



## **NARRATIVE REVIEW**

# **Management Of Fractured Endodontic Instruments In Root Canal: A Review**

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### **ABSTRACT**

With the increased practice of rotary endodontics in recent years, separated rotary nickel-titanium (NiTi) files in root canals is the most commonly reported mishap, causing lot of stress and anxiety among clinicians and patients. No clear guidelines can be drawn from the literature available because there are either too few studies of the effects of broken files on prognosis, or the few studies that have been performed involved so few patients. The prognosis is also dependent on file location, prior condition of the pulp, presence or absence of periapical lesion and many other factors. Each case is different. This paper offers a flowchart to help the general dentists and non-endodontists decide which strategy is best when faced with a broken file in root canal.

**Key words:** Endodontic instruments, Rotary NITI instruments, Separated instrument removal, Fractured endodontic instruments.

**T**he success of endodontic treatment is dictated by appropriate shaping, disinfection and three dimensional obturation of the root canal system. The success and failure of root canal treatment has three criteria; clinical, radio graphical and histological. Criteria for success and failure of endodontic treatment are different for different people. It is paramount to have clinical success to the patient, and clinical as well as radio graphical success to the dentist. The role of separated endodontic instrument on success and failure of endodontic treatment has been a dubious issue. Sometimes it may take several months, or even years, for objective evidence of failure to appear radio graphically as patients rarely experience pain. This may put the dentist in

confusion in regard to the relationship between separated endodontic instrument and prognosis.

### **FREQUENCY OF INSTRUMENT FRACTURE**

Various factors attribute to the breakage of rotary files, these factors are the canal curvature, anatomic variations, practitioner experience, cooperation from patient, frequency of use, torque and speed of rotation. The separation rate of Nickel Titanium (NiTi) rotary instruments were reported to range between 1.3% and 10.0%, whereas separation rates of stainless steel (SS) instruments

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were reported to range between 0.25% and 6<sup>(1,2,3)</sup> The greater range of separation rates reported in above studies might be because of fact that those studies were done with a little standardization in terms of techniques used, operator's skill and experience, position of tooth, and curvature of the root. Lesser rate of separation of Lightspeed system may direct clinicians towards a false sense of safety of NiTi rotary systems against separation of instruments in root canal.<sup>(4,5,6)</sup> Clinician must remember the fact that Lightspeed system is absolutely different from other systems in its design, flexibility, length of cutting surface, recommended rotational speed, torque and easier retrievability.

In most circumstances fracture results from incorrect use or overuse of an endodontic instrument. To date, no study has demonstrated clearly the maximum number of canals a NiTi rotary instrument can be used in a canal such that the chances of separation are minimal. Though some manufacturer claim their systems for single use only, this may not be practically possible in developing countries like India. Though the clinician sticks to the guidelines recommended to minimize the risk of fracture, there is still some possibility of instrument separation in clinical practice.<sup>(7)</sup> Separated instrument in root canal leads the dentist to a state of frustration and anxiety initially and later a state of confusion about treatment and its prognosis.

In order to modify the treatment plan, once this kind of mishap occurred, it is imperative for the dentist to have good knowledge about the role of separated instrument in long-term prognosis of root canal treatment, various methods to manage it, and the best one suits for that condition.

## **ROLE OF SEPARATED INSTRUMENT IN PROGNOSIS OF ROOT CANAL TREATMENT**

Clinicians may be misled by the unjust concept that endodontic mishaps, such as fractured instruments, perforations, overfilling, etc can be the direct cause of endodontic failure. All endodontic mishaps may not lead to a reduced prognosis, but any error that compromises, microbial control is likely to increase the risk of a failure. Separated root canal instruments is one of the most troublesome incidents in endodontic therapy, especially if the tooth is non vital and fragment cannot be removed. In the majority of cases, the procedural mishap does not directly compromise the prognosis, unless a concomitant infection is already present. 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.<sup>(8)</sup>

Thus it is essential to assess the impact of a retained fractured instrument on prognosis so that it can be compared with the possible risk of damage during its removal. There has been a conflict of opinion among researchers regarding the clinical significance of retained fractured instruments.

