Retrieval of separated instrument from the root canal– A review of techniques and management of a case

Anchal Mehta[1], Sumita Bhagwat[2,*], Radhika Kulkarni[3], Leena Padhya[4]

[1]Senior Resident, [2]Professor, [3]Associate Professor, [4]Professor & HOD, Dept. of Conservative Dentistry, DYPU School of Dentistry, Navi Mumbai, Maharashtra, India

***Corresponding Author:**
Email: sumita1572@gmail.com

Abstract
Clinicians are frequently challenged by endodontically treated teeth that have obstructions, such as hard impenetrable pastes, separated instruments, silver points or posts in their root canals. Intracanal separation of endodontic instruments may hinder cleaning and shaping procedures within the root canal system, with a potential impact on the outcome of the treatment. This article presents an overview of the literature in relation to management of separated intracanal instruments and a case report of separated instrument retrieval.

Keywords: Separated instrument, Instrument breakage, Instrument retrieval.

Introduction
Root canal treatment is a common dental procedure and most cases are treated uneventfully. But since the endodontic treatment regimen is a technique sensitive procedure, complications may occur at almost any stage of the treatment.

In the quest to develop better instruments and techniques to improve the quality of treatment, we have developed a "double-edged sword", an instrument that can cut and shape the dentin wall efficiently, and cut into the peace of mind of the operator when it gets separated.

The common causes for instrument separation are improper use (overuse or failure to discard when needed), limitation in physical properties, inadequate access, root canal anatomy and possible manufacturing defects.

Factors influencing retrieval
1. **Type of tooth and root canal:** Van Beek (1983) described the anatomy of permanent teeth in detail. He noted that in maxillary first molars, the buccal root canals had a marked distal curvature with respect to the wide palatal canal. Meanwhile in mandibular molars the distal root canal was less curved than the two mesial canals.
   The majority of instrument fractures are known to occur in molars, the most frequently involved root canals being the mesial canals of mandibular molars followed by buccal canals of maxillary molars. The lowest success rates were found in maxillary (50%) and mandibular premolars (50%).[1]
2. **Site of fragment:** Separation of instrument could be at any level in the canal such as coronal third, middle third, apical third or beyond the apex. The site at which the instrument separates could also influence success rate of its retrieval from the canal.[1]
   In a study by Van Beek, all the separated instruments from the coronal third of the root canal could be removed completely. When the separated instruments were located in the middle third success rate was 68%. For the apical third success rate of retrieval was 59% of separated instruments.
3. **Site of separated instrument with regard to curvature of the root:** Most of the separated instruments were localized inside or beyond the root canal curvature. The success rate was 58% and 52% respectively, which was lower than in straight canals with a success rate of 82%. The highest success rate was found when the instrument had fractured before the curvature.[1]
4. **Degree of curvature of the root:** Research has shown that success rate was highest in roots with a curvature between 0° and 10°(74%) and only slightly worse in root canals with curvature from 11° to 20° and 21°-31° (67%and 68% respectively). Separated instrument localized apical to the curvature show a relatively low success rate compared to fragments localized coronally or inside the curvature.[1]
5. **Type of separated instrument:** Studies have shown that most of the separated instruments are often hedstorm files & their retrieval rate is about 67%. Success rate for retrieval of lentulospirals was found to be very good at 93%. Reamer type separated instruments were treated successfully in almost 76% of the cases.[1]
6. **Length of instrument fragment:** The length of the separated instrument also has a significant impact on the success rate of retrieval. Separated instruments shorter than 5mm have shown a success rate of retrieval of 62% and those between 5-10mm length showed 79% of success rate. For those between 10.5-15mm length, success rate was 89%.[1]

Armamentarium and techniques for broken instrument retrieval

While there is no standard protocol for retrieval of separated instruments from a root canal, there is a practical sequence in which retrieval is attempted, depending upon armamentarium available for the same.

A variety of kits and instruments are available to secure a separated instrument.

