal localization and endodontic treatment. guided endodontic access enables a safer, faster, and more effective procedure with less wear on the healthy dentinal structure of teeth with calcified canals. The more preserved the dental tissue, the better the treatment prognosis and longevity, as more mechanical support and fracture strength are available (Torres *et al.*, 2021). The choice of guided treatment in this clinical case took into account the significant advantages of this technology in addressing pathologies related to calcified root canals, particularly in terms of precise location and access.

A comparative study involving three dentists with diverse experience levels - a professional specialized in endodontics for nine years, a generalist graduated for three years, and a recent dental undergraduate - evaluated the working time and treatment success between conventional and guided endodontic techniques. The authors showed that the success of guided endodontic treatment depends on the operator's experience level, as they observed similar surgery times and treatment success rates (Connert *et al.*, 2017). A last-year undergraduate dental student conducted the analyzed clinical case under the supervision and guidance of an Endodontics specialist professor, obtaining treatment success without transoperative complications.

Guided endodontics has limitations in cases of curved canals, as the guide and bur materials are not malleable, and their use is restricted to teeth with straight roots or the straight part of the curved roots in the apical third. Another limitation is the patient's mouth opening level, especially during the treatment of posterior teeth, because guide positioning requires adequate vertical space for fitting the guide and adapting the bur (Torres *et al.*, 2021). In the present clinical case, the patient presented satisfactory mouth opening, allowing positioning and handling of the instrument.

The endodontic guide is planned virtually using specialized software by overlapping CBCT images with the intraoral scan of the patient's arch. Planning determined the bur penetration limit and its correct angulation to locate the canal. A metal sleeve located in the guide entry hole precisely regulates and directs all these processes (LIMA *et al.*, 2024). The described case collected tomography and scan images at the imaging clinic and saved them in digital files, such as DICOM and STL, respectively. Subsequently, the image files were sent to a prosthetic laboratory for planning, therefore improving the visualization of the canal using filters, measuring the required working length and angulation of both canals, and printing the guide in 3D.

The endodontic guide may be fixed intraosseously or by occlusal overlap (Fonseca Tavares *et al.*, 2022). This case employed occlusal fixation due to its practicality and to reduce one clinical stage of bone fixation. Before starting bur access, the guide's fit and stabilization were verified under the patient's occlusal surface without tilting to prevent bur deviation during the procedure. The clinical case by Lima *et al*. (2021) stabilized the guide by bone milling at two points in the maxilla, and the guide was fixed by screws of the same brand as the access bur. Both techniques are subject to clinical success (Lima *et al.*, 2021).

After using the guided endodontic access for endodontic access, the root canal was located with endodontic instruments, such as manual files, allowing exploration and mechanical instrumentation associated with chemical irrigation for root canal disinfection and cleaning. Finally, unobstructed root canals were three-dimensionally filled, allowing the permanence and survival of the calcified tooth without excessive loss of tooth structure that might mechanically weaken the tooth and compromise its long-term maintenance, using a relatively simple and accessible technology.

4. CONCLUSION

Guided endodontics is an innovative approach to treating teeth with calcified root canals. One of the primary advantages of this technique is the preservation of most of the original dental structure, which is crucial for maintaining the tooth's long-term integrity and function. Moreover, guided endodontics contributes to may reduce the total endodontic treatment time, making the process less tiring for professionals and patients. Another significant benefit is that guided endodontics may reduce reliance on operator experience, while clinical expertise remains essential, allowing the creation of access cavities with millimeter precision, which improves treatment effectiveness and reduces the possibility of clinical errors, such as root perforations. That promotes can improve predictability and safety in the management of teeth with anatomical complexities.

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