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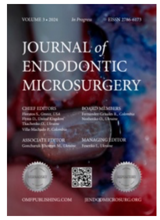

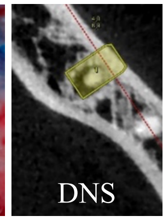

CASE REPORT/TECHNIIQUE

DYNAMIC NAVIGATION SYSTEM (DNS)

Endodontic Microsurgery of a Mandibular Molar Using a Dynamic Navigation System and Cortical Window Technique: Case Report

Gustavo A. Castillo[a,*], Silvia A. Restrepo-Méndez[b], Oscar E. Zuluaga[c], &

Paola A. Escobar-Villegas[d]

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[a] Gustavo A. Castillo, DDS, Endodontist Associate Professor, Department of Endodontics, Universidad del Valle, Cali, Colombia. https://orcid.org/0009-0002-0534-9941 , Corresponding author's address: cra 37 bis # 1a-49 apto 103 b. Cali-Colombia Cel: 3164780316, Email: gcastilloendo@gmail.com - gustavo.barrios@correounivalle.edu.co, Instagram: drgustavocastillo

[b] Silvia A. Restrepo-Méndez, DDS, Endodontist. Pontificia Universidad Javeriana. https://orcid.org/0009-0005-6021-2229

[c] Oscar E. Zuluaga, DDS, Endodontist. Professor, Department of Endodontics, Universidad del Valle, Cali, Colombia. https://orcid.org/0009-0009-0687-3295

[d] Paola A. Escobar-Villegas, DDS, Endodontist, MSc in Dental Sciences. Professor, Colegio Odontológico, Institución Universitaria Colegios de Colombia - Unicoc, Cali, Colombia. https://orcid.org/0000-0003-0703-0475

Abstract

Endodontic microsurgery (EM) of mandibular molars with a periapical lesion and intact buccal cortical bone presents a significant challenge for clinicians. This case report describes the utility of a dynamic navigation system for EM of a mandibular molar diagnosed with a previously treated tooth and symptomatic apical periodontitis, employing the "cortical window" technique using a trephine. The successful healing outcome at 21 months with cone-beam computed tomography (CBCT) was also documented.

Keywords

Apicoectomy, Surgery, Computer-Assisted, case reports, microsurgery, osteotomy, cone-beam computed tomography.

Introduction

The endodontic surgery field has evolved due to technological advancements in various equipment, diagnostic aids, techniques, and materials. More recently, the implementation of digital planning has favored the execution, predictability, and prognosis of the procedure (1). The transition to electronic microscopy (EM) has represented a breakthrough, leading to higher success rates compared to conventional endodontic surgery (2).

Cone-beam computed tomography (CBCT) and magnification have become indispensable tools in endodontic microsurgery (EM). The digital workflow now incorporates navigation systems for both surgical and non-surgical endodontic procedures, primarily employing two techniques: static navigation and dynamic navigation (1-3). Dynamic navigation, a computerguided technology initially developed for precise and real-time planning in oral implantology, utilizes cameras and tracking devices attached to the handpiece and the patient. The system continuously compares the access path using software on the CBCT images, providing the clinician with information related to the milling path, which is visually displayed on a monitor (4).

Dynamic Navigation Systems (DNS) have emerged as valuable tools in endodontics, finding application in various procedures, including the management of obliterated canals, post removal, and EM (2, 5, 6, 7). A key advantage of DNS over static navigation is the elimination of the need for guide fabrication, enabling faster patient treatment (7). Static guides, on the other hand, can pose challenges in accessing posterior regions, particularly when interocclusal space is limited (5). Additionally, static guides can increase the risk of bone overheating due to inadequate irrigation, among other potential complications (2, 8).

The DNS uses instruments that help to perform more precise procedures at different surgical stages. For example, during osteotomy, it allows for a smaller access, which favors the repair process. This case report documented EM in a mandibular first molar using the Navident® DNS (Claronav- Toronto-Canada), applying the cortical window technique. Clinical and CBCT follow-up at 21 months showed a successful outcome in periapical healing.

