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Case Report

Management of separated instruments using a loop technique: Case series with a rapid review

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ABSTRACT

During endodontic practice, a practitioner may encounter iatrogenic errors that are unpleasant and affect the outcome. One common iatrogenic error that can occur during dental treatments is instrument separation. This issue can significantly hinder the disinfection of the root canal system. The clinician must evaluate the treatment alternatives of orthograde or surgical retrieval the separated instrument or bypassing it and sealing the fragment within the root canal space. One method for managing a separated instrument is the loop technique. This case series reports four cases of successful retrieval of separated instruments using the loop technique, which is a reliable, effective, and safe method for file retrieval. It also provides a rapid review of the relevant literature.

Key Words: Dental instrument, endodontics, root canal preparation

INTRODUCTION

One of the iatrogenic errors that every practitioner might face is instruments separated during the root canal treatment. The rate of separated instruments is estimated from 1.83% to 8.2%.[1] The separated instruments might negatively affect the prognosis by impeding the cleaning and shaping of the root canal system and reducing the sealing of the apical foramen.[2,3]

When an instrument is separated, the practitioner has to appraise the treatment options, considering the pulpal and periradicular status, the root canal infection, the root canal anatomy, the position and type of separated instrument, and the amount of dentin loss. The preferred methods include orthograde removal of the separated instrument, surgical retrieval, bypassing the fragment, sealing it within the root canal space, or establishing complete blockage.[4-6]

One approach for managing a separated instrument is orthograde retrieval. For this purpose, special instruments and techniques such as ultrasonic instruments, hollow tubes combined with cyanoacrylate adhesive, trephining methods utilizing an ultrasonic tip or trepan bur, endo extractors, and neodymium-doped yttrium aluminum garnet laser welding have been implemented. Nevertheless, the use of a dental operating microscope (DOM) combined with an ultrasonic device has consistently been identified as a method with high success and safety in many studies.[7]

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One of the approaches for orthograde retrieval is loop techniques that enhance retrieval efficiency when grasping separated instruments.[8] The present case series describes the management of separated instruments by removing them using DOM, an ultrasonic device, and the loop technique.

This case report has been ethically approved by the Ethics Committee of Isfahan University of Medical Sciences (IR.MUI.DHMT.REC.1403.175).

CASE REPORTS

Case 1

A 37-year-old male patient with a noncontributory medical history was referred to the Department of Endodontics with the complaint of separation of endodontic files in tooth #21. After clinical and radiographic examination, the case was diagnosed as previously treated with asymptomatic apical periodontitis. The radiograph revealed that three separated instruments were in the middle and apical third of the canal [Figure 1]. After the separated instruments were successfully removed (described below as the File Retrieval Procedure), the canal was prepared with nickel–titanium (NiTi) rotary instruments to F3 (DENCO Super Files III, China). The canal was irrigated with sodium hypochlorite 5.25% (Cobalt, Iran) and ethylenediaminetetraacetic acid (EDTA) 17% (Cobalt, Iran) using passive ultrasonic irrigation. Obturation was completed with warm vertical technique and AH Plus Jet sealer (Dentsply Sirona, Germany).

Case 2

An 18-year-old male with no significant medical history was referred to the Department of Endodontics for retreatment of tooth #18. After clinical and radiographic examination, the case was diagnosed as previously treated with asymptomatic apical periodontitis. The radiograph revealed a separated instrument in the mesiobuccal (MB) canal in the middle and apical third [Figure 2]. The separated instrument was successfully removed (File Retrieval Procedure described below). The length of the separated instrument was 6.5 mm. The canals were prepared with NiTi rotary instruments to F2 (DENCO Super Files III, China). The canals were irrigated with sodium hypochlorite 5.25% (Cobalt, Iran) and 17% EDTA (Cobalt, Iran) with passive ultrasonic irrigation. Obturation was completed with warm vertical technique and AH Plus Jet sealer (Dentsply Sirona, Germany).

