

Removal of a fractured instrument with a new extractor: clinical cases

Dominique Martin¹

Introduction

The fracture of a root canal instrument during endodontic treatment is a surgical accident that every practitioner is likely to have encountered at some point during their career. The risk of instrument fracture has, however, increased in recent years in line with the constantly growing use of rotary instruments for root canal preparation. A recent study carried out on the practical experience of seven endodontists over a period of 13 years has revealed a risk of instrument fracture of 3.3% (Spili, Parashos, Messer, 2005). 78.1% of the fractured instruments turned out to be rotary instruments made of nickel titanium. A number of factors were associated with the fracture of nickel titanium instruments, including:

- The experience of the operator (Yared, Bou Dagher, Kulkarni, 2003)
- Rotational speed
- The degree of curvature of the root canal
- Instrument design
- Application technique
- Manufacturing procedure
- Non-patency of the root canal.

There are two different situations that typically result in the fracture of rotary nickel titanium instruments:

1. Torsional fracture
2. Fracture due to cyclic fatigue.

Both fractures are associated with the treatment of extremely curved canals. NiTi instruments fracture most frequently because the instrument tip is subjected to excessive torque when the helical blades penetrate into the radicular dentin. The fragment, which usually has a length of 3-4mm, remains jammed in the radicular dentin.

The other characteristic criterion of these fractures is associated with the instrument design. Most of the rotary nickel titanium instruments have a taper of 4% to 12%. Due to this increased taper, which clearly exceeds that defined by the ISO standard (2%), the coronal part of the fragment remains blocked in the canal whereas its tip remains free. This particular feature – typically found in NiTi instruments – complicates the procedure of removing the fragment, which normally entails passing an endodontic hand instrument between the fragment and the canal wall and guiding it along the fragment to regain patency of the canal (Suter, Lussi, Sequeira, 2005). In this case, a more invasive solution is required. This involves straightening the coronal curve and releasing the fragment at the expense of the dentin walls. It has been shown that the attempt of removing these fragments leads to the removal of large quantities of dentin, thus resulting in a significant reduction of the mechanical resistance of the root (Spili, Parashos, Messer, 2005).

¹ *Dominique Martin, Private Practice, Paris, France.*



Figure 1: The Endo Rescue set (Komet) contains five instruments: a cylindro-conical bur with a non-cutting tip, a short Gates Glidden no. 4, a Gates Glidden no. 3, a center drill and a trepan bur.

A multitude of tools designed to remove fragments of fractured instruments have been developed. The Masseran set by Micro Mega being the most well-known. This efficient kit contains an extractor that seizes the fragment before removing it. The main disadvantage, however, is the size of the extractor (external diameter 1.20mm), which requires the canal to be enlarged up to the size of a Gates Glidden drill no. 5 before the extractor can be inserted.

Although this extractor is very useful for removing fragments lodged in the coronal part of large teeth, it is unsuitable when it comes to removing a fragment located in the middle or apical third of the root canal or if the fragment is located in the thin root of a molar.

The introduction of the operating microscope resulted in the development of ultrasonic tips specially designed for this specific use:

- ET 25 (Satelec)
- ProUltra endo 6, 7, 8 (Dentsply)
- RT3 (EMS).

The principal task of these ultrasonic tips is to extract the fragment through vibration (Ruddle, 2004). Although effective, this technique is very time-consuming and requires an operating microscope. What's more, it demands great skill on the part of the



Figure 2

Figure 3

Figure 2: The center drill has the same external diameter as the Gates Glidden no. 3 (0.9mm). The tip at its active part has a tapered concave shape. The center drill is placed onto the coronal part of the fragment, thus allowing the centralization of the passage and the preparation of the trepan bur's intended path.

Figure 3: The trepan bur has the same external diameter as the Gates Glidden no. 3 and the center drill (0.9mm). The internal part of the trepan bur has a diameter of 0.5mm and a length of 5mm. It is used in an anticlockwise direction of rotation.

practitioner and it necessitates the removal of a considerable amount of radicular dentin (Alomairy, 2009).