Case Report

Patient Presentation

A 36-year-old male with no significant medical history presented with chief complaint of pain on chewing in the lower left quadrant. Clinical examination revealed positive vertical percussion test on tooth #36, negative palpation, physiological mobility, and normal periodontal probing depths. No swelling or sinus tract was evident. Cone-beam computed tomography (CBCT) analysis (Myray Hyperion X9 tomograph, 75 microns, 6x4 window) revealed an adequate coronal restoration, along with a previous endodontic treatment performed one year ago, where the mesiolingual canal was underfilled, while the mesiobuccal and distal canals were well obturated. A hypodense periapical area was identified in the mesial root (**Figure 1**), accompanied by a 4 mm diameter periapical lesion. The buccal cortical bone was intact, with a thickness of 5 mm to the root apex. Based on these findings, the tooth was diagnosed as previously treated with symptomatic apical periodontitis, classified as CBCT PAI 3E (9).

Surgical Procedure

Preoperative Planning and Anesthesia

Pre-surgical Planning:

The surgical procedure commenced after obtaining informed consent and explaining treatment options. DICOM (Digital Imaging and Communications in Medicine) data from the CBCT scan was imported into the Navident® software for meticulous surgical planning (**Figure 2A**). The planned angulation was set at 0-10 degrees relative to the tooth's longitudinal axis, as recommended by some studies (5).

Pre-operative Preparation:

Before surgery, a thorough 60-second rinse with 0.12% chlorhexidine solution (PerioGard®, Colgate-Palmolive) was performed for oral disinfection. Local anesthesia was achieved using 2 cartridges of lidocaine 2% with epinephrine 1:80,000 (Newcaína, New Stetic). The anesthetic technique involved an inferior alveolar nerve block and buccal infiltration. This ensures adequate pain control throughout the surgery by blocking the nerve that supplies sensation to the lower jaw and infiltrating the surrounding tissue with an anesthetic.

Surgical Technique

A meticulous submarginal incision with a scalloped margin was placed, followed by a full-thickness flap (mucoperiosteal) elevation for optimal visualization and surgical field access. Mesial and distal releasing incisions were employed to facilitate exposure of the intact cortical bone and allow for adequate flap mobility.

Utilizing the DNS and a 5 mm diameter trephine bur (GMI) attached to a contra-angle handpiece (**Figure 2B**), an osteotomy was performed at a speed of 10.000 rpm under continuous saline irrigation for cooling and debris removal (**Figure 3A**). The DNS precisely guided the trephine bur, ensuring creation of a well-defined bone window and simultaneous apicectomy at the pre-planned angulation of 0 degrees relative to the tooth's longitudinal axis. The bone fragment was carefully retrieved and placed in a sterile container with saline solution for potential grafting. The apical root segment, along with the associated periapical lesion, was meticulously removed with microsurgical instruments under high magnification.

The retropreparation cavity was subsequently stained with methylene blue (Disanfer) to enhance visualization of the root canal orifice and facilitate precise cavity preparation (**Figure 3B**). Ultrasonic diamond tips (E30LD-S, NSK Nakanishi Japan) were employed in conjunction with the Biosonic S1 ultrasonic unit (Coltene Whaledent, Switzerland) for efficient and minimally invasive cavity shaping. Continuous saline irrigation was maintained throughout the procedure to ensure cooling and debris removal, followed by thorough drying with sterile paper points (New Stetic).

Retrograde obturation of the prepared cavity was performed using BIO-C® Repair (Angelus, Londrina, Brazil) to create a hermetic seal and prevent bacterial leakage (**Figure 3C**). The carefully retrieved bone fragment was stabilized within the defect using 0.5 grams of xenograft bone with a particle size range of 300 to 600 microns (Biomod 3Biomat, Bogotá, Colombia) to promote bone healing (**Figure 3D**). The mucoperiosteal flap was meticulously repositioned and sutured with 5-0 Dafilon sutures (B-Braun, Germany) for tension-free closure.

The entire surgical procedure was performed under the magnification of a surgical microscope (Zumax OMS2350) to ensure optimal visualization, precise handling of instruments, and meticulous attention to detail.

Postoperative Care and Follow-up

To prevent potential infections and promote healing, the patient was prescribed a regimen of Amoxal 500 mg capsules (Glaxosmithkline) one capsule every 8 hours for 5 days, Anexia 120 mg tablets (Tecnoquímicas- Cali-Colombia) one tablet daily, and a 0.12% chlorhexidine mouthwash twice daily. Additionally, topical application of fitostimoline gel oral (Euroetika) was recommended to promote healing.

The sutures were carefully removed 7 days following the procedure. Follow-up appointments were scheduled at 6, 12 and 21 months to assess healing and ensure optimal outcomes. Cone-beam computed tomography (CBCT) scans obtained at these follow-up visits revealed complete periapical healing (**Figure 4**), and the patient remained asymptomatic throughout the follow-up period.