Two studies reported that the retained fragment reduced healing, particularly in the presence of a preexisting periapical radiolucency,<sup>(9,10)</sup> whereas another two studies stated that it had no influence on healing.<sup>(11)</sup> According to some authors, the retained fractured instrument can be incorporated into the final root canal filling.<sup>(12)</sup> These are very old studies where stainless steel instruments were used with step back technique, which is not

currently recommended technique, especially with NiTi instruments. These studies may not give strong suggestions because of smaller sample and poor randomization. Though several factors like vitality of tooth, accessibility of tooth, position of fractured instrument in the canal, taper of the instrument, type of alloy with which the instrument is made, have an impact on the prognosis,<sup>(7)</sup> the presence of a periapical lesion served as the main prognostic factor for the successful treatment of such cases.<sup>(13)</sup>

In a case control study in 146 teeth, observed over a period of more than one year, the overall success rate of cases and controls was 93.7%, specifically, 91.8% for cases and 94.5% for controls, in which difference was not statistically significant. Separated instrument in root canals of teeth without a periapical lesion, had minimal effect on outcome of endodontic treatment. But, in presence of preoperative periapical lesion, healing was lower when a fractured instrument was retained (86.7% versus 92.9%[control]), but this 6.2% difference was not statistically significant. The odds of a successful outcome were estimated to be 4.8 times greater in the absence than in the presence of a lesion.<sup>(2)</sup>

One key point that should be remembered is the above results reported are based on radiographic findings. All those teeth had been serving the purpose for more than one year by the time they were evaluated. Can we consider them as failures, particularly from patient point view? This may be considered as surviving endodontics, if not successful endodontics. It is too early to rush for a retreatment; either non-surgically or surgically, unless signs and symptoms like pain, mobility, sinus tract development, swelling, increase in the size of periapical radiolucency etc.

## **OUTCOME OF RETAINED INSTRUMENT REMOVAL**

The four treatment protocols have been suggested by the literature for management of fractured instruments in root canals:

1. Allowing the separated instrument to be retained in the canal and treating the remaining portion of canal.
2. Bypassing the separated fragment and treating the canal.
3. Retrieving the separated fragment and treating the canal.

4. Surgical approach for retrieval of separated fragment followed by treatment accordingly.

1. Separated fragment may be left in the canal, and that the canal coronal to the object should be treated according to standard endodontic procedures.<sup>(14,15)</sup> Separated fragments that could not be retrieved may be left over in the canal. This approach can be considered if the fractured segment binds snugly in apical third only. Any file that binds in coronal third or middle third must be either removed or bypassed.

Thermo plasticized obturation techniques were suggested in these cases since they seal the gap between the fractured fragment and canal walls better than other techniques like cold lateral compaction, single greater tapered cone obturation, because of their excellent flow.<sup>(16)</sup>

2. Object should be bypassed and that the canal should be treated according to standard endodontic procedures and the separated fragment should be incorporated into the root filling material. In these cases a good quality of obturation is mandatory so that the obturating material or sealer flows and seals the spaces between the flutes of separated file and canal wall.<sup>(17)</sup>

In a study on evaluation of recall radiographs, 2%-

6% of root canals had separated instruments and majority of the tooth had been serving the function for considerable, time with an acceptable periapical healing.<sup>(18)</sup>

“Bypassing technique” based on the fact that none of the root canals are perfectly round, and a small gap exists between the root canal wall and the fractured fragment, which allows a smaller file to bypass the separated fragment. It involves inserting a fine file between the fracture fragment and the root canal wall, and negotiating the canal to full working length which enables thorough instrumentation and root canal obturation with the fragment remaining in situ. Allowing the fragment in situ along with thermo plasticized guttapercha considerably improves the prognosis. This is an easy technique to master, and works out successfully majority of times, especially when the instrument is bound in coronal and middle thirds of canal. While bypassing with the fine or small size instrument, there can be a possibility that the fractured segment can be retrieved from the canal. One more advantage of this technique is it does not demand direct visibility to the fragment i.e. it can be suitable when the fragment is located beyond a considerable root canal curvature. This method does not demand magnification aids strictly, as it is more dependent on tactile sensation of dentist, allowing its practical feasibility among general dentists; especially in developing countries like India where usage of modern endodontic equipment like surgical microscopes, ultrasonic etc is not common in their daily practice.

3. Special instruments and techniques are suggested for retrieval of the separated instrument and the canal should be treated according to standard endodontic procedures.<sup>(19)</sup>

Successful retrieval of fractured instrument depends on tooth factor, equipment and instrument factor, clinician factor and patient factor.