A new set has recently been introduced (Endo Rescue kit 4601, Komet) (Figure 1), which – though following the same basic approach as trepan burs, i.e. the exposure of the instrument fragment at the expense of the dentin walls – includes a number of special, advantageous features. The first feature is the presence of a center drill (Figure 2) with the same diameter as the trepan bur. The task of this center drill is to prepare the site for the work of the trepan bur. The other special feature is the miniaturisation of the trepan bur. The external diameter of the trepan bur is merely 0.9mm, which corresponds to that of a Gates Glidden drill no. 3 (Figure 3).



Figures 4 and 5: Clinical case: The patient arrives at the practice with a lesion of endodontic origin on tooth 26. Once the indication for retreatment has been established, the fractured instrument has to be removed from the mesio-buccal root in order to access the infected apical portion of the root. The shape of the access cavity was modified in such a way that direct access to the fragment could be achieved (cylindro-conical bur with non-cutting tip). The coronal curve of the canal was straightened by guiding the short Gates Glidden no. 4 with vertical back-and-forth movements along the canal wall opposite the curve. Subsequently, the accessible canal portion was prepared up to the fragment, using a Gates Glidden bur no. 3.

Clinical sequence

The clinical procedure consists of three consecutive steps:

First step

The aim is to achieve direct access to the fragment while removing as little dentin as possible. Instrument fractures in the coronal or middle third of the root canal are most frequently caused by incorrect preparation of the access cavity or the presence of a curve in the coronal third of the canal. The first step is, therefore, dedicated to rectifying the canal access and relocating the coronal entrance. This requires straightening of the canal wall opposite the curve. The instruments recommended in the Endo Rescue set for this step are those that are usually suggested for this task:

- A cylindro-conical bur with non-cutting tip for straightening the walls of the access cavity
- A short Gates Glidden no. 4 for relocation of the canal entrance, which is moved along the wall opposite the coronal curve with vertical back-and-forth movements
- A Gates Glidden no. 3 to prepare access to the fragment (clinical case Figures 4 and 5).

Second step

The aim of this step is to expose the coronal part of the fragment and re-center the access passage to the fractured instrument.

A center drill (RKP.204.090) has been specially designed for this purpose. This center drill has the same external diameter as the Gates Glidden no. 3, but the active part at its end has a tapered, concave shape. The outer blades drill into the dentin surrounding the fragment, and the concave, tapered area that encounters the coronal part of the fragment allows centering of the preparation. Thanks to the small diameter of the instrument, this task can be carried out removing just a minimum of dentin, while working in the center of the canal.

Third step

The aim of this step is to remove the fragment by separating it from the surrounding dentin walls. To this end, the trepan bur (RKT.204.090), which has the same external diameter as the preceding instrument, is positioned in the preparation previously carried out with the center bur in order to separate the fragment by drilling into the surrounding dentin. The cutting blades at the front of the trepan bur allow easy penetration into the dentin. The trepan bur has to be used in an anti-clockwise direction. As the bur penetrates further, dentin chips get deposited between the inner wall of the trepan bur and the fragment and jam the coronal part of the fragment. Once the coronal part of the fragment has been freed from the canal wall, it is pulled out of the

