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Management of Separated Instruments Using Ultrasonic Technique and a Novel Loop Device (Kamand): A Case Report

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ABSTRACT

Separation of endodontic instruments can compromise canal disinfection and long-term prognosis. Microscope-guided ultrasonics combined with a loop device may improve retrieval in anatomically demanding canals. Three molars with fractured instruments in challenging canals (maxillary MB2, maxillary distobuccal, mandibular mesiolingual) were managed under a dental operating microscope. A staging platform was created with a modified #2 Gates-Glidden bur, followed by conservative ultrasonic troughing (ED87 tip) to create space around the fragment. The Kamand loop system was then used to engage and retrieve the fragment. Devices were used according to manufacturers' instructions; any variant use is reported in the Case Presentation. All fragments were retrieved and canals were subsequently cleaned/shaped to 25–30/.04 with warm vertical obturation using AH Plus sealer. Patients were asymptomatic at 6–12 months with radiographic findings consistent with periapical healing. A combined approach, precise ultrasonic troughing to create safe space, followed by loop capture, enabled conservative and predictable retrieval of separated instruments across different canal anatomies, facilitating definitive disinfection and obturation.

Keywords: Dental equipment; Endodontics; Equipment failure; Root canal therapy; Ultrasonics.

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Introduction

Root canal (re) treatment has evolved significantly over recent decades with advancements in techniques, materials, and technologies. Inevitably, procedural mishaps may occur during any phase of root canal (re) treatment; instrument fracture is one of the most challenging complications in clinical endodontics [1,2]. The prevalence of file fracture varies considerably in the literature, with reported rates of 2-6% for stainless steel hand files and 1.04-13.54% for nickel-titanium (NiTi) rotary instruments [3]. This variation reflects differences in Shaping method, operator experience, and the type of instrument. Instrument separation happens etiologically because of two mechanisms: cyclic flexural fatigue and torsional failure [4]. Cyclic fatigue results from repeated compression and tension as files rotate within curved canals, leading to metal fatigue and eventual fracture. Torsional failure occurs when the tip of the instrument binds in the canal while the shaft continues to rotate, exceeding the elastic limit of the metal [5]. Several factors increase the risk of instrument fracture, including canal anatomy (particularly severe curvatures), instrument design, metallurgical properties, operator technique, and frequency of instrument use [6].

The presence of a separated instrument may prevent adequate disinfection of the root canal system apical to the fragment, potentially compromising treatment outcome. When instrument fracture occurs, clinicians face a critical decision whether to attempt removal, bypass the fragment, or leave it in the final obturation. This decision should consider the location of the fragment, canal anatomy, remaining dentin thickness, and potential risks of complications [7]. Retrieval is generally more predictable in the coronal and middle thirds than in the apical third, and canal curvature further reduces success—patterns consistently reported in clinical/experimental series [8,9]. Various techniques have been developed for managing separated instruments. Ultrasonic techniques represent the most studied approach, offering reported success rates ranging from 67% to 94% depending on the location of the fragment [10]. The introduction of dental operating microscopes has significantly enhanced visualization during using ultrasonic tips. Alternative methods include microtube extraction systems (such as the Instrument Removal System), specialized kits like the Masserann system and bypass techniquesn [11]. Some Techniques carry potential risks, like excessive dentin removal that may predispose the tooth to unwanted fractures. Studies have demonstrated that the ultrasonic technique combined with microscopic visualization significantly improves success rates while minimizing procedural complications and preserving tooth structure integrity. The mesiobuccal canals of maxillary and mandibular molars present particular challenges for instrument retrieval due to their complex anatomy, pronounced curvatures, and narrow dimensions. Studies have shown that the probability of instrument breakage in these canals is higher than in other locations, with approximately 73% of fractures occurring in molar teeth, and the mesiobuccal canal being the most frequent site [13]. The second mesiobuccal canal (MB2) in maxillary molars presents additional challenges due to its complex anatomy and difficult accessibility. Therefore, the purpose of this case series is to present and analyze the successful management of separated instruments in three distinct and anatomically challenging scenarios—a maxillary molar MB2 canal, a maxillary molar distobuccal canal, and a mandibular molar mesiolingual canal. This report aims to illustrate a combined, conservative treatment strategy utilizing ultrasonic techniques and the Kamand loop system under microscopic visualization, and to highlight the critical factors for achieving predictable outcomes in such clinical situations.

