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REVIEW ARTICLE

Our needles in the haystack: An endodontist's review and case reports

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Abstract

During root canal preparation procedures, the potential for instrument breakage is always present. This review focuses on basic principles involved in separated instrument retrieval, factors on which successful retrieval of the separated instrument depends on and various treatment options available for the same. A decision-making flowchart for the techniques to be used in the management of intracanal separated instruments is presented. Prognostic factors depending on the phase (that of chemo-mechanical preparation) of separation and pre-operative status of pulp are discussed. Few case reports that document cases with instrument separation that were successfully treated in our department are also presented.

Keywords: Instrument retrieval, dental operating microscope, prognosis, runaway gates, staging platform

Introduction

Many objects have been reported to separate and subsequently anchor themselves in root canals. Glass beads from sterilizers, burs, Gates-Glidden (GG) drills, amalgam, lentulo paste fillers, files and reamers, nails, pencil lead, toothpicks, tomato seeds, hat pins, needles, pins: all have eventually succeeded to get stuck in unwanted places in root canals.[1]

Instrument separation instantly (if realized the moment it happens, some of them may go unnoticed.!!, [Figure 1]) evokes apprehension, despair, and frustration. After all the deal was to deliver a quality treatment to the patient, not to bestow him/her with our delicate tools..!!

Files and reamers are the most frequently encountered culprits.[2] The introduction of Ni-Ti rotary instruments has lead to an increased incidence of separation because of cyclic fatigue and torsional stress incorporated in these files rotating on high speeds.[3] The angle and radius of canal curvature, the frequency of use, thermo-cycling, and instrument procedures (pre-flaring and the establishment of glide path) involved in the chemo-mechanical preparation of the canal; all contribute to the separation of endodontic files.[4]

The most common canals to witness separation of instruments are the mesial canals of mandibular molars, and the mesiobuccal (MB) roots of maxillary molars. These roots not only curve distally, but often the MB canal curves lingually, and the mesio-lingual canal (ML) curves slightly to the buccal. These lingual and buccal curves are not visible on an Intraoral periapical radiograph (IOPAR).[5]

You may end up with any of the following three possible outcomes when treating these cases:

i. Retrieval
ii. Bypass and entomb the instrument
iii. Irretrievable instrument

Success of retrieval depends on:[5,6]

1. The Canal anatomy (diameter, length, and curvature)
2. The Composition of the broken fragment
3. The length of the separated fragment
4. The location of the fragment-coronal, middle, apical third of the canal or beyond apex
5. The thickness of dentin and the depth of an external concavity

Instruments that lie in the linear portions of the canal (even in the apical third) can typically be removed.

Figure 1: Some instrument separations may go completely unnoticed

Retrieval of instruments that lie along the canal curvatures can be attempted if straight-line access can be obtained to their coronal-most extent.

If the fragment lies apical to the curvature of the canal and safe access cannot be established, then retrieval is usually not possible and heroic attempts to salvage the tooth may be impractical.

Instrument Retrieval: Factors Governing, Principles, and Techniques

Factors governing the successful retrieval of an instrument

1. Optics
2. Coronal and radicular access.

Optics

Working under high magnification like a dental operating microscope (DOM) improves vision and significantly increases the likelihood of retrieval. Attempting to remove a fragment without adequate visualization is a blind experiment, and overzealous attempts to do so can lead to the removal of dentin in places where it will have no benefit or disastrous complications like perforations.

Coronal access

Coronal flaring and establishing a straight-line access is the first step in attempting to remove an instrument.

Radicular access

Following adequate coronal flaring, hand files are used starting from the coronal aspect of the obstruction and working up the orifice. Hand files create a smooth and safe "glide-path" for subsequent introduction of GG drills which when used in a sequential manner will provide direct access and visibility to the head of the broken instrument.

Principles involved[5]

i. Tube-sleeve-fit principle: A microtube is placed over the exposed part of the fragment, and a corresponding stylus is used to "lock" the fragment. An adhesive could also be used with the micro tube. This technique is mainly indicated in the coronal and middle third as adequate dentin must be present peripheral to the fragment.

ii. Disengage, rebound and recover: Ultrasonic (US) vibrations are used to "tease" the fragment coronally. This technique is indicated in apical third with the coronal most part of the fragment just beyond curvature or when minimal dentin exists peripheral to the fragment.