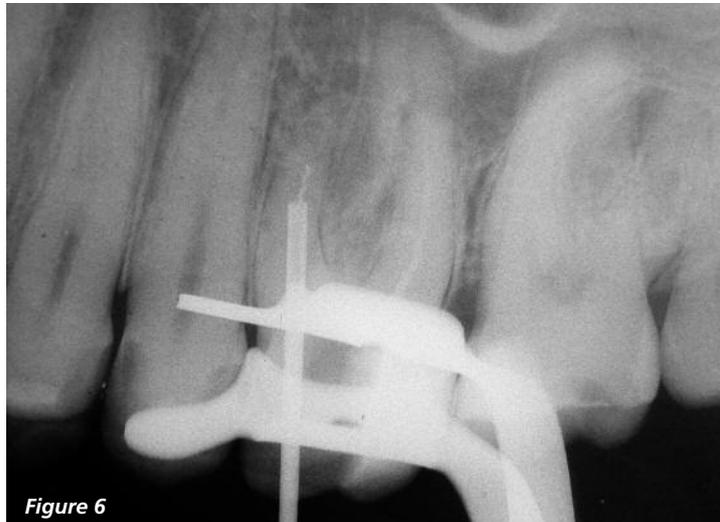


Figure 6

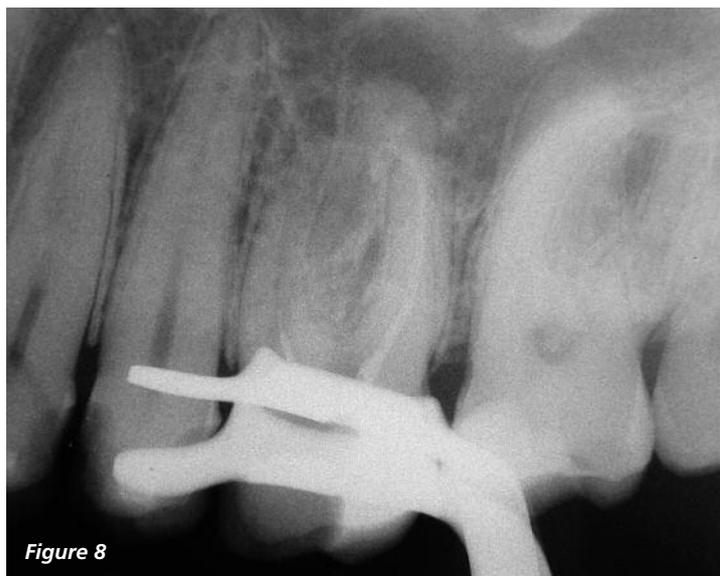


Figure 8



Figure 7

Figures 6, 7 and 8: The center drill is inserted into the canal in a rotary motion until it comes in contact with the fragment. The trepan bur is then inserted into the canal in an anti-clockwise rotation. The trepan bur gradually cuts the dentin surrounding the fragment in order to separate the fragment from the canal walls. The fragment is seized and held in place by the dentin chips. The fragment is then pulled out of the root with the trepan bur.

canal together with the trepan bur (Figures 6, 7, 8).

The center drill and the trepan bur have extremely sharp blades and, therefore, they have to be used either at low-speed (300rpm at maximum) in a drive system for rotary NiTi instruments or manually (the set contains a special mandrel).

Limitations

The Endo Rescue kit reaches its limits when the fragment is particularly long or located beyond the curve of the canal, in which case the blades of the trepan bur expose

the coronal part of the fragment until the stop position is reached. The action of the trepan bur is interrupted before the fragment can be released from the dentin in the root canal. In this situation, the trepan bur can be used in combination with a suitable aid, such as an ultrasonic tip or a cannula filled with composite. As detailed above, the trepan exposes the coronal part of the fragment, but this is followed by a cannula of the same outer diameter as the trepan bur (i.e. size 20) filled with auto-polymerizing composite, which is placed onto the already exposed part of the fragment. Once the composite has hardened, the