All armamentarium and techniques exhibit maximum utility and efficacy when used under magnification with either magnifying loupes (Fig. 1) or under dental operating microscope. (Fig. 2)

Fig 1: Magnifying loupes

Fig 2: Dental operating microscope

Endodontic ultrasonic tips

They have a contra angle design with alloy tips of different lengths and sizes to enable use in different parts of the root canal[2] (Fig. 3). A staging platform is prepared around the most coronal aspect of the fragment by using modified GG drills or ultrasonic tips.[3] The platform is kept centred to allow better visualization of the fragment and the surrounding dentin root canal walls, therefore equal amounts of dentin around the fragments are preserved. The ultrasonic tip is activated at lower power settings, so it trephines dentin in a counterclockwise motion around a fragment. With this trephining action and the vibration being transmitted to the fragment, the later often begins to loosen and then jumps out of the canal.

Fig 3: Endodontic ultrasonic tips

GG Drills

With safety in mind, radicular access is an important step required in the successful removal of a broken instrument. If radicular access is limited, hand files are used serially small to large, coronal to the obstruction, to create sufficient space to safely introduce Gates Glidden (GG) drills. Gates Gliddens (Fig. 4) are rotated at speeds ranging between 800 to 900 rpm and, importantly, are used like "brushes" to create additional space and maximize visibility coronal to the obstruction. Increasingly larger Gates Gliddens are uniformly stepped out of the canal to create a smooth-flowing funnel that is largest at the orifice and narrowest at the obstruction.

Fig 4: Gates Glidden Drills

Masserann Kit

The Masseran Kit (Fig. 5) consists of 14 hollow cutting trephine burs (sizes 11-24) ranging in diameter from 1.1-2.4 mm and 2 extractors (tubes into which a plunger can be advanced). The trephines (burs) are used in counterclockwise fashion to prepare a groove (trough) around the coronal portion of the fragment. When inserted into the groove and tightening the screw, the free part of the fragment is locked between the plunger and internal embossment. The relatively large diameter of the exractors (1.2 and 1.5mm) require removal of considerable amount of dentin, which may weaken the root and lead to perforation and post operative root fracture.[4,5] This largely restricts the use

of Masserann instruments to anterior teeth.[6-8] However, by creating a wider space between the tube and plunger inside the tubular extractor, it can be used in the straight portion of canals of posterior teeth.[9] This also increases retention while gripping the firmly wedged separated instrument.

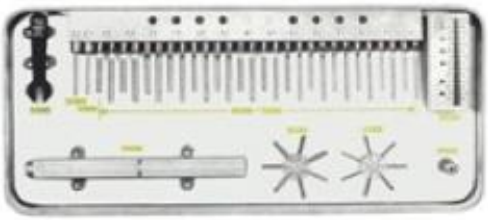

Fig 5: Masserann Kit

Roydent Extractor

The endo extractor system (Roydent) (Fig. 6) has 3 extractors of different sizes & colors (red 80, yellow 50 & white 30). Each extractor has its corresponding trephine bur that prepares a groove around the separated instrument. The extractor tip contains six prongs.[10,11]

The disadvantage is that there is a lack of variety of instruments and potential breaking of the prongs may occur. It is only to be used for the removal of small obstructions.

Fig 6: Roydent Extractor

Brasseler Endo Extractor

This system includes a cynoacrylate adhesive, 4 trephine burs and an extractor (Fig. 7). The recommended amount of overlap – 2mm.

The disadvantage is that trephine burs are larger than their ISO equivalent. The bur cuts aggressively when new.

Fig 7: Brasseler endo extractor

Microtube Retrieval Methods

a) Spinal Tap Needle
b) Lasso & Anchor
c) Tube & Glue
d) Masserann
e) Endo Extractor/Meisinger Meitrac
f) The Instrument Removal System
g) Separated instrument retrieval system
h) Tap and thread

Another technique advocated to remove broken instruments utilizes a microtube and a hedstroem file. With limitations, this method of removal involved sizing and gauging the correct microtube so it could reach and be placed over the ultrasonically exposed obstruction. Microtube sizes that were clinically relevant were 18, 20 and 22 gauge. Because of their unique ability to engage, a 35, 40 or 45 hedstroem was selected and, when possible, inserted into the coronal most aspect of the microtube. The hedstroem was then passed down the length of the tube until it was engaged tightly between the obstruction and the internal lumen of the microtube and then all three were pulled out together.