Techniques of instrument retrieval

Specialized forceps[7]

Can be used for retrieval of loosened silver cone, a loose endodontic file or a shaft of the GG drill (coronal third).

1. Stieglitz forceps: It is a serrated needle-nosed plier, but it is too bulky for small access openings.
2. Perry gold foil pliers, Peet splinter forceps, Hartman 3½ mosquito forceps (curved): Taper on beaks of these forceps is more gradual and hence the beaks are very slender. These forceps are indicated in deep access openings. Furthermore, the tips are stronger than that of Stieglitz's.

Single file technique[7]

Can be used for retrieval of a silver cone or endodontic file (coronal/middle third).

If adequate space is available between the separated fragment and the dentinal walls, insert a Hedstrom-file alongside the fragment until tight; it is followed by gently pulling the file-fragment "assembly" towards the orifice. H-file used in this technique should be larger (ISO 35 or larger).

File braiding technique[7]

Can be used for retrieval of a silver cone (coronal/middle third).

Place two or more Hedstrom files alongside the silver cone as far apically as possible, and screw them into position until tight. Screw and twist the Hedstrom files together to engage the silver cone and pull them simultaneously. H-files used in this technique are usually smaller (ISO 20-ISO 35).

Microtube removal techniques[8] (coronal/middle third)

Numerous kits are available for the retrieval of separated instruments. Some of the commonly used kits are discussed below:

a. The Endo Extractor (Brasseler): This kit consists of trephining burs, extractors, and an adhesive cement (cyanoacrylate). These are finger instruments and hence the main disadvantage of these instruments is that they block visibility when working under DOM.

b. The cancellier instrument (Sybron Endodontics): This kit is similar to Endo Extractor but unlike finger instruments in Endo Extractor, these instruments are manufactured with a handle which allows straight-line vision under DOM. Furthermore, this kit does not include any trephine burs.

c. The Masserann kit (Medidenta International, NY): It

consists of trephine burs and extractors. These burs trephine in an anticlockwise direction, which imparts additional unscrewing action.

d. The Extractor System (Roydent Dental products): This kit includes 1 trephining bur and 3 extractors. Each extractor has 6 prongs to grasp the fragment.
e. Instrument retrieval system -iRS (DENTSPLY-Tulsa Dental): It consists of two microtubes and their corresponding internal stylus. First, the microtube is inserted; engaging the fragment, following which the stylus is inserted into the micro tube locking the fragment.
f. Separated instrument removal (SIR) system (Vista Dental products): This kit consists of bendable dead soft tubes and adhesive cement (cyanoacrylate). Because the tubes are flexible, it allows easy access, even in cases of curved canals.
g. File removal system (not in the market yet):[9] Terauchi *et al.* developed this system. It involves three sequential steps:
    - Step 1: Two low-speed burs are used. The cutting bur A (diameter 0.5 mm) has a pilot tip and is used to enlarge the canal. The cutting bur B has a hollow cylindrical tip (diameter 0.45 mm) and is similar to a trephining bur. Both burs are flexible and hence can be used in curved canals. If this step fails, step 2 is attempted.
    - Step 2: An US tip is used to prepare a groove around the fragment. This usually removes the fragment, but if this step also fails, step 3 is attempted
    - Step 3: This step works on wire-loop-and-tube-method. One part consists of a head connected to a disposable tube (0.45 mm) with a brass body made of NiTi wire (0.08 mm), which forms a loop. This loop is used as a "lasso" to grasp the fragment. The second part consists of a sliding handle that holds the wire. When the handle is moved downward, it fastens the loop and *viz*.
h. Remove all kit (Sybron Endo): It consists of 2 trephines and 4 easy push extractors. With a squeeze of the thumb and forefinger and a twist of the wrist, the obstruction lifts out of the canal along with the extractor.
i. Meitrac endo safety (Quality Endodontic Distributors): Similar to remove all kit but trephine drill includes a ventilation aperture for stress-free working.
j. Others: Microtube with Hedstrom files technique and wire-loop-and-tube method.

US (Coronal, middle and apical third)

Microscopic visualization with US instrumentation is a safe and effective combination for retrieval of instruments and introduction of US has reduced the time and at the same time increased the predictability of the treatment.