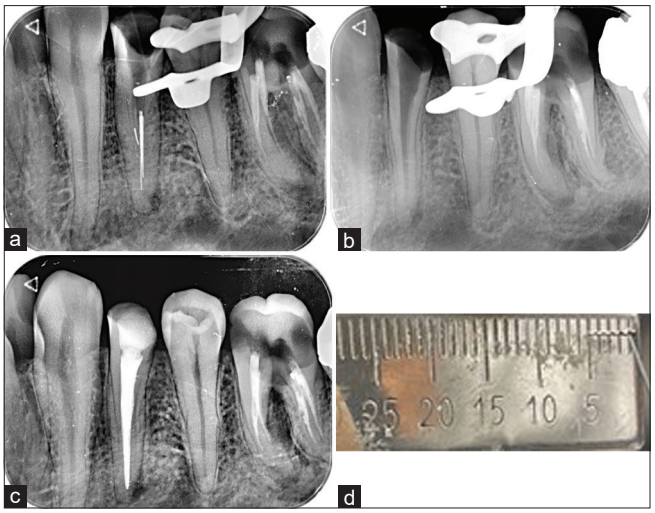

Figure 1: Case 1 with three separated instruments in tooth #21. a) Radiographic examination showing three separated instruments in the canal. b) The instruments were retrieved from the canal and confirmed with a radiograph. c) Root canal treatment completed. d) The length of one of the separated instruments.

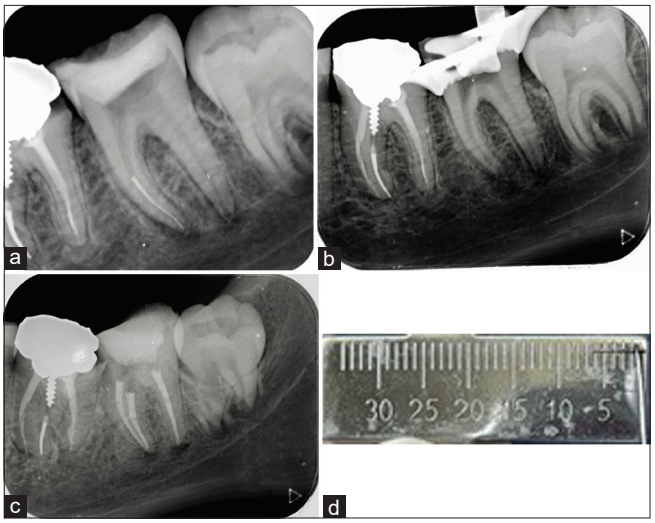

Figure 2: Case 2 with a separated instrument in tooth #18. a) Radiographic examination showing a separated instrument in the MB canal. b) The instrument was retrieved from the canal and confirmed with a radiograph. c) Root canal treatment completed. d) The length of the separated instrument.

Case 3

A 27-year-old male, having no notable medical history, was referred to the Department of Endodontics for retreatment of tooth #3. After clinical and radiographic examination, the case was diagnosed as previously treated with normal periradicular status. The radiograph revealed a separated instrument in the apical and middle third of the MB canal and missed MB2 [Figure 3]. The

separated instrument was successfully removed (File Retrieval Procedure described below) The length of the separated instrument was 7 mm. After the retrieval procedure, gutta-percha was removed from the distobuccal and palatal canals, MB2 was negotiated, and all canals were prepared with NiTi rotary instruments to F2 (DENCO Super Files III, China). The canals were irrigated with sodium hypochlorite 5.25% (Cobalt, Iran) and EDTA (Cobalt, Iran) with passive ultrasonic irrigation. Obturation was completed with warm vertical technique and AH Plus Jet sealer (Dentsply Sirona, Germany).