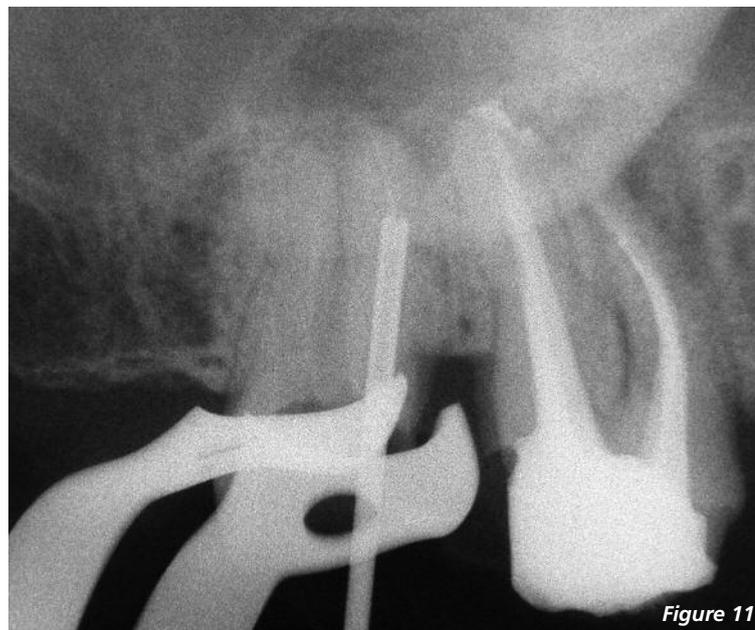
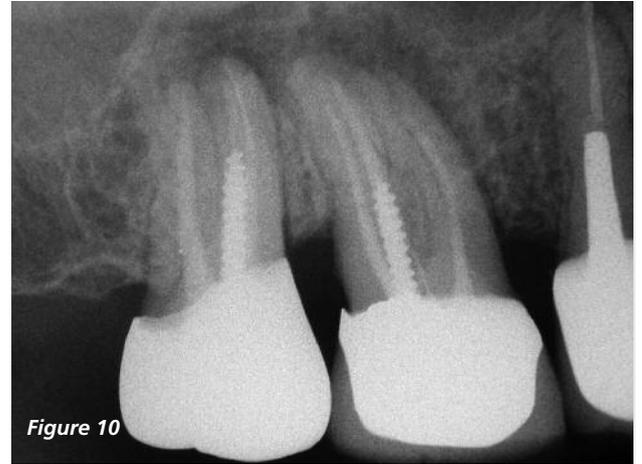
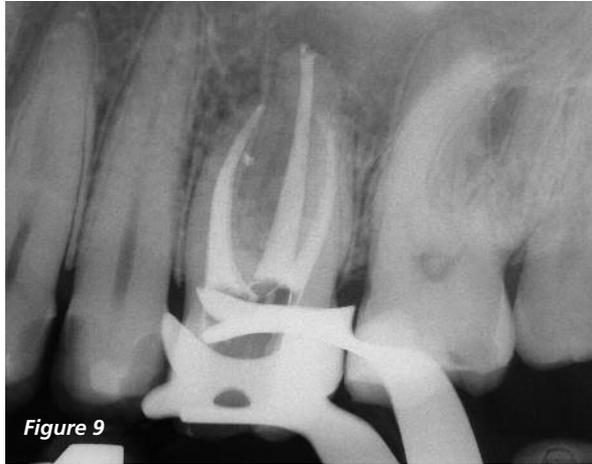


Figure 9: Clinical case completed. Please note that only a very small quantity of mesio-buccal root tissue had to be removed.

Figures 10 and 11: The patient arrives at the practice with a lesion of endodontic origin on teeth 16 and 17. Once the indication for retreatment has been established, the fractured instrument in the mesio-buccal root of tooth 17 has to be removed. The coronal part of the fragment is exposed by means of the trepan bur, but due to its length and its position in the apical part of the canal, the fragment cannot be removed by the trepan bur.

cannula is pulled out in anti-clockwise direction. The fragment that has now adhered to the hardened composite is pulled out along with the cannula (Figures 10, 11, 12, 13, 14, and 15).

Discussion

There are numerous tools and methods for the removal of instrument fragments fractured in the root canal, however, most of them produce unreliable results and cause

significant damage to the remaining radicular structure. Ideally, the radicular dentin should be preserved as far as possible and the extent of the root canal preparation after removal of the fragment should not exceed that of a conventional preparation. Although the Endo Rescue system requires the removal of an additional amount of dentin, the reduced diameter of the instruments allows the fragment to be accessed with a minimum of damage to the root structure.