Case Presentation

Case 1

A 33-year-old female patient was referred to the Department of Endodontics at Mashhad Dental School after instrument separation occurred during root canal treatment at the general endodontic clinic. The patient's medical history was non-contributory (ASA II).

Clinical and Radiographic Examination

Upon clinical examination, the maxillary first molar was sensitive to percussion and palpation. After obtaining the initial radiograph and estimating the length of the separated instrument to be approximately 4mm using the CMOS sensor (Eighteeth Medical, Changzhou, China), the fragment was visible and determined to be located in the coronal third of the second mesiobuccal canal (MB2) of the maxillary first molar (Figure 1).

Treatment Protocol

Local anesthesia was administered using 1% lidocaine with 1:100,000 epinephrine (Daroupakhsh, Tehran, Iran). Following the removal of the temporary filling, the tooth was isolated with a rubber dam using a medium-sized Falcon clamp (Falcon Surgical, Sialkot, Pakistan). The other root canals were covered with ZT

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Dental (ZT Dental, Tangshan Hengxin Medical Supply Co, China) Teflon tape to maintain a clean operating field. Under magnification with a Zumax dental operating microscope (Zumax Medical Co., China), specifically the Zumax model 2380, a modified Gates Glidden #2 bur (Mani Inc., Japan) was used to create a staging platform coronal to the separated fragment. An ED87 ultrasonic tip (Woodpecker, Guilin Woodpecker Medical Instrument Co., China) was then carefully used to create a 1mm space around the coronal aspect of the broken instrument. After conservative dentin removal from the inner wall of the canal curvature (adjacent to the danger zone), the space for needle penetration was examined. The tip of the 27-gauge needle was placed in the created space beside the fragment, 1 mm below the fragment's surface. The loop formed in the wire was then approximately sized to match the cross-sectional area of the fractured piece using a NiTi spreader. After the needle and wire were properly positioned, the main screw of the Zumax Kamand was slowly turned counterclockwise to securely grasp the fragment with the wire. Then, gentle lateral movements were applied to the fragment, and the fragment was subsequently removed.

Following instrument retrieval, all canals were negotiated with a #15 K-file (Mani Inc., Japan). Working lengths were determined using an electronic apex locator (Propex IQ, Dentsply Sirona, USA). All canals were instrumented to size 25/.04 using M3 rotary files (UDG, Changzhou, China) and irrigated with 2.5% sodium hypochlorite solution (Kobalt, Tehran, Iran). Patency was maintained throughout the procedure using a #10 file. Final irrigation was performed with normal saline for 2 minutes using a 30-gauge side-vented needle (UDG, Changzhou, China). Root canal obturation was completed using the warm vertical condensation technique with Meta gutta-percha points (Meta Biomed, South Korea) of size 25/.04 taper and AH Plus sealer (Dentsply Sirona, North Carolina, United States). The Fast Fill and Fast Pack system (Eighteeth Medical, Changzhou, China) was used for obturation. The tooth was temporarily restored with Coltosol (Coltene, Switzerland) and the patient was referred to the restorative department for definitive restoration.

Follow-up

At the one-year follow-up appointment, the patient reported no symptoms. Clinical examination revealed no sensitivity to percussion or palpation, and no periodontal probing defects were detected. The follow-up radiograph demonstrated a reduction in the size of the periapical radiolucency, indicating successful healing.

Case 2

History and Clinical Examination:

A 45-year-old male patient was referred for the management of a procedural error during endodontic therapy on the maxillary left first molar. The patient's medical history was non-contributory. The tooth was tender to percussion, and the general practitioner had initiated the initial treatment. A preoperative periapical radiograph revealed a separated instrument, approximately 10 mm in length (Figure 7), located in the first third of the distobuccal (DB) canal (Figure 5). A diagnosis of previously initiated therapy with symptomatic apical periodontitis was established.

