Case report

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Retrieval of a separated nickel-titanium instrument using a modified 18-guage needle and cyanoacrylate glue: a case report

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During root canal preparation procedures, the potential for instrument breakage is always present. When instrument breakage occurs, it leads to anxiety of the clinician and as well as a metallic obstruction of the canal which hinders further cleaning and shaping. Separated instruments must always be attempted for retrieval and if retrieval is not possible bypass should be tried. With the increased use of nickel-titanium (NiTi) instruments the incidence of separated instruments has increased. A considerable amount of research has been done to understand the various factors related to the fracture of NiTi instruments to minimize its occurrence. This paper presents a review of the literature regarding the fracture of NiTi instruments and also describes a case report showing the use of a modified 18-guage needle and cyanoacrylate glue to retrieve a separated NiTi instrument from the mesiolingual canal of a mandibular first molar. (*Restor Dent Endod* 2013;38(2):93-97)

Key words: Instrument, Retrieval, Root canal, Separated instrument

Introduction

Clinicians involved in endodontic practice may face various unwanted procedural errors at almost any stage of routine endodontic treatment. Among the various procedural accidents, fracture of endodontic instruments within root canals is one of the most troublesome incidents.[1] Fractured root canal instruments may include endodontic files, sectioned silver points, a segment of lentulo spirals, gates glidden drills, a portion of carrier-based obturators, finger spreaders, and paste fillers, or any other instrument left inside the canal.[2] The use of both nickel-titanium (NiTi) hand files and rotary instruments has become popular and currently they are the mainstay of root canal instrumentation. This is mainly because of the much greater flexibility of NiTi files compared to their stainless steel counterparts, which offers distinct clinical advantages in curved root canals.[3-6] However, despite their undeniably favorable qualities, there is a potential risk of 'unexpected' fracture with NiTi instruments. With the increased use of NiTi instruments there has been an unfortunate increase in the occurrence of broken instruments.[7] Instrument breakage during treatment leads to considerable anxiety, and then all attempts are made to non-surgically liberate the instrument from the canal. The removal of separated instruments from root canals is very difficult and at times can be impossible, with a reported success rate ranging from 55 to 79%.[7,8] Several techniques and devices for retrieving the separated instrument fragment have been described in the literature with most successful method being the use of ultrasonics along with a dental operating microscope (DOM).[9,10]

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Presented is a case of retrieval of a separated NiTi instrument with a modified 18-guage needle and cyanoacrylate glue.

Case report

An 18-year old girl reported to the Department of Conservative Dentistry & Endodontics with pain in her right mandibular first molar (#46). On examination a carious exposure was found in the tooth #46. The tooth showed a negative response to electric pulp testing (EPT) and cold testing. The intra-oral periapical (IOPA) radiograph also revealed slight periapical changes in relation to tooth #46. Therefore a diagnosis of pulp necrosis was made and endodontic treatment was started in tooth # 46. The access opening was made and the canals were located and the working length was established with size 20 K stainless steelhand files (Dentsply Maillefer, Ballaigues, Switzerland). During the cleaning and shaping procedures for coronal shaping, a ProTaper shaper SX (Dentsply Maillefer) separated in the mesiolingual canal of the tooth.

On taking the radiograph the separated instrument fragment was found within the coronal portion of the canal (Figure 1a). The fragment was well past the orifice of the canal and far enough to be removed by forceps. Removal of the fragment was attempted with various small forceps and pliers but without success, as a sufficient grip of the fragment could not be established. Ultrasonic scaler was also used but the instrument could not be loosened probably because it was locked within the dentinal wall of the root canal. Therefore an alternative method to retrieve the instrument fragment was used as follows:

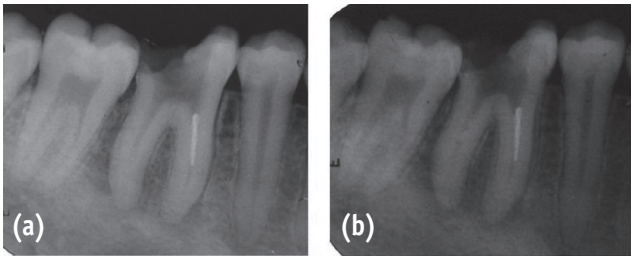

Figure 1. (a) Radiograph showing separated instrument; (b) Radiograph showing dentine surrounding the coronal end of the separated fragment removed with GG drill.

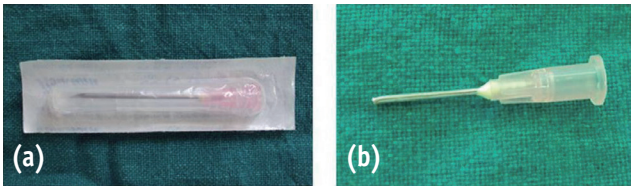

Figure 2. An 18-guage needle, modified by cutting with a carborandum disc from the tip to transform it into a microtube.

