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DIFFERENT TECHNIQUES TO REMOVE A FRACTURED ENDODONTIC INSTRUMENT IN AN UPPER FIRST MOLAR: CASE REPORT

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ABSTRACT

In endodontics, the removal of fractured endodontic instruments is one of the most difficult and complex surgical procedures. The depth of the fractured fragment and its relation to root curvature are key factors in determining success of the procedure. This is a case report of the removal of three endodontic instruments fragments in the upper first molar by different techniques. Three fractured segments were found in the canals: two in the cervical and middle third of the distobuccal canal and one in the middle third of the mesiobuccal canal. An ultrasound, an operating microscope and the wire loop technique were used in a single session to remove all fragments. The pre-planned and accuracy of recovery maneuvers of fractured instruments, as well as the position of the segment within the root canal, are what define the effectiveness of the procedure.

KEYWORDS: Root canal, endodontics, retreatment, ultrasound.

1. INTRODUCTION

The use of nickel-titanium rotary instruments (NiTi) implemented a new concept in the mechanical preparation of root canals[1]. These demonstrate a significant increase in flexibility, better maintenance of the original canal morphology, less canal transportation and more centered canal preparation[2]. Despite all advantages, the fracture of these instruments has become a real concern due to their high prevalence[3].

Several factors are associated with fractures, such as: operator’s experience, rotational speed, curvature of the canal, instrument design, instrumentation technique, torque, manufacturing process and absence of glide path[4].

In this sense, the removal of fractured instruments from root canals in most cases becomes difficult and sometimes impossible[5] depending on their location[6,7]. A fractured instrument in the canal prevents proper cleaning and shaping of the root canal system, compromising the result of endodontic treatment, especially in cases of pulp necrosis and infection[8].

There are a variety of different techniques and devices to aid in the removal of fractured instruments[9]. The use of microscope in combination with an ultrasound dramatically improves the efficiency and safety in removing these instruments[10]. The most used techniques are the wire loop technique, the Masserann kit, adhesives such as cyanoacrylate, the Canal-Finder system, the Hedstroëm tube technique and the use of chemical agents such as iodine trichloride[11,12].

Handling a case of a fractured instrument may involve an orthograde technique or a surgical approach. The three orthograde approaches are: (a) attempting to remove the instrument; (b) attempting to deflect the instrument; and (c) preparing and filling with the fractured instrument inside the canal. When these instruments can be removed, treatment or retreatment usually occurs[5]. If the fragment is inaccessible and a periapical lesion is present at the time of the instrument's fracture, surgical approached including apical surgery, intentional reimplantation, root amputation or hemisection, can be considered as the best option[13,14]. Thus, the present article aims to report a case of the removal of three endodontic instruments fragments in the upper first molar, utilizing various techniques.

2. CASE REPORT

A 23 years-old female patient, feoderma presented for endodontic treatment of tooth #16 at the Dentistry Graduate Program. She reported that the dentist had fractured two endodontic instruments in the referred tooth. Our clinical examination revealed, glass ionomer provisional restoration on tooth #16, and negative responses to percussion and palpation. In the periapical radiographic examination, we identified a wide coronary chamber, and long, atresic canals with smooth curvatures in the mesiobuccal and distobuccal roots. Fragments in the radicular middle third of the mesiobuccal canal and in the cervical and middle third in the distobuccal canal were observed (Figure 1). The suggested diagnosis of this tooth was previously treated endodontic therapy.

Figure 1. X-ray showing the presence of fragments in the root canal

In the first session, posterior superior alveolar nerve and interpapillary nerve blocks were performed using Mepivalem 2% with adrenaline 1:100,000 (Maillefer - Dentsply, Switzerland). Under absolute isolation, the temporary restoration was removed with a spherical diamond bur (#1012, KG - Sorensen, Brazil) and cone-drill Endo Z (Maillefer - Dentsply, Switzerland) were used for the access opening (Figure 2). Then, the apparent length of the tooth (ALT) was determined, the palatal root length was 23mm and the distobuccal and mesiobuccal were both 21mm.

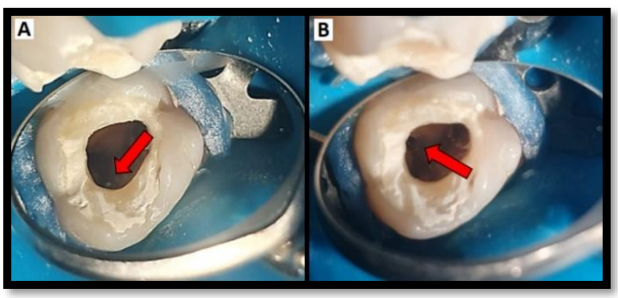

Figure 2. Coronal access of tooth #16. **A.** Fragment can be visualized in the distobuccal canal (red arrow). **B.** Fragment in the mesiobuccal canal (red arrow).