Treatment Protocol

After administration of 2% lidocaine with 1:200,000 epinephrine and rubber dam isolation, the temporary restoration was removed. To prevent accidental displacement of the fragment into other canals during the retrieval process, the orifices of the mesiobuccal and palatal canals were protected with sterile Teflon tape. The entire procedure was performed under a dental operating microscope (Zumax Medical Co., China). A staging platform was first created coronal to the fragment using a modified Gates Glidden #2 bur to improve visualization and provide straight-line access. The retrieval process began with ultrasonic troughing. An ED87 ultrasonic tip (Woodpecker) was used with intermittent activation, keeping its long axis parallel to the fragment to minimize the risk of further fracture. The canal was kept dry to ensure optimal visibility, and dentin was carefully removed from the inner wall of the canal's curvature to a depth of approximately half the estimated fragment length. This created space and initiated a "bodily movement" of the fragment, confirming it was dislodged. To facilitate loop-based retrieval, the ultrasonic tip was used to consciously create an additional 0.5 mm of circumferential space around the most coronal aspect of the fragment. The 27-gauge Kamand instrument needle was placed in the space created by ultrasonic, next to the broken fragment, adjacent to the inner wall of the curvature. The tip of the needle was positioned approximately 2 mm below the file's cross-section. The wire was placed circumferentially around the fragment, 0.5 mm below its surface. Then, by slowly turning the main Kamand screw, the fragment was gently grasped and removed from the canal with lateral and out-of-canal movements. (Figure 6).

Following retrieval, a minor ledge created during the procedure was bypassed with a #10 K-file (Mani Inc., Japan). Working lengths were confirmed with a Propex IQ apex locator. The canals were then cleaned and shaped using M3 rotary files to a final size of 25/.04, with copious irrigation using 2.5% sodium hypochlorite. Final irrigation was performed with normal saline. Obturation was completed with the warm vertical condensation technique using AH Plus sealer and the Fast Fill and Fast Pack system. The tooth was sealed with temporary restoration, and the patient was scheduled for a permanent coronal restoration. (Figure 8).

Follow-up

At the one-year recall, the patient was asymptomatic. Clinical examination revealed no signs of tenderness to percussion or palpation, and periodontal probing depths were within normal limits. A follow-up radiograph confirmed the placement of a definitive restoration. Although the radiographic angle did not permit a complete view of the periapical tissues, the absence of clinical signs and symptoms was indicative of a successful treatment outcome. (Figure 9).

Case 3:

History and Diagnosis

A 33-year-old female patient with a non-contributory medical history was referred to the specialized endodontic department for management of a separated instrument in the mandibular right first molar during RCT. An instrument had fractured during the shaping of the mesiolingual canal. Clinical examination revealed that the tooth was sensitive to both percussion and palpation. Parallel periapical Radiographic examination, utilizing a CMOS sensor (Eighteeth Medical, Changzhou, China), confirmed a fragment approximately 6 mm in length, extending from the mid-canal to the apex, located in the mesiolingual canal (Figure 10). The estimated length of the fragment was 6 mm, and it extended approximately from the middle of the canal to the apex. Given the long length of the fragment, dentin removal up to half the length of the broken fragment would result in significant loss of dentin in the inner wall. Therefore, the retrieval treatment plan was based on the loop technique from the outset. Based on the clinical and radiographic findings, a diagnosis of Previously Initiated Therapy with Symptomatic Apical Periodontitis was made. Given the significant length of the fragment, extensive dentin removal from the inner wall to half its length, as per traditional troughing techniques, would have led to substantial dentin loss adjacent to the danger zone. Therefore, the retrieval strategy was initially planned around a loop-based technique from the outset. The treatment plan, prognosis, and potential risks, including the possibility of being unable to retrieve the fragment, were thoroughly explained to the patient. Written informed consent was obtained before the procedure.

Treatment Protocol

Following local anesthesia (an inferior alveolar nerve block supplemented with a supraperiosteal infiltration of 2% lidocaine with 1:50,000 epinephrine) and rubber dam isolation (Falcon Surgical, Sialkot, Pakistan) Along with liquid dam(Kobalt, Tehran, Iran) to complete the insulation, The Other canals were first cleaned and shaped and then Their orifices were protected with sterile Teflon tape (ZT Dental) to prevent debris entry. The procedure was performed under a dental operating microscope (Zumax Medical Co., China). A staging platform was first created coronal to the fragment using a modified #2 Gates-Glidden drill (Mani Inc., Japan).