Discussion

In the presented case, guided endodontic microsurgery (EM) emerged as the preferred treatment approach due to the low likelihood of successful retreatment via an orthograde technique. This decision aimed to circumvent the potential risks associated with adverse events during non-surgical endodontic retreatment, particularly root perforation in the danger zone. By employing EM, conservative management of the furcation area was achieved, an area particularly susceptible to stripping-type perforations (10,11).

Dynamic navigation (DNS) stands as a novel technology that significantly enhances precision during microsurgical endodontic procedures. It serves as a real-time guide for instrument orientation, fostering the protection of adjacent anatomical structures (6). DNS enables a conservative approach during osteotomy, particularly in cases where cortical bone fenestration is absent or when the cortical thickness hinders access to the root apex. This conservative approach positively impacts bone healing time, as evidenced by the successful outcome in the presented case. However, DNS has drawbacks, including its high acquisition cost and the substantial space requirement due to the equipment's size (12). Additionally, it presents a steeper learning curve than traditional techniques or static guides, demanding operator calibration, manual dexterity, and exceptional hand-eye coordination (4).

Currently, several systems facilitate a more conservative and precise osteotomy phase during EM. One such system is the piezoelectric system, equipped with diverse tips that offer protection against nerve structure damage and minimize bleeding, enhancing visibility during the procedure (13,14). Another option is the use of trephines, available in various diameters and lengths. Trephines allow for the preservation of the intact bone block that is removed, enabling its subsequent repositioning and, if necessary, fixation before flap replacement (12,15).

Research suggests that computer-assisted static navigation techniques planned with trephines offer a cylindrical geometry that helps prevent unwanted deviations during osteotomy. This can result in greater accuracy in locating the root apex (16). This technique, known as the "cortical window," facilitates faster healing, considering autologous bone's osteogenic, osteoinductive, and osteoconductive potential (14). Given the advantages mentioned above and others reported in the literature, the cortical window technique guided by DNS using a trephine was employed in the presented case. The primary objective was to preserve the bone structure, maintain the integrity of the vestibular cortical bone, facilitate access to the root to be treated, and enable successful apicectomy (12,14,17).

Conclusion

This case report demonstrates the successful application of dynamic navigation system (DNS) combined with the cortical window technique using a trephine for endodontic microsurgery (EM) of a mandibular molar with a periapical lesion and intact buccal cortical bone. This minimally invasive approach facilitated precise osteotomy, root apex access, and retrograde filling, leading to successful periapical healing at the 21-month follow-up as confirmed by CBCT.

Key Advantages of the Technique:

- **Enhanced Precision:** DNS provides real-time guidance, minimizing the risk of iatrogenic complications during osteotomy and protecting vital structures.
- **Conservative Approach:** The cortical window technique allows for a smaller access cavity, preserving bone structure and promoting faster healing.
- **Autologous Bone Grafting:** Repositioning the retrieved bone fragment promotes osteoconduction and facilitates bone regeneration in the defect area.

Future Directions:

While DNS offers significant benefits, further research is needed to evaluate its long-term cost-effectiveness compared to traditional techniques. Additionally, advancements in technology and user interface design can potentially reduce the learning curve associated with DNS.

Overall Significance:

This case report highlights the potential of DNS-guided EM with the cortical window technique as a predictable and minimally invasive treatment option for managing complex endodontic cases with limited surgical access. This approach offers a promising future for improving surgical outcomes and patient care in endodontic microsurgery.

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Figure 1. CBCT Images. **A.** Coronal View. **B.** Sagittal View.