### **3a. Tooth factor**

Anatomical features of tooth such as length of the root, curvature of root, size of the root canal, position of the fragment within the root canal and its relation to root canal curvature and anatomical abnormalities plays considerable role in retrievability.

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.<sup>(20,21,22)</sup>

A minimum of two mm of instrument should be exposed for predictable removal with various equipments like Masserann kit<sup>(23)</sup>.

Nevertheless, most NiTi instruments, because of their flexibility, generally fracture more apically at or beyond the root canal curvature, making their removal difficult.<sup>(24)</sup> Ability to reach the separated instrument without weakening and/or perforating the root is the main challenge for the endodontist, especially in the case of curved canals, in which instruments are more likely to engage the canal walls and demand more time and efforts without guarantee of success.<sup>(25)</sup>

Lowest success rate (59%) was reported when fractured instruments were removed from the apical third compared with middle and coronal thirds (69% and 100%).<sup>(20)</sup>

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 endodontists.<sup>(26)</sup>

The success rate for retrieval of the instruments fractured beyond apex was significantly lower compared with the instruments fractured short of the apex. There was no significant difference in retrieval rates of instruments fractured in coronal third, middle third and apical third in relatively straighter canals.

### 3b. Separated Instrument Factors

It is generally believed that Hedstrom files, NiTi rotary instruments, and shorter fragments are more difficult to remove compared with K-file, SS rotary instrument and longer fragments respectively.<sup>(23,26)</sup> Compared with K-files, Hedstrom files are more challenging for removal from canal because of their larger helix angle, deeper flutes, and greater positive rake angle and greater engagement in root canal walls at the time when separation occurs.<sup>(25)</sup>

NiTi files usually fracture in short lengths, especially after torsional failure and tend to thread into root canal walls, making them difficult for retrieval compared to SS rotary instruments. Fragments of NiTi instruments in curved root canals tend to lie against the outer root canal wall and have greater tendencies to fracture repeatedly during removal procedures, particularly when ultrasonic files are used.<sup>(23,26)</sup>

### 3c. Equipment factor

Varieties of instruments and equipments have been introduced to dentistry to remove these instruments from root canal. Stieglitz pliers, small mosquito hemostats to remove the silver points and separated instruments from coronal third, Masserann kit to remove the fractured files

and posts, Cavi-Endo ultrasonic instruments, Micro tube removal systems like Lasso and Anchor, Tube and Glue, Tap and tread, Endo extractor removal system are few of the available systems for this purpose.<sup>(27)</sup> These devices, techniques, and methods described here vary in their effectiveness as per the operator's skill, magnification, illumination and other factors. Masserann kit, for example, has a reported success rate of between 48%–55%.<sup>(28)</sup>

The increased use of modern equipment that provides various advantages of better illumination, higher magnification, better irrigation and oscillation, easier and better accessibility to separated instrument allows more safer and predictable retrieval. 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).<sup>(22)</sup> Ultrasonic tips may remove the dentine more vigorously and weaken the roots. They should be used without irrigation and at low power setting to maintain constant vision to minimize the root damage. This reduces heat generated and, therefore, lowers the risk of secondary separation of the fragment itself or the ultrasonic tip, and more kind to periodontium. (29) The success rates may drop with increased time of treatment.

### 3d. Dentist factor

Endodontic treatment per se is complex issue which needs adequate training. The dentist should have extra knowledge, training, familiarity with techniques and instruments of retrieval, and needs utmost patience to deal with a frustrating incident like separated instrument. Dentist needs to develop a methodological approach with perseverance, and creativity.<sup>(30)</sup> Referring the

patient to a specialist would be the preferred approach, in case clinician believes that he/she does not have the competence for successful management.

### 3e. Patient Factors

Separated endodontic file in canal may result the patient in a state of anxiety, anguish and agony. It is an embarrassing condition for dentist to face the patient once this mishap results, unless he explained the patient about complexity of the root canal treatment and its potential complications before initiation of treatment itself. Extent of mouth opening, co-operation on dental chair, time constraints, ability to extend “good will support” to dentist, motivation to retain teeth and financial liabilities are some of the important factors to be considered from patient point of view. Patient’s age, general health and any existing medical complications are critical factors to choose the best among the available treatment options. More conservative treatment has to planned for children and older patients because of the limited quality and quantity of co-operation from them. Anyhow, before arriving the final decision about further treatment, patient’s autonomy should be respected utmost.

