

Broken Instrument Retrieval: A Review

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ABSTRACT

Background: Root canal treatment is full of challenges, curves, complexities and contentment. Broken instrument in the canal is one such mishap leading to stress and anxiety among both. It not only hinders in cleaning and shaping of the canal but also affects its prognosis. Various methods are available for retrieval of broken instrument with its own advantages and disadvantages. This article presents an overview of cause, prevalence and management of separated intracanal instrument.

Keywords: Broken instrument, retrieval, NiTi, prognosis.

INTRODUCTION

Who has not felt the pang, the anguish, the mortification caused by the breaking of an instrument? That moment of remorse lives on for days until it is faded out by time."These sage and emotional words were published by Dr. Louis I. Grossman almost 50 yrs ago and yet "the pang, the anguish, and the mortification" continue to plague us¹.

Every clinician who has performed endodontics has faced a variety of emotions ranging from the excitement to a dismay like the procedural accident of breaking an instrument. During root canal preparation procedures, the risk for instrument breakage is always present. When instrument separation occurs, it leads to distress, nervousness, and then the hope that nonsurgical retreatment techniques exist to remove the instrument from the canal.^{2,3} Fractured root canal instruments may include files, silver point, a lentulo, a Gates Glidden burs, spreaders, and paste fillers, and they can be made from nickel-titanium (NiTi), stainless steel or carbon steel.^{3,4,5}

Two ways of fracture of rotary NiTi endodontic instruments have been recognized clinically: (1) torsional fracture and (2) flexural fracture. Of clinical concern is the fact that flexural fatigue occurs with no visible signs of deformation of the instrument, and, as such, there are no signs to warn the clinician that the instrument is fatigued.⁶

Furthermore, fracture of rotary NiTi instruments may occur without forewarning and it is often not noticed without magnification.⁵ When instrument separation occurs, the clinician has the choice of leaving the instrument in the canal or attempting to retrieve it.⁷

A number of techniques are available to ease the removal of separated instrument in the canal. Each technique has its own advantages and disadvantages. Technology advancements such as dental operating microscope, ultrasonics and lasers have not only reduced the stress and anxiety of clinician and patient but also has resulted in high success rate in instrument removal.

The purpose of this review article is to summarize the current understanding of the prevalence, causes,

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its impact on prognosis, recommendations concerning clinical decision making associated with fractured rotary NiTi instruments and the techniques in managing fractured instrument .

Factors Contributing To The Instrument Fracture

5,6

Anatomy of the root canal system, both in terms of radius and degree of curvature ;
Operator's proficiency
Operating speed and torque ;
Number of uses ,
Cleaning and sterilization procedures
Cross-sectional area and design of the instrument.
Preparation/Instrumentation Technique
Manufacturing process
Dynamics of instruments use

Different Strategies When Coping With The Broken File:

Management of a case with a broken instrument may involve an orthograde or a surgical approach. The three orthograde approaches are⁸

- (a) Attempt to remove the instrument;
- (b) Attempt to bypass the instrument; and
- (c) Prepare and obturate to the fractured segment.

The aim of treatment remains the same, namely disinfection of the canal. In removing the fragment one must take into consideration the amount of destruction it causes. If instrument removal is considered to be very dangerous excellent results can be obtained by bypassing the fragment and inserting the root filling⁷. Finally if its impossible to bypass then canal should be cleaned, shaped and obturated till the blockage .Success rate will depend on disinfection and fragment position. However radiographic follow up is mandatory for evaluation of periapical health .If lesion is seen to be increasing with clinical symptoms apical surgery or extraction should be done.

Factors Influencing Broken File Retrieval^{2,3,9,10}

The ability to non-surgically access and remove a broken instrument is influenced by

- 1) The diameter, length and position of the fragment within a canal.

- 2) The anatomy, including the diameter, length, curvature of the canal, and additionally limited by root morphology, including the thickness of dentin and the depth of external concavities.
- 3) The type of material which is causing obstruction.
- 4) Preoperative pulpal and periapical diagnosis
- 5) Extent of chemo-mechanical debridement prior to instrument breakage

In general removal of separated instrument is easy when ^{2,3}

-one-third of the overall length of an obstruction is visible .

-lying in the straightaway portions of the canal .

-lying partially around canal curvatures, although more difficult, can oftentimes be removed if straightline access can be established to their most coronal extents.