Initially, a very fine and long ultrasonic tip was cautiously used to prepare the inner wall, which serves as the optimal location for loop (needle) placement. Specifically, 2 mm of dentin was removed from the inner wall adjacent to the danger zone, beneath the cross-section of the broken instrument (BI). Additionally, 0.5 mm of circumferential dentin was removed from the outer wall adjacent to the fragment. Subsequently, after positioning the 27-gauge needle in the prepared space, the main Kamand screw was slowly rotated to gently grasp the fragment, which was then removed from the canal using gentle lateral and out-of-canal movements. (Figure 11).

Following retrieval, calcium hydroxide (Diadent Chungcheongbuk-do, Korea) was placed as an intracanal medicament, and the access cavity was sealed with a temporary restoration. At the second visit, the temporary restoration and calcium hydroxide were removed and the canals flushed with saline. The working length of all canals was determined electronically using apex locator (Propex IQ, Dentsply Sirona, USA) along with a #15 K-file (Mani Inc., Japan). The canals were then cleaned and shaped with M3 rotary files (UDG, Changzhou, China) up to size 25/0.04. Throughout instrumentation, the canals were irrigated with 5.25% sodium hypochlorite (Kobalt, Tehran, Iran), and patency was maintained with a #15 K-file. A final two-minute rinse with normal saline was performed.

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The canals were obturated using gutta-percha (Meta Biomed, South Korea) and AH Plus sealer (Dentsply Sirona, United States) with the warm vertical condensation technique, employing the Fast Pack and Fast Fill systems (Eighteeth, China). The tooth was sealed with a temporary restorative material (Coltene, Asia Shimi Teb, Tehran, Iran).) and the patient was referred to the restorative department for a definitive restoration.

Follow-up

At a six-month and one-year follow-up, the patient remained completely asymptomatic. Clinical and radiographic examinations showed no adverse signs and were consistent with a favorable healing response (Figure 12). The patient was referred for a definitive cuspal coverage restoration.

Ethical Considerations and Consent

The study adhered to the Declaration of Helsinki. An institutional review board waiver was obtained from the Ethics Committee of Mashhad University of Medical Sciences. Written informed consent for treatment and publication of de-identified images was obtained from all patients.

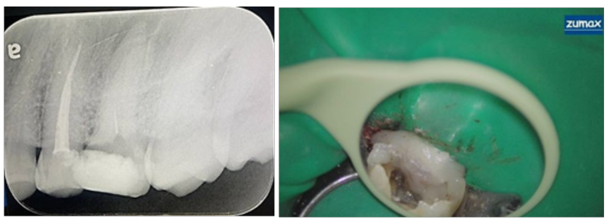
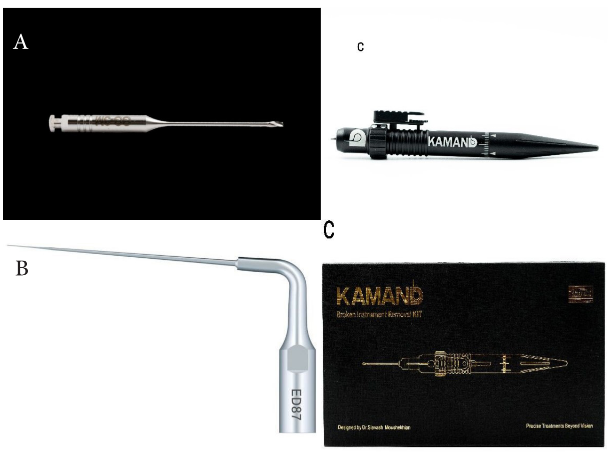


Figure 1. Preoperative radiograph and clinical view showing the separated instrument within the MB2 canal.



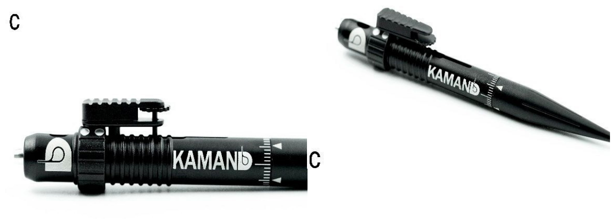


Figure 2. A) Modified Gates Glidden bur utilized for creating a staging platform coronal to the separated instrument. This preparation provides direct visualization and straight-line access to the fragment. & B) ED87 ultrasonic tip (Woodpecker) employed.

Figure 3. Working length determination (A), Radiographic confirmation of master Apical cone (B).