Some other non surgical methods such as ‘Hypodermic needle and cyanoacrylate glue technique’,<sup>(31)</sup> ‘Electrochemical dissolution of fractured fragment’,<sup>(32)</sup> ‘stainless steel hand files and a chloroform-dipped gutta-percha cone to remove a fractured rotary NiTi instrument’<sup>(33)</sup> are also found to be successful in few cases. But, the predictability and consistency of these methods are too poor to be recommended.

Recently Nd:YAG laser are found to be successful in laboratory studies for removal of separated instruments.<sup>(34)</sup> with minimum amounts of dentin

removal, reducing the risk of root fracture. Further research has to be continued to make it a successful method in clinical situation.

4. Surgical approach may be needed for removal of either separated instrument itself or the entire portion of the root encompassing the fractured instrument.<sup>(35)</sup>

The last two protocols i.e., orthograde retrieval and surgical retrieval might result in loss of considerable tooth structure and clinical complications such as root perforation, weakening of root, unfavorable crown-root ratio and other surgical complications, which may compromise the long-term restorative success of tooth.<sup>(36)</sup>

Unfortunately file breakage occurs most frequently in molar; especially mesial roots of mandibular molars and mesiobuccal roots of maxillary molars. These can be tough tooth for surgery even for experienced clinicians because of their intimate anatomical relation with vital structures like mandibular nerve, mental nerve, lingual artery, maxillary sinus and maxillary artery. Without magnification with surgical microscope, ultrasonic equipments, microsurgical instruments and good visibility it is almost impossible to do a precise job in these situations.

Removal of separated fragment after intentional extraction, and replantation should be considered as a last option after all other options fail or are likely to fail. Though few successful cases are reported,<sup>(28, 37)</sup> generally this is less preferred to periapical surgery due to higher chances of root resorption on long term. This method is useful especially in cases where instrument separation occurs beyond the apex. Since it is less traumatic and less time consuming it may be a preferred technique to conventional periapical surgical techniques, particularly in cases of limited

accessibility to surgical area, medically compromised patients who can not tolerate periapical surgery.

### **SUGGESTED GUIDELINES**

There is no universal agreement on treatment plan of instrument retrieval methods. The following guidelines can suggested based on available literature evidence.

Availability of modern armamentaria and competency of dentist to operate them, clinical skills, knowledge, patience and experience of operator are the key factors for successful retrieval. If any of these is lacking, patient should be referred to a competent specialist.

Removal of fragment is mandatory if the fractured fragment is located in the coronal third, middle third or before the canal curvature. Most of the times is possible to achieve success with 'bypassing the fragment and enlargement of canal' method or/and simple use of ultra sonic tips, even without surgical microscope.

If the fractured fragment is located in the apical third, or after the canal curvature, tooth factor, equipment factor, dentist factor and patient factor should be considered to weight each method for probability of successful removal and possibilities of risk involved, before arriving at a decision.

A. Never attempt aggressive methods of retrieval without operating microscope, since it may turn into a blind guess.

B. Attempt simple methods of retrieval when operating microscope is not available.

C. If not succeeded refer the patient to a specialist.

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D. If specialist is not available, and the patient is asymptomatic, obturate the canal after cleaning and shaping the canal in best possible way in that particular case. Patient should be followed with regular recall visits for long term to evaluate the possibilities of failure in this situation.

E. Surgical retrieval should be kept in reserve as the last resort for a persistently symptomatic tooth, or an asymptomatic tooth with increasing periapical radiolucency during follow up visits.

Practicing of retrieval methods of broken files on extracted teeth is highly recommended in order to tackle the mishap effectively.

### **CONCLUSION**

Management of instrument separation is a complex issue. Under ideal conditions it is preferable to remove the fragment and pursue treatment, but this is not always possible. The risks of removal should be balanced against benefits, as weakening of the tooth or perforation during instrument removal may be more detrimental than the fragment of instrument.

The factors like visibility and accessibility, anatomical complexities of tooth, level of contamination of the canal prior to treatment, timing of the fracture during treatment, the degree to which the instrument will compromise the seal of the canal, strategic value of tooth in maintaining occlusal harmony, availability of modern equipment, dentist's skill and knowledge and patient's autonomy need to be taken into account before deciding the mode of treatment in a particular case.

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