Gates Glidden drill (GG No.3) was used to remove dentine surrounding the coronal end of the separated fragment (Figure 1b). An 18-guage needle was modified by cutting it with a carborandum disc from the tip to transform it into a microtube (Figures 2). The modified needle microtube was then inserted into the canal so that it engulfed the coronal end of the separated fragment. Some cyanoacrylate glue was dropped into the microtube and then the tube was placed again into the canal engulfing the coronal end of the separated fragment. The outside of the tube was coated with petroleum jelly. The modified needle microtube was kept in place without disturbance for about three minutes to ensure proper adhesion of the separated fragment with the microtube. The separated fragment adhered to the microtube was then removed as a single unit by giving slight counterclockwise rotation and simultaneous pull out motion (Figures 3). A confirmatory radiograph was taken and the working length was then reconfirmed (Figures 4). The cleaning and shaping was completed and the tooth was obturated with laterally condensed gutta-percha and zinc oxide-eugenol based sealer (Figure 5a). The tooth stays in normal function two years after the endodontic treatment (Figure 5b).

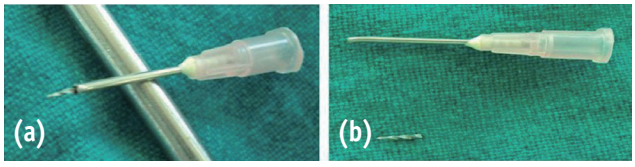

Figure 3. Separated instrument fragment removed adhered to the microtube.

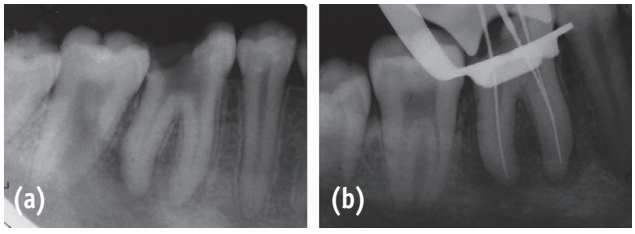

Figure 4. (a) Radiograph confirming instrument removal; (b) Working length reconfirmed.

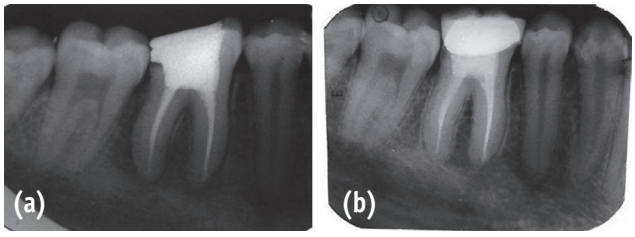

Figure 5. (a) Post-obturation radiograph; (b) Two-year follow up radiograph.

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Discussion

Super-elasticity, shape memory effect, and corrosion resistance are the beneficial properties of NiTi alloys which have led to their widespread use for many dental, medical, and commercial purposes.[8] The properties of the alloy occur as a result of the austenite to martensite transition, which in turn is because of the alloy having an inherent ability to alter its type of atomic bonding.[8] However a major disadvantage of NiTi alloy is its low ultimate tensile and yield strength compared with stainless steel, making it more susceptible to fracture at lower loads.[10]

Endodontic instrument fracture is a procedural accident that creates an obstacle in the normal routine therapy. With the advent of rotary NiTi files, the occurrence of broken instruments has increased, especially in the hands of inexperienced clinicians. The factors contributing to breakage have been identified and several guidelines have been established to minimize instrument fracture during clinical use. Proper training of new techniques and adherence to established principles and guidelines of clinical usage can reduce the incidence of NiTi instrument fracture.

Mechanism of fracture

Metals undergo two types of fractures, either brittle or ductile fractures. Examination of a fracture surface using the scanning electron microscope provides useful information to characterize the major aspects of the fracture.[11] A ductile metal undergoes plastic deformation before it breaks, but there is little or no plastic deformation in brittle fracture. Brittle fractures usually occur in metals with poor ductility, typically, there is a crack initiation site at the metal surface, stress concentration at the crack tip leads to propagation of the crack and finally to fracture. In brittle fracture, cracks spread along different planes and radiate from the initiation site.[12] In ductile fracture, microvoids are formed in the metal, and coalescence of the microvoids finally weakens the material, leading to fracture.[12] Fractured rotary NiTi endodontic instruments show features of both brittle and ductile fractures.

The fracture of NiTi rotary instruments during clinical use may be due to cyclic loading or a single episode of sudden overload.[11,13] Cyclically fatigued instruments show no macroscopic evidence of plastic deformation, but instruments that fracture as a result of sudden torsional overload demonstrate variable deformation such as instrument unwinding, straightening, reverse winding, and twisting.[14] Rotating NiTi instruments in curved root canals are subjected to fluctuating tensile and compressive stresses, which may result in work hardening of the metal and induce the initiation of microcracks leading to eventual cyclic flexural fatigue.[6,14]

Factors contributing to the fracture of NiTi rotary instruments

Factors linked to the fracture of NiTi rotary instruments during clinical use include operator skills, instrumentation techniques, anatomy of the root canal system, number of instrument uses, and instrument design, manufacturing process, and cleaning and sterilization.