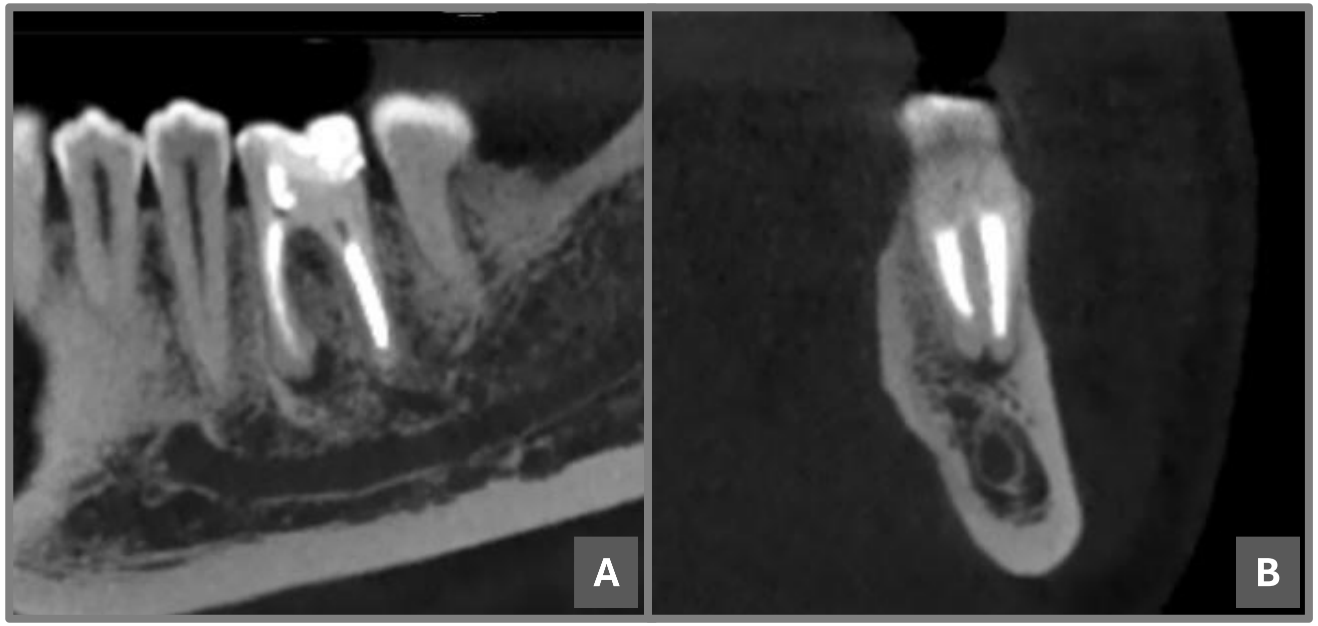

Figure 2. A. Navident Planning for Trephine Placement. **B.** Trephine Kit, the *red arrow* shows the trephine used.