Proultra Endo

The development of Pro-ultra endo 3, 4, 5 tips (Fig 8) is a clinical breakthrough in nonsurgical ultrasonic instrumentation, as their contra-angled and parallel walls improve vision when working below the orifice. Additionally, the ENDO-3, 4, and 5 are stainless steel instruments coated with zirconium nitride to improve durability and cutting efficiency. Importantly, zirconium nitride resists corrosion regardless of the irrigant employed, does not flake off during use, and provides safe efficiency when performing delicate and precise intracanal procedures, as compared with more aggressive diamond coatings. The ProUltra instruments are used on the lower power settings.

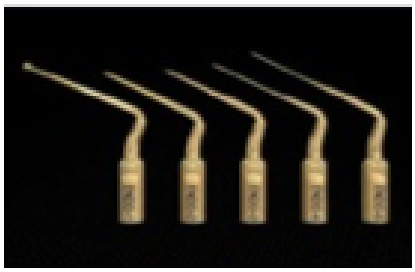

Fig 8: Proultra Endo

File Braiding Technique

This technique involves the use of several H files (Fig. 9). This method can be effective when the fragment is positioned deeply in the canal and not visible and the clinician is relying on tactile sense or the fragment is loose but cannot be retrieved by using other means.[12,13]

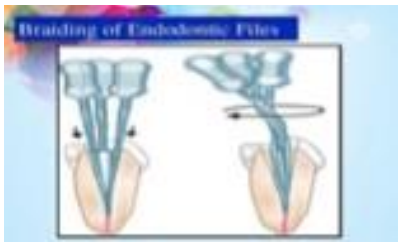

Fig 9: Braiding of Endodontic Files

Canal Finder System

This system consist of a hand piece and specially designed files[14] (Fig. 10). This system produces vertical movement with maximum amplitude of 1-2 mm that decreases when the speed increases.[15] It effectively assists in bypassing a fragment, but caution should be exercised not to perforate the root or apically extrude the fragment, especially in curved root canals. The flutes of the file can mechanically engage with the separated fragment, and with vertical vibration, the fragment can be loosened or even retrieved.[16] In a clinical study that used the canal finder system as the primary retrieval technique, a 68% overall success rate was reported.[17]

Fig 10: Canal finder system

Bypassing

The ultimate goal of management of separated instruments is not only to retrieve the fragment but also to preserve the integrity of the tooth. With associated complications, bypassing a fragment located deep in the root canal or beyond the root canal curvature if possible, may be only appropriate treatment option (Fig 11). To some extent it fulfills the objective of root canal treatment: proper cleaning and shaping of the root canal system followed by good filling. Thus, bypasssing a separated fragment has been considered as a successful approach.[17-21]

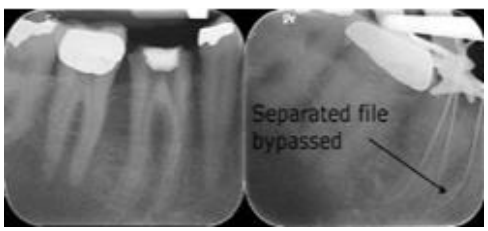

Fig 11: Bypassing technique

Separated Instrument Removal System

The iRS (Fig. 12) is a device for engaging and removing broken instruments. Each iRS is composed of a different gauge microtube and screw wedge. It contains 3 extractors. The black extractor has an outside diameter of 1mm and is used in the coronal one third of larger root canals. The red and yellow extractors are used in narrower canals.[22]

Fig 12: Separated instrument removal system

Case Report

A 27 year-old female patient reported to DY Patil School of Dentistry with a chief complaint of pain in upper front tooth region since a week.

On examination, 21 had Ellis class III fracture. Intraoral periapical radiograph revealed pulpal involvement of 21 and mild periapical changes in relation to 21.

Thermal test (heat & cold) were performed and the patient gave positive response to both heat and cold, which was comparable with the adjacent teeth, indicating positive vitality.

A provisional diagnosis of chronic irreversible pulpitis secondary to Ellis class III fracture with 21.

The treatment plan was to perform root canal treatment of 21.

Treatment procedure

Initial treatment- Root canal treatment was initiated in 21. Working length was determined, canal was irrigated using 3% Sodium hypochlorite. Cleaning and shaping was performed till #40 no. H file using Step back technique. The canal was obturated using 2% Gutta percha by lateral condensation technique.