A staging platform [Figure 2b-d] is created at the level of the "head" of the separated fragment using Runaway gates [Figure 2a]. Sectioning the conventional GGs at the maximum diameter using a diamond stone makes runaway gates. Conventional GG drills are operated at around 750 rpm whereas Runaway gates are operated at a decreased speed of about 300 rpm.[5] It is prudent to conduct all US instrumentation below the orifice in a dry field to ensure a clear field of operation.[5]

Bypass and entomb

When all the attempts fail to retrieve the instrument, bypassing the fragment allows cleaning and shaping of the entire canal and hence ensures favorable prognosis. Bypassing should also be the treatment of choice when the fragment is not visible under DOM. It consists of wedging a stainless steel size 8 or 10 K-file between the fragment and the dentinal wall and then the file is advanced and withdrawn repeatedly in an attempt to reach the full working length.

Surgical management[9]

Includes apical surgery, intentional replantation, root amputation, or hemisection.

Surgical intervention can be warranted if the orthograde removal techniques fail and the tooth presents with a periapical lesion at the time of separation. Fragments in the apical third are removed during root resection itself.

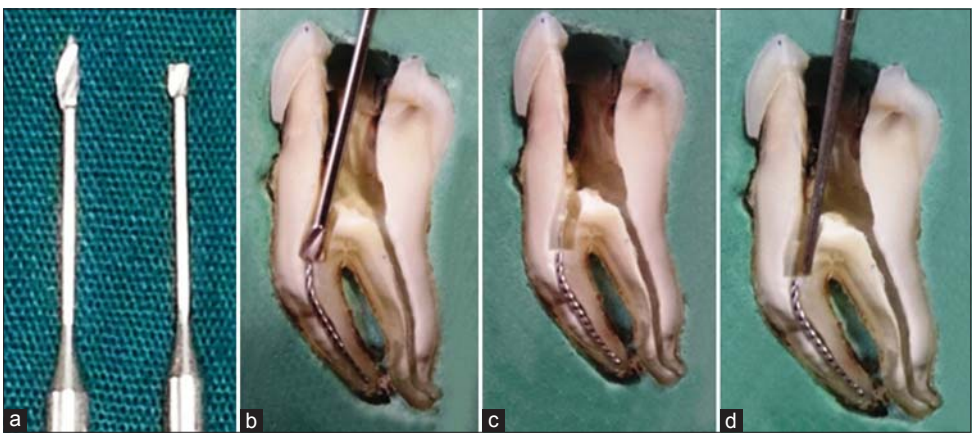


Figure 2: (a) Runaway gates, (b) coronal and radicular access followed by preparation of staging platform, (c) staging platform complete, (d) ultrasonic tip placed on the platform

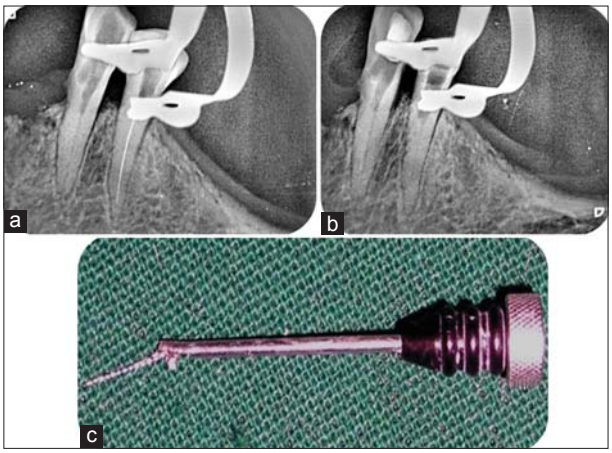


Figure 3: (a-c) # 15 stainless steel K file was separated in the lower canine of this patient. Instrument retrieval system (iRS) was used to retrieve the fragment

Figure 4: (a-c) # 20 stainless steel K file was separated in the upper central incisor of this patient. Instrument retrieval system (iRS) was used to retrieve the fragment

If the fragment is located in the middle third, a retrograde filling can be done following retro-preparation without fragment removal.