Case 4

A 39-year-old male with an unremarkable medical history was referred to the Department of Endodontics for retreatment of tooth #31. After clinical and radiographic examination, the case was diagnosed as previously treated with asymptomatic apical periodontitis. The radiograph revealed two separated instruments in the MB and mesiolingual (ML) canals in the middle third beyond the coronal curve and the coronal third, respectively [Figure 4]. After retrieval (described below as the File Retrieval Procedure), the lengths of the separated instruments were 6 mm in the MB and 3 mm in the ML canals. All canals were prepared with NiTi rotary instruments to F2 (DENCO Super Files III, China). The canals were irrigated with sodium hypochlorite 5.25% (Cobalt, Iran) and EDTA (Cobalt, Iran) with passive ultrasonic irrigation. Obturation was completed with warm vertical technique and AH Plus Jet sealer (Dentsply Sirona, Germany).

File retrieval procedure

After isolation with a dental dam and access cavity preparation, the separated instruments were visualized under DOM (Carl Zeiss, Germany). Coronal enlargement was performed, and a modified Gates Glidden size 3 (GG3) was utilized to create a staging platform. Each separated instrument was contacted and vibrated using the ultrasonic system with an endodontic ultrasonic tip (E4 and E9 Eighteeth, China) set at a low power setting. After each application of the ultrasonic device, the canal was rinsed with EDTA 17% (Cobalt, Iran) and dried with paper points. After observing the bodily movements in each of the separated instruments, they were grasped and removed by the BTEX pen (Daimotech, Iran) [Figure 5]. The BTEX pen features a thin, flexible nitinol loop available in various sizes (25, 27, 30 gauge), seamlessly integrated with an ergonomic handle for efficient grasping and extraction of separated instruments. A radiograph was taken to confirm the retrieval of instruments.

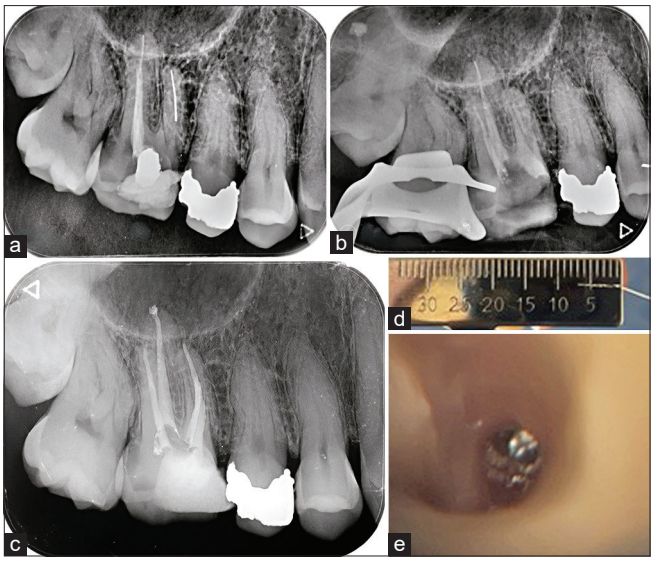

Figure 3: Case 3 with a separated instrument in tooth #3. a) Radiographic examination showing three broken instruments in the MB canal. b) The instrument was retrieved from the canal and confirmed with a radiograph. c) Root canal treatment completed. d) The length of the separated instrument. e) Coronal portion of the separated instrument in the mesiobuccal canal was visualized under a DOM.

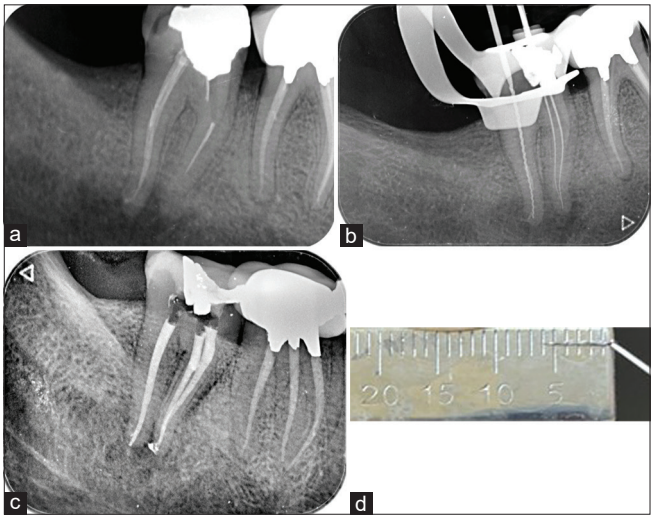

Figure 4: Case 4 with two separated instruments in tooth #31. a) Radiographic examination showing two separated instruments in the MB and ML canals. b) The instruments were retrieved from the canals and confirmed with a radiograph. c) Root canal treatment completed. d) The length of the separated instrument in the MB canal.