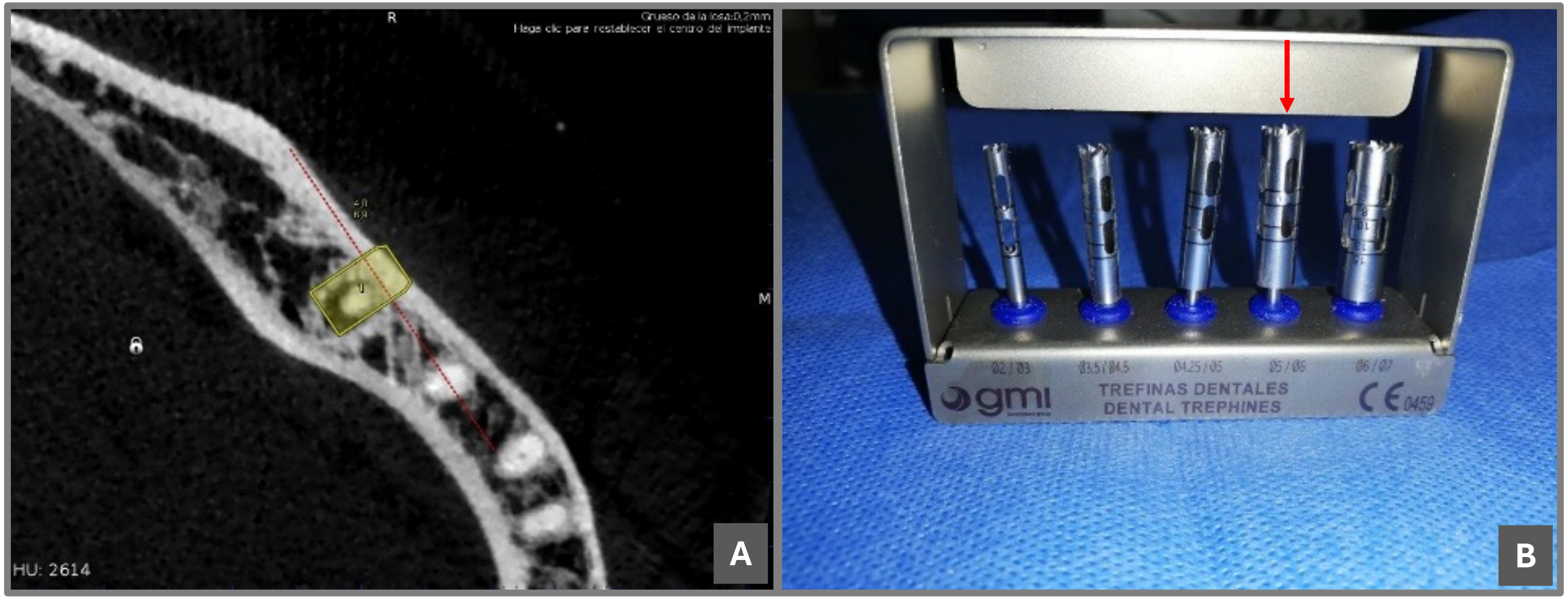

Fig. 3: A. Trephine Positioning **B.** Osteotomy and Navident-Guided Apicectomy with Methylene Blue Staining **C.** Retrograde Obturation with BIO-C® Repair **D.** "Cortical Window" Replacement and Stabilization with Biomod Bone Graft

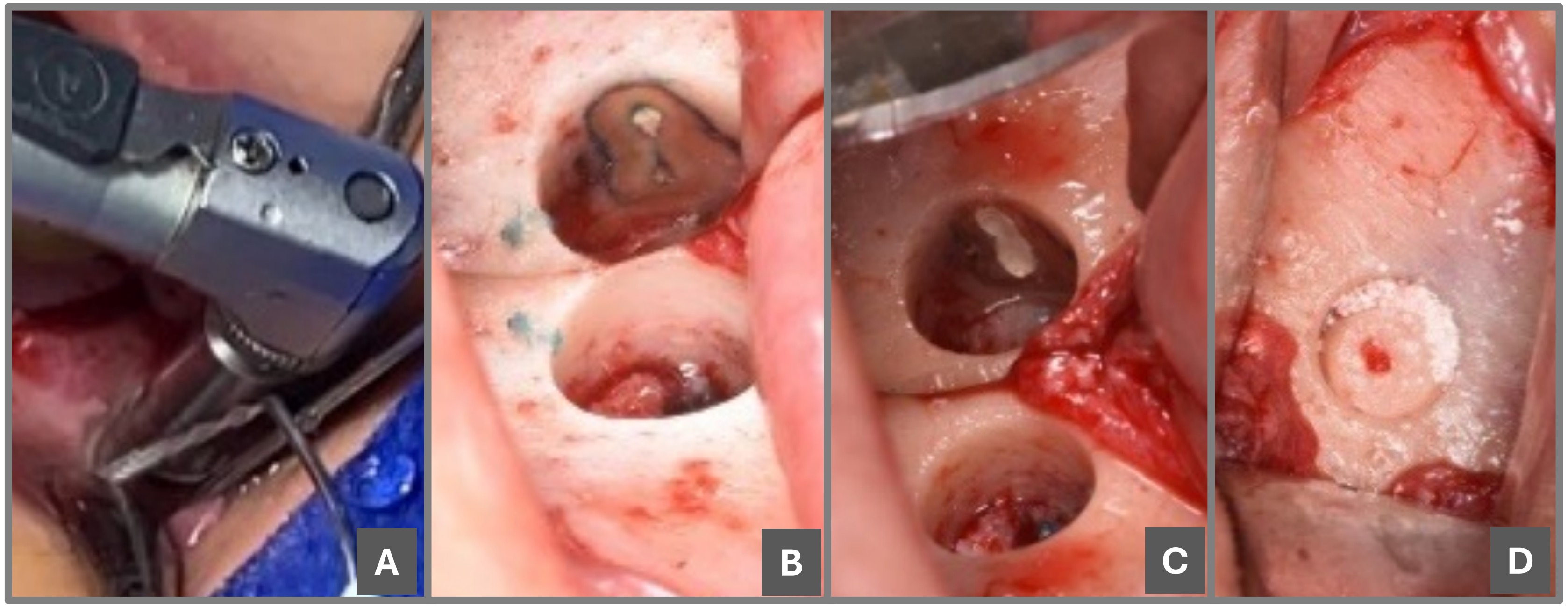

Figure 4: CBCT follow-up control of tooth #36. **A, B.** 12-month follow-up in coronal and sagittal views. **C, D.** 21-month follow-up in coronal and sagittal views.