The initial exploration of the palatal canal was performed with a size 10 K-file (Maillefer - Dentsply, Switzerland). Subsequently, a pre-enlargement was performed with a size 15 K-file (Maillefer - Dentsply, Switzerland) in the ALT subtracting 4mm. Then, using a size 10 K-file and with the Novapex foraminal locator (Romidan, Israel) the working length (WL) of the palatal root canal was confirmed (24.0mm), mesio-palatal cusp was used as a reference point.

The chemical-mechanical preparation of the canal was performed under copious irrigation with 2.5% sodium hypochlorite (Asfer, Brazil) using a 5ml disposable plastic syringe (Ultradent, Brazil) and Navitips irrigation tips (Ultradent, Brazil) throughout the ALT - 4mm. In the palatal canal, when reaching the WL, the apical stop was created up to the 60 K-file (Maillefer - Dentsply, Switzerland). Cellpack absorbent paper tips (AllPrime, Brazil) size 60 were used and, then a calcium hydroxide-based intracanal medication (Ultracall - Ultradent, Brazil) was inserted. Tricresol formalin (Biodinâmica, Brazil) on a small pledge of cotton wool was placed over the opening of the buccal canals (Biodinâmica, Brazil) followed by Maxxion R restorative glass ionomer cement sealing (FGM, Brazil).

One session was necessary to perform the removal of the three fractured fragments. The endodontic operating microscope (Alliance, Brazil) and Profi Neo US ultrasound (Dabi Atlante, Brazil) were used during the procedure. During the removal of fractured fragments in the distobuccal canal, the wire loop technique was used, but was not successful. Thus, we opted to use E8 ultrasonic inserts Scouter (Helse, Brazil) and E3D conic diamond (Helse, Brazil), with power of 20% and 60%, respectively. Dentin wall shaping was performed with a counterclockwise movement around the fragment to remove one of the two fractured segments (Figure 3a).

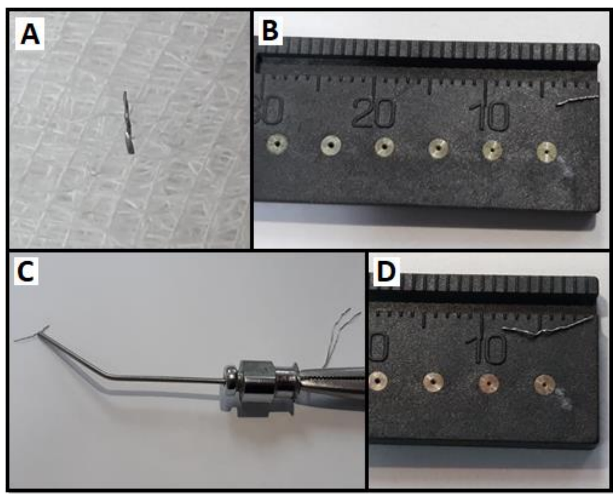

Figure 3. A and **B**. Fragments removed from the distobuccal canal. **C**. Fragment laced in the orthodontic wire attached to a metal suction tip. **D.** Fragment removed from the mesiobuccal canal.

The second fractured file in the distobuccal canal was removed with the E18 ultrasonic inserts (Helse, Brazil) and R1-Clearsonic (Dabi-Helse, Brazil), with a power of 10% and 40%, respectively (counterclockwise movement) (Figure 3b). Irrigation was performed with 9% saline (A.D.V.), using a 5ml luer lok plastic syringe (Ultradent) and Navitips irrigation tips (Ultradent, Brazil).

In the mesiobuccal canal, the fractured instrument was removed using the wire loop technique, which requires a metallic suction tip (Fava, Brazil) and a #8 orthodontic steel ligature wire. A loop on the wire is made and must pass through the suction tip, leaving the end of the wire out (Figure 3C). The fragment is laced by the end of the thread, tightened with a Mayo Hegar needle holder (Golgran, Brazil) and subsequently pulled for removal (Figure 3D). Then, tricresol formalin (Biodinâmica, Brazil) was placed as intracanal medication, and coronal sealing was performed with Maxxion R restorative glass ionomer cement (FGM, Brazil). In addition, a new radiograph was performed (Figure 4).

Figure 4. X-ray after removal of fractured fragments.