One week after the obturation, the patient complained of pain in 21. An IOPA radiograph was taken and the obturation was found to be 1.5mm short of the apex. Retreatment was initiated and the gutta percha was removed using H files. During the process of gutta percha removal #25 and #30 no. H files got separated within the canal in the apical 3rd of the root.

The patient was informed about the instrument separation within the canal and also about the different techniques with which an attempt could be made to retrieve the fragments. Informed written consent was duely taken from the patient.

Access opening was modified using round bur, so as to widen the orifice for better visualization. IOPA radiograph was taken to determine the exact site of separation. Radiographic examination revealed 2 H files in the apical 1/3rd of the canal. (Fig. 13)

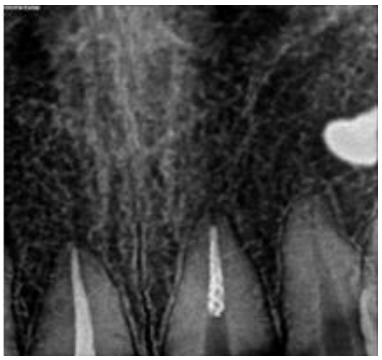

Fig 13: IOPA showing separated instruments in apical 3rd of 21

The instrument retrieval was carried out in two sittings.
The first step of retrieval was carried out under Dental operating Microscope.
Canal was irrigated using saline and #10 and #15 K files were used for retrieval.
The fragments could not be engaged with hand files and hence an ultrasonic tip was used.
Ultrasonic tip that could passively fit next to the separated instrument was used.

The tip of the ultrasonic device was placed in direct contact with the coronal part of the separated file and activated repeatedly at short intervals until the fragment became loose.

One instrument fragment was thus retrieved. The second fragment appeared to be embedded in the dentinal wall. Another attempt at retrieval was made in the subsequent appointment using #15 H file under copious irrigation by circumferential filing motion. The fragment was successfully dislodged from the dentinal wall and retrieved. A radiograph was taken to confirm complete retrieval of all fragments from the canal. (Fig. 14 & Fig. 15)

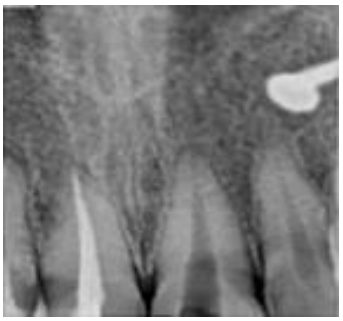

Fig 14: IOPA x ray confirming removal of separated instruments

Fig 15: Instruments fragments retrieved from 21

The canal was thoroughly irrigated and Calcium hydroxide closed dressing was placed and patient was recalled after a week.

Working length determination was done, cleaning and shaping was performed till #45 no. H file using step back technique. A master cone radiograph was taken to confirm the apical fit of master cone (Fig 16). Obturation was done with #45 gutta percha and lateral condensation technique. A post obturation radiograph was taken (Fig. 17).

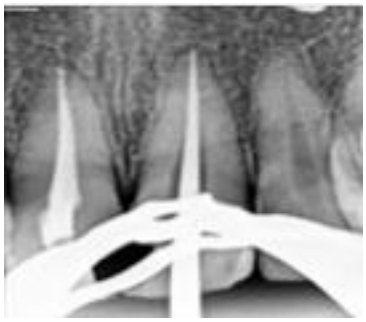

Fig 16: Mastercone IOPA x ray of 21

Fig 17: Post obturation IOPA x ray of 21

Discussion and Conclusion

Every case of instrument separation within a root canal is very unique. No standardized procedure for the successful removal of broken instruments in the canal exists, however various techniques and devices have been successfully employed for the same. Many factors must be considered before removal of separated instruments is attempted. The chances of success should be balanced against potential complications like excessive thinning of remaining dentinal wall and compromise in structural integrity of the tooth. The best

antidote for a separated file is prevention. Adhering to proven concepts, integrating best strategies and utilizing safe techniques during root canal preparation procedures will virtually eliminate the separated instrument procedural accident. Prevention may also be greatly facilitated by thinking of negotiating and shaping instruments as disposable instruments. Simply discarding all instruments after the completion of each endodontic case will reduce breakage and lost clinical time and may well put all literature related to instrument separation in the archives.

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