Figure 5: a) BTEX pen. b) Retrieval of a separated instrument with a BTEX pen.

DISCUSSION

When dealing with a separated instrument, the primary objective is to thoroughly clean the root canal system. Retrieval of the separated instrument should be attempted whenever feasible. If retrieval is not possible, alternative strategies include bypassing the fragment or obturating the canal up to the level of the instrument. In cases previously treated without any signs or symptoms, opting for no further treatment may also be considered.[9] If the retrieval file was selected, the predictive factors affecting instrument retrieval are: the location, visibility, dimensions, length, and classification of the separated instrument; the curvature of the root canal; the radius of curvature; as well as the operator's experience and level of fatigue.[10-15]

One commonly cited method for retrieving separated instruments in the literature is the technique detailed by Ward *et al*.,[15] which modifies the protocol originally described by Ruddle.[16] This approach involves the use of thin ultrasonic tips, typically after creating a "staging platform" with a Gates Glidden (GG) bur. Ward *et al*. suggest using a size 3 bur for the coronal portion and a size 2 for the apical third, as recommended by Cujé *et al*.[11] The procedure is performed under a DOM to either vibrate and dislodge the instrument or bypass it. This technique has proven effective for removing separated instrument when they are partially located in the straight section of the root canal. However, its success decreases significantly when separated instruments are entirely within the curved portion of the canal, as this increases the risk of root perforation. According to Cujé *et al*.,[11] the lowest success rates are observed in root canals with curvature angles between 41° and 50°.

The retrieval loop is employed for the extraction of separated instruments longer than 4.5 mm in length or in instances where retrieval via ultrasonics proves unsuccessful after a duration exceeding 10 s. In contrast to ultrasonics, which are utilized under wet conditions, the retrieval loop necessitates dry conditions to ensure visibility. Furthermore, loop systems, such as EndoCowboy (Köhrer Medical Engineering), BTR Pen (CERKAMED), and Yoshi Loop (DELabs), are designed to engage and extract elongated, loosened, separated instruments by applying forces in a coronal direction. To use these systems effectively, the canal must have a minimum diameter of 0.4 mm, and the coronal portion of the separated instrument should be exposed to a depth of at least 0.7 mm to allow the loop system to grasp it securely. A #40 plugger is inserted into the canal to assess the space adjacent to the separated instrument. The loop dimensions are then adjusted to match the coronal diameter of the instrument using an endodontic explorer or calibrator. The loop is bent at a 45° angle initially to minimize space requirements for placement over the separated instrument. Once positioned, the loop is inserted into the canal and adjusted to a 90° angle upon contact with the instrument. The loop is tightened around the separated piece and smoothly pulled to extract it. If resistance occurs, the loop should be gently maneuvered in various directions with a swaying motion until the instrument is successfully removed. It is crucial to avoid forcing the loop vertically, as this could cause breakage. The pulling motion and direction are key factors in ensuring successful retrieval.[17]

A literature search showed the promise of the loop technique for file retrieval [Tables 1 and 2]. Barakat *and Attia*. found a significant difference in the changes in root canal space volume before and after instrument retrieval in the BTR Pen and Zumax kit, with the difference being higher in the Zumax kit. However, no significant difference was found for mean fracture resistance. Therefore, retrieving separated instruments from the coronal third of the root canal is considered safe and does not impact tooth fracture resistance.[22] Dulundu and Helvacioglu-Yigit

Table 1: Summary of the loop technique of separated instruments retrieval in case reports/series studies