Figure 4. Retrieved fragment measured approximately 3.8 mm in length following removal.

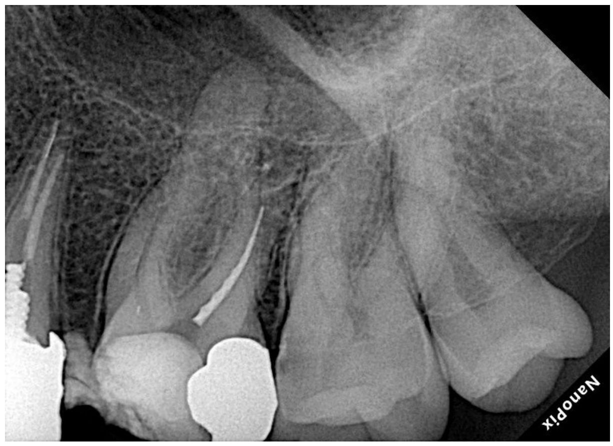


Figure 5. Radiograph view showing the separated instrument.

Figure 6. Stage of creating a staging platform and retrieval file with loop.

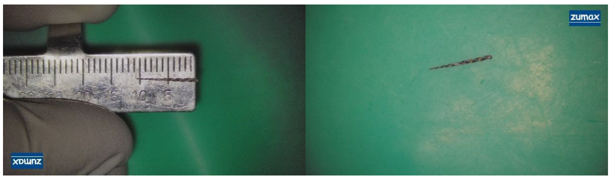


Figure 7. Retrieved metallic particles.

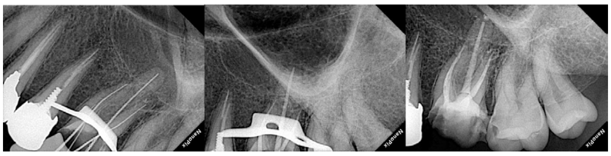


Figure 8. Working length determination (A), Radiographic confirmation of master Apical cone (B), Final obturation (C).

Figure 9. Follow-up session showing Final indirect restoration.

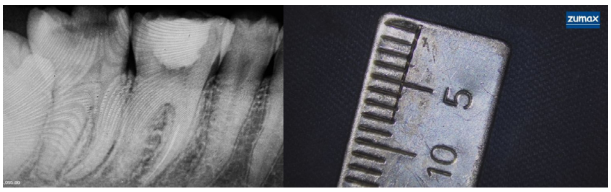


Figure 10. Radiograph view showing the separated instrument (A), Retrieved fragment measured approximately 8mm in length following removal (B).

Figure 11. Working length determination (A), Radiographic confirmation of master Apical cone (B), Final obturation (C).

Figure 12. 6 month follow-up.

Discussion

Instrument separation is a common iatrogenic mishap in endodontics and, while challenging, it is often manageable with modern techniques [2]. The cases presented in this report—retrieval from MB2, distobuccal, and mesiolingual canals—demonstrate a successful, stepwise strategy for managing fractured instruments in anatomically complex situations. This discussion will analyze the key factors that contributed to these outcomes, focusing on clinical decision-making, the synergistic use of ultrasonic techniques and loop-based retrieval systems under high magnification, and meticulous case planning. Firstly, when clinically feasible, the primary objective is complete removal of the separated instrument because retrieval permits thorough canal disinfection and may improve long-term prognosis [15]. This is because fragment retrieval significantly enhances the subsequent cleaning and disinfection of the root canal system, thereby improving the long-term prognosis. Choosing a retrieval method should be based on fragment visibility, length, and its position relative to the canal curvature. Evidence syntheses indicate that ultrasonics are effective for short, visible fragments and gentle curvatures, whereas loop or tube-based systems are preferable for longer fragments or when the fragment lies beyond a pronounced curvature [17]. Secondly, ultrasonic techniques, particularly under a dental operating microscope, are well supported for conservative retrieval; however, excessive troughing can remove tooth structure and increase complication risk, so case selection and controlled dentin removal are critical [8,10]. The initial decision in all three cases was to attempt instrument retrieval rather than bypassing or entombing the fragment. This decision was guided by several factors outlined in the literature. In Cases 1 and 2, the fragments were located in the coronal and middle thirds of the canal and were visible under the dental operating microscope, factors that are associated with a high probability of successful retrieval. Case 3 presented the greatest challenge, with the fragment located in the apical third of the mesiolingual canal. Although retrieval from this location is statistically less predictable, the decision to proceed was based on the straight-line access achievable post-coronal flaring and the presence of symptomatic apical periodontitis, which necessitated maximal disinfection of the canal system. The cornerstone of the retrieval process was the combined use of the dental operating microscope and precise ultrasonic instrumentation. Creation of a conservative staging platform with a modified Gates-Glidden #2 enabled straight-line access and reduced uncontrolled contact between the ultrasonic tip and canal walls. Magnification and illumination were indispensable for guiding the ultrasonic tip to create a conservative trough beside the fragment. Controlled dentin removal preserves root integrity and mitigates perforation risk [8,10,17].