Clinical Recommendations For Broken Instrument Management⁵

- a. Establish the location of the instrument fragment radiographically and by tactile sensation—if the fragment is at or beyond the canal curve, retrieval is much less predictable.
- b. Consider the time of fracture—the earlier in the instrumentation procedure, the greater the likelihood of inadequate debridement.
- c. Consider the presence or otherwise of a periapical radiolucency— this will compromise prognosis somewhat.
- d. Initially attempt to directly bypass the instrument fragment by the very careful use of hand instruments—in some instances where the root has more than one canal it may be possible to bypass the instrument indirectly, using the other canal(s), provided they join well before the apical foramen.
- e. After this attempt and after due consideration of the first three factors above, as well as symptomatology, justify the need to undertake more invasive measures.

f. If the decision is made to attempt to remove the fragment a staging platform technique is recommended—it is *sine qua non* that this be undertaken using the operating microscope and using appropriate ultrasonic instrumentation.

g. Should retrieval attempts prove unsuccessful without further compromising the tooth, and the case continues to be symptomatic or fails to show any signs of healing at periodic recall reviews, alternative treatment options such as apical surgery, intentional replantation, or even extraction can always be considered.

h. The patient must always be informed at that appointment of the presence of the fragment and your proposed management, if any.

Impact on The Prognosis

The effect of broken instruments on prognosis is hardly affected if it is bypassed and disinfection is obtained¹¹. However in cases with existing periapical lesion, in between shaping procedure instrument breaks or in retreatments with pain and apical radiolucency, canal anatomy, fragment position prognosis is significantly influenced¹².

Techniques

H –FILES

A Hedstrom file can be placed inside the root canal to engage with the fractured fragment and then withdrawn. This method is effective when the fragment is not visible and located deeply within the canal and the clinician is dependent on the tactile sense.¹³

FORCEPS/PLIERS

Accessible solid obstructions may be retrieved from the canal by a variety of instruments, including forceps, pliers, or a Castroviejós needle holder¹⁴.

CHEMICAL AGENTS

In the past chemicals such as hydrochloric acid, sulfuric acid and concentrated iodine-potassium iodide were used to dissolve the metal obstruction⁵.

HYPODERMIC SURGICAL NEEDLE

The bevelled tip of a hypodermic needle can be shortened to cut a groove around the coronal part of the fragment by rotating a needle under light apical pressure. The needle size should allow its lumen to entirely enclose the coronal tip of the fragment, which guides the needle tip while cutting so as to remove the minimum amount of dentin.¹⁵ Counter clockwise rotation allows removal of instruments with right hand threads and vice versa. The groove (trough) around the fragment can also be prepared by using thin ultrasonic tips or trephine burs.

To remove the fragment a cyanoacrylate glue or strong dental cement can be inserted into the needle and when set the complex needle-adhesive-fragment can be pulled out delicately in a clockwise or counter clockwise rotational movement. Roughening the smooth lumen by small burs can enhance the bond.¹⁶

WIRE LOOP TECHNIQUE

A thin steel wire is inserted into a 25-gauge needle. On one side of the needle, a loop is formed, while on its other side, the loose ends of the wire are pulled to tighten the loop. When inserted around a broken instrument, the loop is tightened and the object retrieved by pulling coronally on the wire. To obtain success with this technique, the object must be exposed enough to allow gripping with the wire loop.¹⁷

CANAL FINDER SYSTEM

The original canal Finder system (Fa Societe Endo Technique, Marseille, France) consisted of a handpiece and specially designed files.¹⁸

The system produces a vertical movement with maximum amplitude of 1-2 mm that decreases when the speed increases. The flutes of the file can mechanically engage with the separated fragment and with the vertical vibration the fragment can be loosened or even retrieved.¹⁹

MICROTUBE REMOVAL METHODS

- *Lasso & Anchor*: An appropriately sized microtube is selected and a wire passed through the tube then looped at one end and passed back through the tube. This loop can potentially lasso a coronally exposed

obstruction and, when successful, form a purchase by pushing the tube apically while simultaneously pulling the wire ends coronally.²⁰

- *Tube & Glue:* The Cancellier Extractor Kit (SybronEndo) contains four different sized microtubes with outside diameters of approximately 0.50, 0.60, 0.70, and 0.80 mm. An abrasively coated ultrasonic instrument is typically used to trephine around and ideally expose the coronal 3 mm of an obstruction. A microtube is prefitted to ensure its internal diameter can just fit over the coronally exposed obstruction. The prefitted microtube may now be bonded onto the obstruction with an adhesive, such as core paste.