A single session was necessary for the chemical-mechanical preparation of the buccal canals. During the initial exploration with a size 08 and 10 K-files (Maillefer - Dentsply, Switzerland), the presence of a ledge was observed in both canals. Thus, liquid E.D.T.A (Biodinâmica, Brazil) was inserted into the two root canals. Then, a C-Pilot # 08 and C-Pilot # 10 (VDW, Germany) file was used to gain patency in the distobuccal and mesiobuccal canals, respectively. Subsequently, the WL of the buccal canals was confirmed using the size 10 K-file and the foraminal locator Novapex (Romidan, Israel), the length of the distobuccal canal was 23.5mm (mesiopalatal cusp was used as reference) and 21mm for the mesiobuccal (mesiobuccal cusp was used as reference) cusp. After working length establishment, Prodesign Logic files 25.01, 25.03, 25.05 (Easy, Canada) and #30 K-file (Maillefer - Dentsply, Switzerland) were used for instrumentation of the two canals. Then, the #35 K-file (Maillefer - Dentsply, Switzerland) was used for foraminal enlargement of the mesiobuccal canal. During chemical-mechanical preparation, 2.5% sodium hypochlorite (Asfer, Brazil) was used for irrigation with a 5ml luer plastic syringe (Ultradent, Brazil) and Navitips irrigation tips (Ultradent, Brazil).

After the instrumentation, the final irrigation protocol was carried out, which consists of three irrigations with 2.5% sodium hypochlorite (Asfer, Brazil), then 3 times with liquid EDTA (Biodinâmica, Brazil) and again three times with hypochlorite of 2.5% sodium (Asfer, Brazil), 30 seconds each, activated with Easy Clean tips (Easy, Canada). After the canals were dried with sterile absorbent paper, the photodynamic therapy (PDT) was used and the canal was filled with Chimiolux methylene blue (DMC, Brazil). After three minutes of pre-irradiation time, the irradiation of each canal was performed with the red low-power laser coupled with the optical fiber (DMC, São Carlos, Brazil), with constant movements in the apex-crown direction, for three minutes.

The root canal fillings were performed using the lateral compaction technique, using accessory gutta percha cones (Maillefer - Dentsply, Switzerland) ISO sizes of 30, 35 and 60 standard cone (Maillefer - Dentsply, Switzerland) as main cones for the distobuccal, mesiobuccal and palatal canals, respectively. Accessory cones F, MF and FM were also used for filling the canals. AH Plus (Maillefer - Dentsply, Switzerland) was the endodontic cement of choice. Excess gutta-percha was removed with heated Paiva condensers (Golgran, Brazil), and the final compaction was carried out through apical compression with NiTi condensers (Odous de Deus, Brazil). The canal was sealed and a base with Coltosol (Coltene, Switzerland), followed by crown sealing with Maxxion R restorative glass ionomer cement (FGM, Brazil) and final radiography (Figure 5).

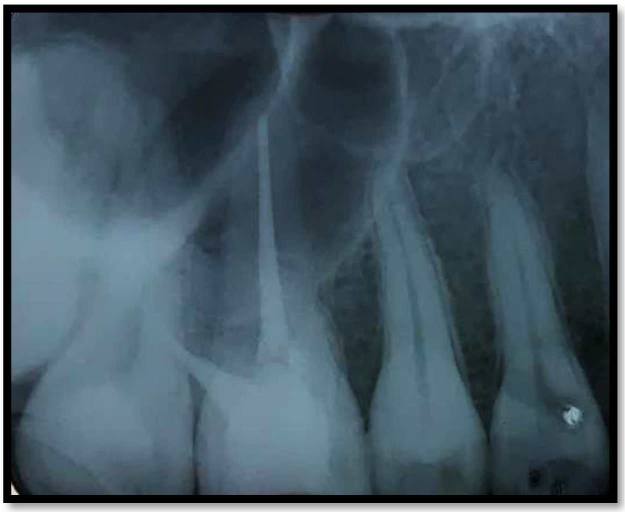

Figure 5. Final x-ray.

3. DISCUSSION

The success of non-surgical removal of fractured root canal instruments depends on several factors, amongst them are Length and location of the fragment, diameter and curvature of the root canal and the friction and impaction of the instrument fragment on the canal wall.

Regarding the location of the fractured instrument and the curvature degree of the root, a fragment that is positioned in the cervical third or in the straight portion of the canal is easily removed. If the segment is in the middle third or in a curved portion of the canal, the risk to benefit ratio of the removal must be evaluated. However, if the fractured fragment is found in the root apical third or beyond the curvature, due to the limited accessibility and visualization, it usually cannot be removed [5,6,7]. In the present case, we removed the fractured instrument, as the fragment in the mesiobuccal canal was in the middle third and the root was slightly curved, and the ones in the distobuccal canal were in the cervical and middle third, in a straight root.

The curvature of the root canal of the first maxillary molars is generally more severe in the mesiobuccal root canals, especially in the apical third[15]. The probability of fracturing instruments using Ni-Ti rotators is almost three times greater for the mesiobuccal canal when compared to the distobuccal canal[16]. However, in the present case, two fractured instruments were in the distobuccal canals, despite being a straight canal and, one fragment was in the mesiobuccal (smooth curvatures). In both canals, due to their anatomy, access and removal of the fragments were possible.