Electrochemical dissolution[10]

This technique has been tried *in vitro* for removal of separated instruments. It requires the existence of two electrodes immersed in the solution, one acting as a cathode and the other as an anode. An adequate electrochemical potential difference is imposed between the two electrodes, resulting in the migration of the electrons from the anode to the cathode and consequently, the release of metallic ions to the solution. This process results in the progressive dissolution of the fragment inside the root canal. It has the following advantages over conventional methods:

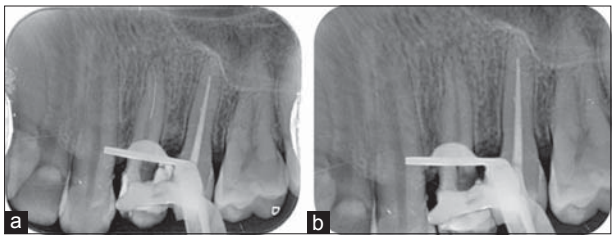


Figure 5: (a and b) # 20 stainless steel file K file was separated in the upper premolar of this patient. A close look at the intraoral periapical shows adequate space between root canal wall and the fragment. The fragment was retrieved using ultrasonic (US)

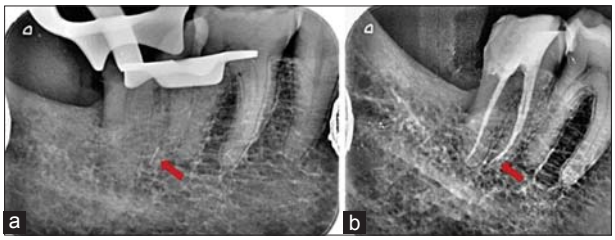


Figure 6: (a and b) An F1 Protaper file separated in the mesio-lingual canal in the lower second molar in this patient. The obturation was done till the level of the fragment. The instrument could neither be retrieved nor be bypassed. After 8 months of treatment, patient is currently asymptomatic

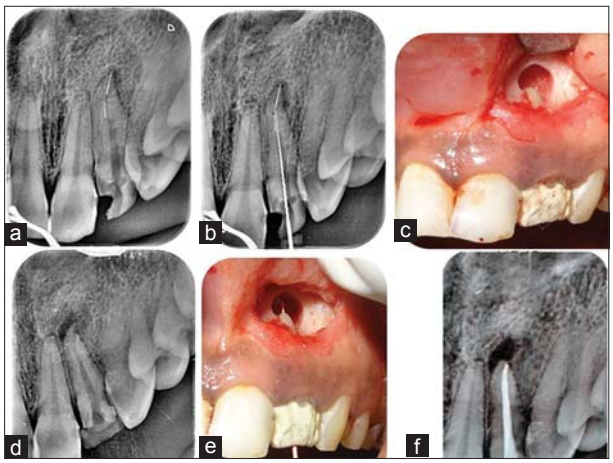
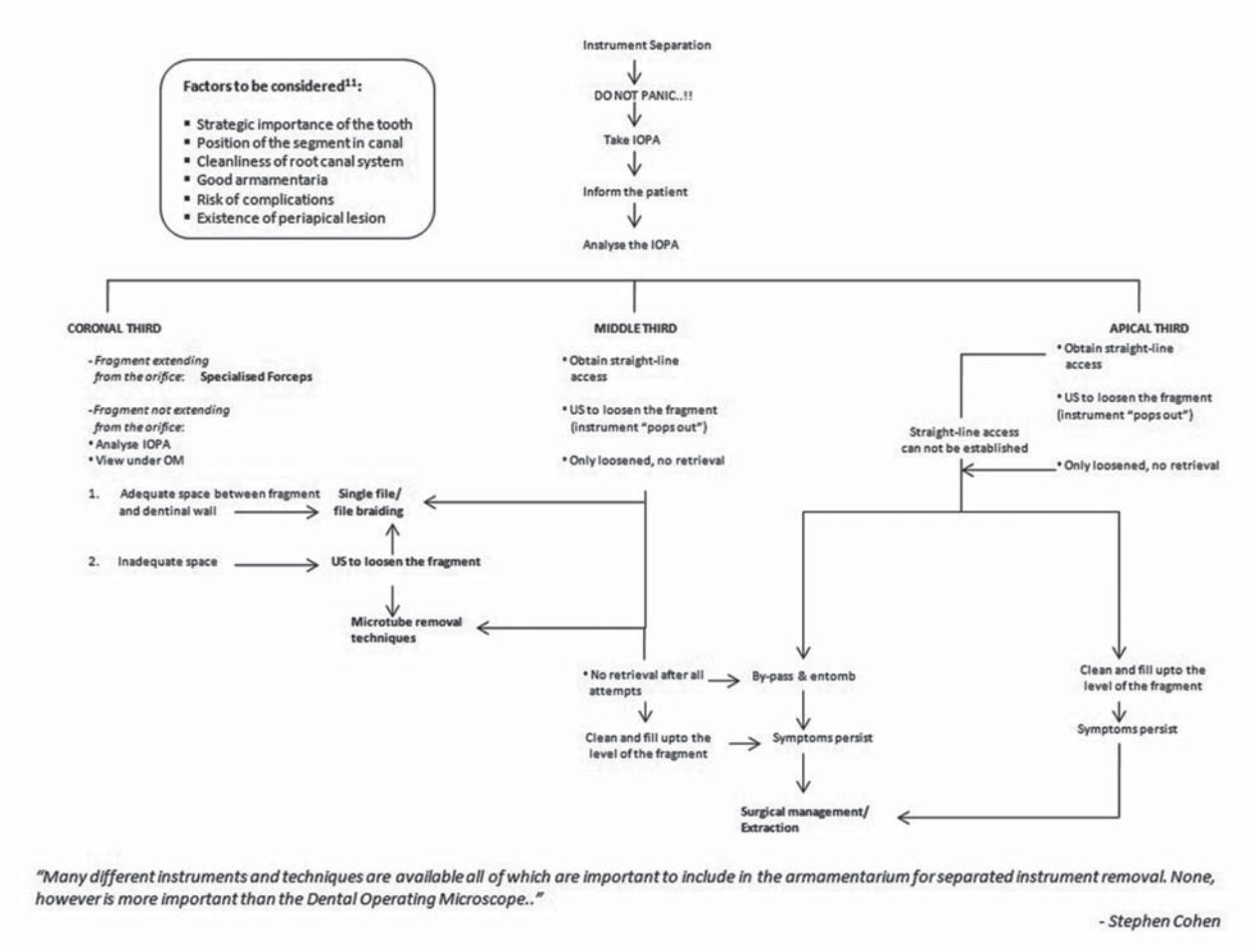