The Cancellier microtubes are safely scaled for progressively deeper placement into canals of posterior roots. This removal method is quite effective for retrieving a nonfluted broken instrument or when there is difficulty retrieving a separated file that is already loose.²¹

- *Tap & Thread:* The Post Removal System (PRS) contains five microtubular taps. The smallest PRS tap has an outside diameter of about 1.50 mm and internally forms threads and mechanically engages the most coronal aspect of any obstruction whose diameter is 0.60 mm or greater.

However, the outside diameter of the smallest microtubular tap generally limits its use to radicular obstructions that extend coronally into the pulp chamber or the coronal one-third of larger canals.²²

- *Masserann:*

The Masserann kit (Micromega, Besancon, France) is specially designed for the removal of metallic objects from root canals. It consists of a series of trepan burs that are used to prepare a space around the most coronal part of an obstructing object and two sizes (1.2 and 1.5 mm in outer diameter) of tubular extractors, which are inserted into the created space and mechanically grip the object. The extractor consists of a tube in which a plunger can be screwed down. By tightening the screw, the free part of the object is locked between the plunger and the internal embossment just short of the apical end of the tube. However, limitations exist regarding the application of this technique. The trepan burs and extractors are rigid and relatively large, and thus establishment of

straight-line access to the target object often requires considerable removal of the root dentin, potentially leading to failures such as root perforation.²³

- *Spinal Tap Needle:* A spinal tap needle (Ranfac; Avon, MA) in conjunction with its metal insert plunger or a hedstroem file is another technique advocated to remove broken instruments.²²

With limitations, this method of removal involves sizing the correct microtube so it can be placed over an ultrasonically exposed obstruction. Microtube sizes that are clinically relevant are 19, 21, and 23 gauge needles corresponding to outside tube diameters of approximately 1.00, 0.80, and 0.60 mm, respectively. Because of their unique ability to engage, smaller sized hedstroem files may be selected and inserted into the coronal most aspect of the microtube.^{22,24}

The hedstroem is passed down the length of the tube until it wedges tightly between the obstruction and the internal lumen of the microtube. However, because ISO files taper 0.32 mm over 16 mm of cutting blades, the taper of the file oftentimes restricts its placement through a smaller sized parallel microtube. In this instance, the spinal tap needle's metal insert plunger must be used to potentially form a purchase on the obstruction. This method is quite effective when removing obstructions from larger canals.

- *Endo Extractor/MeisingerMeitrac:* The Endo Extractor System and the MeisingerMeitrac Instrument System (Hager & Meisinger GmbH; Neuss, Germany) are able to gain a strong mechanical purchase on a broken instrument. The Meitrac Instrument System has been reported in a trade journal to be able to remove broken files from otherwise inaccessible locations. However, the smallest Meitrac I trephine and extractor have outside diameters of approximately 1.50 mm which limits the practical use of this instrument to the coronal aspects of larger canals.³

- *Instrument Removal System*

The Instrument Removal System (iRS) (Dentsply Tulsa Dental; Tulsa, OK) provides another mechanical method for the removal of intracanal obstructions such as silver points, carrier-based

obturators or broken file. The iRS is indicated when ultrasonic efforts prove to be unsuccessful and may be used to remove broken instruments that are lodged in the straightaway portions of the root or partially around the canal curvature.

The black instrument has an outside diameter of 1.00 mm and is designed to work in the coronal one-third of larger canals, whereas the red and yellow instruments have outside diameters of 0.80 and 0.60 mm, respectively, and can be placed deeper into more narrow canals. Each complete instrument is comprised of a color coordinated microtube and screw wedge. Each microtube has a small-sized plastic handle to enhance vision during placement, a side window to improve mechanics, and a 45° beveled end to “scoop up” the coronal end of a broken instrument. Each screw wedge has a knurled metal handle, a left handed screw mechanism proximally, and a solid cylinder that transitions into 0.02 tapered K-type file blades towards its distal end to facilitate engaging an obstruction.^{22,25,26}

DISSOLUTION OF NICKEL-TITANIUM ENDODONTIC FILES VIA AN ELECTROCHEMICAL PROCESS

The concept of retrieval of fractured instruments by an electrochemical process is based on the dissolution of a metal alloy in aqueous environments, and it requires the existence of 2 electrodes and an electrolyte. The electrolyte might have a composition that varies according to the metal to be dissolved; it is essential that the metal has susceptibility for dissolution in this electrolyte²⁷.