Study	Year	Location in root	Type of tooth	Instrument length	Instrument type	Conclusion
Terauchi *et al.*[18] Case series (4 cases)	2006	Apical third	Mandibular third molar	8	K file	The loop technique is considered safe as it minimizes dentinal removal, avoids perforation, and prevents weakening of tooth structure
		Apical third	Mandibular second molar	5	K file	
		Apical third	Mandibular second molar	5	N/A	
		Coronal to apical	Mandibular first molar	14	K file	
Terauchi *et al.*[14] Case report	2021	Apical third	Mandibular first molar	4	NiTi instrument	
Aminsobhani *et al.*[19] Case report		Extra radicular	Maxillary second premolar	N/A	N/A	The loop technique required less time than the ultrasonic
Othman[20] Case series (2 cases)	2025	Middle third	Mandibular first molar	5	H file	Combining ultrasonic and loop techniques allows for the predictable retrieval of separated instruments from a root canal while minimizing dentin loss
Koteeswaran *et al.*[21] Case series (2 cases)	2025	Extra radicular	Maxillary first molar	N/A	N/A	The success rate of combining ultrasonics with loop techniques varies from 46% to 100%
		Extra radicular	mandibular second molar	N/A	N/A	
Penukonda *et al.*[24] Case series (3 cases)	2023	Coronal to apical	Mandibular canine	14–15	NiTi instrument	The loop technique is easy to use, minimizes tooth structure damage, and significantly reduces tooth fracture incidence. However, inserting the separated fragment into the loop can be difficult, potentially causing perforations or deviations in the canals
		Apical third	Mandibular first molar	3	NiTi instrument	
		apical third	Mandibular second premolar	7–8	NiTi instrument	

N/A: Not available

Table 2: Summary of the comparison between some techniques of separated instrument retrieval

Article	Year	Retrieval kit	Success rate (%)	Dentin loss	Procedural time
Abdeen *et al.*[23] *Ex vivo*	2023	Ruddle technique	70	2.33±1.03 mm^3	N/A
		TFRK	80	1.28±0.78 mm^3	N/A
		Endo rescue kit	0	3.18±0.83 mm^3	N/A
Barakat *et al.*[22] *In vitro*	2024	BTR Pen	80	1.53±1.04 mm^3	29.56±3.69 min
		Zumax kit	90	3.10±1.69 mm^3	22.89±7.15 min
Dulundu and Helvacioglu-Yigit[8] *In vitro*	2022	BTR Pen	86.7	N/A	23.97 min
		Ultrasonic	83.3	N/A	24.10 min
Shajahan *et al.*[25] *In vitro*	2024	Apical			
		BTR Pen	30	N/A	18.5 min
		Endo rescue kit	0	N/A	0 min
		Ultrasonic	0	N/A	0 min
		Middle			
		BTR pen	70	N/A	34.2 min
		Endo rescue kit	20	N/A	10.8 min
		Ultrasonic	80	N/A	36.6 min

TFRK: Terauchi file retrieval kit; N/A: Not available

concluded that the BTR-Pen and ultrasonic techniques had similar success rates (86.7% and 83.3%, respectively) and similar procedural times (23.97 and 24.1 min, respectively). However, the roots treated with the BTR-Pen system exhibited less fracture resistance.[8] Pruthi found that Terauchi File Retrieval Kit (TFRK) and ProUltra tips were deemed acceptable clinical tools for instrument retrieval, but the loop system required slightly more dexterity.[26] The loop technique is generally a reliable, efficient, and safe method for file retrieval in certain clinical situations

CONCLUSION

By leveraging cutting-edge technologies and refined techniques such as DOM, ultrasonic

tools, and loop techniques, dental professionals can effectively identify and remove separated instruments. Although no single approach ensures consistent outcomes, the success rate of retrieving separated instruments significantly depends on operator expertise, careful case selection, and the application of magnification tools and advanced retrieval systems.

Acknowledgment

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Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or nonfinancial in this article.

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