Figure 7: This patient reported to the department with a chief complaint of a dislodged crown in relation to her upper left lateral incisor. Intraoral periapical radiograph (IOPA) in relation to 22 reveals a separated instrument in the apical third. The second instrument is an ultrasonic (US) file that separated when attempting the removal of the apical fragment. The US file was bypassed and subsequently came out with irrigation when flushed with 3% NaOCl. Apical surgery was planned for the first fragment. (a) US file that separated when attempting the removal of the apical fragment, (b) US file bypassed, (c) lesion curetted and apicoectomy done, (d) IOPA confirms successful retrieval of the fragment, (e) mid-surgical obturation, (f) post-obturation



Flowchart 1: Decision-making flowchart for the techniques to be used in the management of intracanal separated instruments

1. Increased safety as compared to mechanical methods
2. Not necessary to obtain straight-line access
3. Minimal removal of dentinal tissue

Prognosis

- Prognosis of the tooth after instrument separation depends on:[11]
  - Pre-operative status of the pulp and periradicular tissues (vital/non-vital or infected/non-infected or periapical radiolucency present/absent?)
  - Phase at which separation occurs (CMP complete/"almost" complete?)
  - Whether or not the file can be removed/bypassed
- Prognosis is favorable if the CMP is almost complete at the time of separation[12] (e.g. separation of the F3 file in case of Protaper Rotary System). Furthermore, if the pre-operative pulp is vital and there is no apical periodontitis, the presence of the separated instrument should not affect the prognosis.[7]

Flowchart 1 shows a decision-making flowchart for the techniques to be used in the management of intracanal separated instruments [Flowchart 1].

Following are some case reports that document some cases with instrument separation that were successfully treated in the Department of Conservative Dentistry and Endodontics, M.S.Ramaiah Dental College, Bengaluru.

Case Reports

A. Coronal third
   - Case 1 [Figure 3a-c]
   - Case 2 [Figure 4a-c]

B. Middle third
   - Case 3 [Figure 5a and b]

C. Apical third
   - Case 4 [Figure 6a and b]
   - Case 5 [Figure 7a-f]

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