MAGNIFICATION & LIGHTING.

Magnification glasses, headlamps, fiberoptictransilluminating devices and dental operating microscopes contribute to better vision. Specifically, the microscope provides options in magnification and coaxial light to promote superior vision. The microscope is a practice building instrument that promotes professional growth, improves technical results and distinguishes a practice in its community²⁵.

MICROSONIC TECHNIQUE

The most important, predictable and safe removal schemes utilize the microscope in conjunction with optimally designed ultrasonic instruments and/or a microtube method.²⁸

The technique first begins with establishing complete coronal access. Before establishing radicular access, attention is directed towards pre-operative radiographs and working films to better appreciate the root bulk, thickness of the dentinal walls, and if present, the depth of an external concavity. If radicular access is limited, then hand files are used serially small to large, coronal to the obstruction, to create sufficient space to safely introduce gates glidden (GG) drills. GG's are used like “brushes” and each larger GG is stepped out of the canal to create a smooth flowing funnel which is largest coronally and tapers down to the head of the broken file.

The microscope, in conjunction with ultrasonic techniques, has led to precise microsonic techniques. Once the head of the broken instrument is readily visible then specially designed contra-angled, parallel-walled and abrasively-coated ultrasonic instruments (ProUltra Endo Tips #3, 4, 5) are selected to sand away dentin and trephine circumferentially around the obstruction. The idea is to transfer ultrasonic energy to the broken instrument so that it will loosen, unwind and then spin. Oftentimes, the broken instrument will “jump out” of the canal.²⁹

LASERS

Nd:YAG lasers in recent years has revolutionized dentistry and it is claimed that in removal of fractured instrument Nd:YAG laser takes less than 5 minutes in removal along with minimal removal of the surrounding dentin. There are two ways with which this laser works

(1)melting of dentin followed by bypassing with H file and removing it (2)melting the broken fragment^{30,31}

DISCUSSION

Separated fragment of instrument in root canal may be indirectly responsible for an endodontic failure by limiting the access to the apical part of the canal, compromising disinfection and obturation, but is rarely directly responsible.³²

A number of treatment protocols for removing obstructions have been described in the literature. Earlier authors have suggested that the object, regardless of the primary endodontic diagnosis,

should be left in the canal, and that the canal coronal to the object should be treated according to the standard endodontic procedures. Others have suggested that the object should be bypassed and incorporated into the root filling material. Surgical techniques for removal of either the object itself or the entire portion of the root encompassing the object have been recommended¹².

Separated instruments can be removed in anterior teeth than posterior, in maxillary teeth than mandibular, when the fragment separates in the coronal third of the root canal than middle or apical third and when the fragment separates coronal to the curvature than apical. Visibility and accessibility of coronal end of the fractured segment is the key factor in retrievability.^{13,33,34}

Lowest success rate (59%) was reported when fractured instruments were removed from the apical third compared with middle and coronal thirds (69% and 100%).³³

In a clinical study 87% of the fractured instruments were removed completely from the root canal without creating clinically detectable root perforation. The higher success rate achieved in this study was due to usage of ultrasonic instruments under microscopic vision, exclusively by endodontists³⁵. Among all techniques and devices described in the literature for retrieving the separated instrument fragment the most successful method is use of ultrasonic files along with a dental operating microscope (DOM).³⁴

Depending on the technique used, perforation of the root, ledge formation and transportation of the original canal may occur, as well as weakening of the affected root in case of excessive removal of dentine or fracture of an additional instrument (Hu'smann & Schinkel 1999, Ward et al. 2003a, Souter & Messer 2005, Suter et al. 2005, Rhodes 2007, Cheung 2009). Therefore, treatment planning should include a risk assessment. If removal is attempted, the chances of success should be balanced against the potential complications.³⁶

CONCLUSION

The best treatment for a broken file is prevention. Sticking to proven concepts, incorporating best

strategies and using safe techniques during root canal procedures will abolish the broken instrument procedural accident. If despite of all precautions instrument breaks and failure in retrieval occurs especially in the presence of clinical symptoms and or radiographic pathology, surgery or extraction will be the last resort.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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