In line with all previously described methods, the decisive factor for a successful intervention is the preparation of the access to the fragment. Due to the fact that instruments fracture most frequently in the canal curve, it is vital to straighten the coronal curve in order to achieve direct access and an unobstructed view of the fragment.

A special situation that is particularly associated with the fracture of rotary nickel titanium instruments should be noted. Due to the fact that the helical blades of the instrument penetrate the radicular dentin in a rotary motion, thus generating a torque that exceeds the resistance of the instrument, most of the fragments are of small diameter, reduced length and above all completely surrounded by dentin at the site of the fracture. If ordinary ultrasonic tips are to be used for the removal of the fragment, this should take place without touching the fragment to avoid further fracture. This is a very tricky and delicate procedure. However, by centering the access passage to the fragment (center drill), exposing the fragment by removing the surrounding dentin (trepan bur) and then pulling it out in an anti-clockwise direction, this tool is ideal for removing fragments of nickel titanium instruments – which currently constitute the majority of instrument fractures. At the moment, no other tool designed for dealing with this specific situation is available on the market.

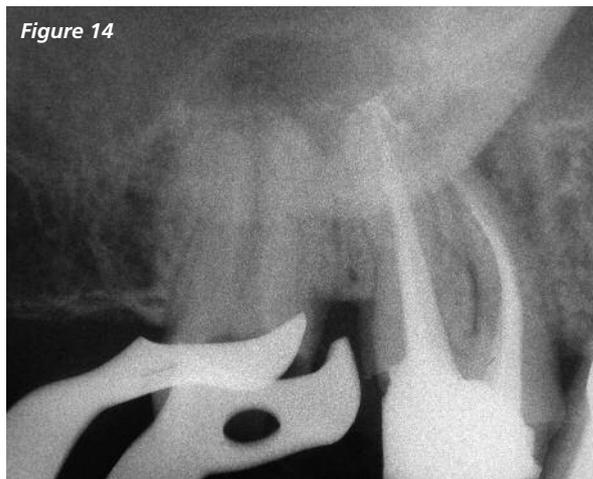
The limitations of this system are associated with the root canal anatomy and the feasibility of achieving the required straight access to the fragment. An instrument fragment located in the apical third beyond an extreme curve cannot be removed with the Endo Rescue kit alone. In such cases it is recommended to use the trepan bur in combination with a cannula of identical diameter filled with composite.

Conclusion

The Endo Rescue kit described in this report aims to provide a standardized procedure for the removal of fractured instruments. Compared to other instruments available for this purpose, it not only significantly reduces the amount of dentin that has to be removed in order to pull out the fragment, but also the amount of time needed for this procedure.

References

- Alomairy KH (2009) Evaluating two techniques on removal of fractured rotary nickel titanium endodontic instruments from root canals: an in vitro study. *J Endod* 35(4): 559-62
- Ruddle CJ (2004) Non-surgical retreatment. *J Endod*



Figures 12, 13 and 14: A cannula of the same diameter as the trepan bur (AccuDose Needle Tube 20 gauge, Centrix) filled with auto-polymerizing (or dual-polymerizing) composite is placed in the canal. Once the composite has hardened, the cannula is pulled out of the canal in an anti-clockwise direction. The fragment has adhered to the hardened composite and can therefore be pulled out along with the cannula.

Figure 15: Clinical case completed. Please note that hardly any damage was caused by the removal of the fragment.

30: 827-45

Souter NJ, Messer HH (2005) Complications associated with fractured file removal using an ultrasonic technique. J Endod 31(6): 450-2

Spili P, Parashos P Messer HH (2005) The impact of instrument fracture on outcome of endodontic treatment J Endod 31(12): 845-50

Suter B, Lussi A, Sequeira P (2005) Probability of removing fractured instruments from root canals. Int Endod J 38(2): 112-23

Yared G, Bou Dagher F, Kulkarni K (2003) Influence of torque control motors and the operator's proficiency on ProTaper failures. Oral Surg Med Oral Pathol Oral Radiol Endod 96(2): 229-33