Procedural success was further ensured by intermittent activation with the tip aligned to the fragment's long axis and maintenance of a largely dry field to optimize visibility and mitigate thermal risk. Furthermore, it is crucial to note the nuanced application of these techniques across the presented cases. In Case 1, loop retrieval was successfully achieved with minimal ultrasonic intervention. In Case 2, although the fragment became completely loose through ultrasonic action, it remained lodged within the canal. The use of the loop in this instance was instrumental not only in facilitating its final removal but also in preventing excessive dentin removal by prolonged ultrasonic use and averting a secondary fracture of the instrument, which would have significantly complicated the procedure by creating a fragment at a deeper level. For Case 3, ultrasonics were employed specifically to create space for the loop technique, rather than for complete troughing. This involved removing only 2 mm of dentin from the inner wall of the curvature and a 0.5 mm rim from the outer wall, even if the fragment was not entirely loose, thereby preserving more radicular dentin compared to traditional ultrasonic techniques that might remove up to half the fragment's length. Therefore, the Kamand loop system is particularly advantageous in cases with a visible coronal segment of the fragment, where preservation of dentin is paramount and ultrasonic action is limited solely to creating space for the loop technique [15].

1) Very long fragments—where extensive ultrasonic troughing would risk secondary fracture and excessive removal of radicular dentin [15].

2) Mobilized but unretrieved fragments—when ultrasonics produce bodily movement but the fragment cannot be disengaged from the canal [15].

3) Long fragments in the mid-root to apical region—where maximal dentin preservation is critical and ultrasonics are confined to space creation for the loop [15].

The ultrasonic technique used in these cases allowed controlled dentin removal around the fragment without excessive enlargement, reducing the risk of root weakening or perforation [8,10]. The creation of a 1 mm space around the fragment was sufficient to grab the instrumentation while preserving radicular dentin While ultrasonics were essential for exposing the fragments, the Kamand loop system played a pivotal and complementary role in their final retrieval. This synergy was most evident in Case 2, where the 10mm fragment, despite being mobilized by ultrasonics, could not be removed from the canal by vibration alone. The loop provided the necessary secure grip for its gentle withdrawal. In all three cases, the loop-based system allowed for a definitive and non-destructive retrieval, minimizing the risk of pushing the fragment further apically or causing additional fractures, which can be a concern with prolonged ultrasonic use.

Although this case series highlights its efficacy, the Kamand loop is a relatively new device, and further clinical studies are needed to systematically evaluate its performance against other retrieval systems. The favorable outcomes at the one-year follow-ups, characterized by the absence of clinical symptoms and radiographic signs of periapical healing, validate the efficacy of the applied protocol. Ultimately, successful retrieval of the obstructing fragment allowed for proper cleaning, shaping, and obturation of the root canal systems, leading to the resolution of apical periodontitis. This study has several limitations inherent to a case series. The findings are based on a small number of cases, which limits the generalizability of the results. There was no control group to compare this technique against other methods like bypassing the instrument. Furthermore, all procedures were performed by a specialized operator in a university setting, and success rates may differ for clinicians with varying levels of experience. A specific limitation in Case 2 was the inability to obtain a follow-up radiograph with an optimal projection, though the clinical success was unequivocal.

Conclusion

Microscope-guided ultrasonic troughing followed by loop capture enabled conservative and predictable removal of separated instruments in challenging canal anatomies, allowing definitive chemomechanical preparation and favorable clinical and radiographic outcomes at follow-up.

Conflict of Interest

There is no conflict of interest to declare.

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