From the current available evidence we cannot fully understand the mechanisms of fracture of rotary NiTi instruments nor can we predict when it will occur. However the literature highlights the importance of undertaking training in the correct techniques of use of rotary instruments and also gives us a general set of guidelines to minimize the instrument fracture if not prevent it actually.

Guidelines to minimize the risk of fracture in clinical practice

- Ensure straight line access, good finger rests; create a glide path and patency.
- Use a crown-down shaping technique with stiffer, larger, and stronger files (such as orifice shapers) to create coronal shape before using the narrower, more fragile instruments in the apical regions.
- Never push hard on the instrument. Use a light touch and retract (pecking) motion.
- Avoid rapid jerking movements of instruments; beware of clicking.
- Replace files sooner after use in very narrow and much curved canals.
- Examine files regularly during use, preferably with magnification.
- Keep the instruments moving in a chamber flooded with sodium hypochlorite
- Avoid keeping the file in one spot, particularly in curved canals, and with larger and greater taper instruments.
- Practice is essential when learning new techniques and new instruments

Inspite of observing all the caution instrument separation may still occur in day to day clinical practice. Whenever an instrument separates in the canal attempts must be made to retrieve it or at least bypass it. The factors influencing broken instrument removal should be identified before attempting its retrieval. According to Ruddle[15] the nonsurgical removal of a broken instrument will be influenced by the diameter, length and position of the fragment within the canal. Moreover, canal anatomy, including the diameter, length, and curvature of the canal, as well as the thickness of root dentin and the depth of external concavities will influence the safe removal of the separated instrument fragment. In general, if one-third of the overall length of an obstruction can be exposed, it can usually be removed. Instruments that lie

in the straightaway portions of the canal can typically be removed. Separated instruments that lie partially around canal curvatures, can oftentimes be removed if straight-line access can be established to their most coronal extents. If the broken instrument segment is apical to the curvature of the canal and safe access cannot be accomplished, then removal is usually not possible and, in the presence of signs or symptoms, surgery or an extraction will at times be required.

The type of the material of the broken instrument is another important factor to be considered during its removal. The stainless steel files are usually easier to remove with ultrasonics, as they do not further fracture during the removal process. Nickel titanium instruments may undergo further fracture due to heat build-up when ultrasonics are used for their removal.[15,16] On ultrasonic application a stainless steel fragment absorbs the ultrasonic energy bodily, and will show early movement where as a NiTi fragment absorbs the energy at the point of contact with the tip.[16] This can result in the separated fragment gradually getting smaller, as the flutes are worn away by the energy applied.[16,18]

Once an instrument fractures, the consequences of leaving, versus removing broken instruments from the canal must be considered by the clinician and decision taken accordingly. Contemporary techniques must be tried but if they prove to be unsuccessful, alternative devices should be used for the removal of broken endodontic instruments. Several methods and instrument removal systems have been proposed for retrieval of broken instruments from the canals. However none of these can guarantee success in every case. Individualized case analysis evaluating such factors as the anatomy of tooth, degree of root canal curvature, and the location of the fragment needs to be made to choose the appropriate method of instrument removal or bypass. These factors seem to have a greater influence on separated instrument removal than the specific technique used.

Clinical importance of broken instrument removal

Fracture of an endodontic instrument during root canal treatment hinders further cleaning and shaping of the root canal system. This inability to further clean and shape the root canal system can compromise the outcome of the treatment. The prognosis of any particular case is dependent on the stage of canal preparation at the time of instrument separation. Separation of an instrument at the apex, at later stages of treatment when considerable debridement and disinfection of the canal has been achieved has the best prognosis.[16] Separation of an instrument short of working length, at early stages of treatment will compromise the treatment outcome, because in such cases it is difficult to determine the true extent of debridement and disinfection of the root canal system.[17] Prognosis will be further reduced in presence of periapical radiolucency.[17] Therefore, it becomes important in such cases to bypass or retrieve the separated instruments without further damage to the tooth structure.[16,17] The removal of NiTi rotary instrument separated in the apical one-third of a curved canal (beyond the curvature) tends to be more difficult. Such cases often require removal of a large amount of root dentin, which ends up reducing the root strength by 30 to 40%.[18]

Therefore, it's recommended that file removal beyond the curve should not be routinely attempted and the decision to retrieve a particular separated file must be the judgement of the clinician. The clinician must weigh out the advantages and disadvantages of retrieval of separated instruments, keeping in view the prognosis of the procedure and its effect on the structural integrity of the tooth.

Conclusions

In the present case report an alternative method, involving the use of a modified 18-guage needle and cyanoacrylate glue helped to successfully retrieve the instrument fragment. This can be utilized as an alternative method by any general practitioner or a specialist in absence of an instrument removal system with ease. The method is simple, cost effective and at the same time can result in predictable success.

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

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