The dental operating microscope plays a fundamental role in removing fractured instruments, as it allows better visualization and control of the intracanal procedures[5,7,10]. In the present study, magnification was of paramount importance to assist in locating the fractured instrument, in the controlled removal of dentin around the fragment and in preserving the original canal anatomy, allowing a bigger field of view and more light for the clinician.

Ultrasonic devices have proven to be an efficient system for loosening and removing various obstructions in root canals, due to the vibration capacity of the endodontic instrument[17]. The ultrasonic tip is activated in low-power configurations, instrumenting the dentin with an anti-clockwise movement around the fragment[7]. For better visualization under the microscope, it is recommended to use the ultrasonic device without any source of irrigation[18]. However, another study indicates, the addition of an irrigating solution can improve the removal of the instrument[5]. In the present case, we used the dry ultrasonic tip for better visualization and control of dentin removal.

The high frequency vibration and the friction between the ultrasonic tip, the dentin and the fragment, generates heat that can be transmitted to the surface of the external root and later to the periodontium[19]. Ultrasonic systems are recommended when fractured segments can be visualized, which usually occurs in straight canals, or when the fragment is in the cervical third or when it is before the curvature of the root canal. This limitation is considered a disadvantage of ultrasonic systems[5]. In the present study, small ultrasonic tips were used, according to the manufacturer's indication, with low power, which varied between 10% and 60%. Due to the ultrasonic vibration, the segment could fall into the adjacent canals, therefore their openings were blocked with cotton pellets to prevent this from happening.

Roig-Greene (1983) was the first to describe the use of the wire loop technique for fragments of separated instruments from the root canals. His technique consists in making a loop by passing the 2 free ends of a 0.14mm diameter steel ligature through a 25 gauge injection needle from the open end until it slides out. Using a small hemostatic mosquito forceps, the loop can be tightened around the free upper part of the fragment and then the entire set can be removed from the root canal. The limitation of this maneuver is that the fractured fragment needs to be located in the coronal portion of the root, so that it can be looped and pulled out of the conduit[11]. The technique was modified in this case report, as we used a #8 orthodontic steel ligature wire to make the loop (going beyond the edge of the metallic suction tip) and a Mayo Hegar needle holder. Prior to the use of this maneuver, dentine around the fragment had been reshaped to allow the fragment grasp with the loop, through continuous twisting of the thread, and traction was exerted by the needle holder.

Several studies have concluded that attempts to remove fractured instruments can lead to unwanted effects such as weakening of the tooth if too much dentin is removed, ledge formation, root perforation, deviation of the original canal, vertical root fracture and apical fragment extrusion into the periapical tissues[5,6,9]. These consequences of fragment removal were not observed in the present case report, except for the formation of a ledge inside the canal, which was bypassed during the chemical-mechanical preparation.. There are several reasons that explain ledge formation: the cervical location of the fragment, fragment located in the middle third of the canal, straight roots, smooth curvatures, operator's ability to enlarge and visualize the field with a surgical microscope and controlled shaping of the surrounding dentin with an ultrasonic system.

The success rate of removing fractures instruments ranges between 68% to 87[5,10]. Regarding the canal curvature, the success rate depends on the location of the fractured instrument in relation to the curvature of the canal and the degree of curvature. Fragments located before the curvature of the canal have a 100% success rate for recovery[20]. When fragments are located at and beyond the curvature, the success rate decreases to 60% and 31%, respectively[21]. The present study confirms the high success rate of removing fractured instruments when fragments are located in the straight and in the curvature portion of the canal.

It is well established that root canal bacteria eradication is difficult, and contemporary techniques are unable to consistently disinfect canal systems[22,23]. New approaches to disinfect root canals such as PDT have recently been proposed[24]. PDT is a new antimicrobial strategy that involves combining a non-toxic photosensitizing agent (PS) and a light source[25]. The photosensitizer is applied to a target tissue that is subsequently irradiated with light of an appropriate wavelength in the presence of oxygen to produce radicals, singlet oxygen and other reactive oxygen species[26], which induce lesions and death of microorganisms[25]. In the present case report, we used PDT in order to expand the disinfection of the root canals, with methylene blue being used as the photosensitizing agent, and the optical fiber coupled in a low power red laser, for three minutes in each root canal.

Endodontic therapy consists of the triad of debridement, disinfection and filling of the root canal system. The filling must be a dense three-dimensional and well adapted to the entire root canal system with a homogeneous core[27]. Cold lateral compaction using gutta-percha cones and sealer still remains very widespread today. However, this method produces a non-homogeneous filling with empty spaces between the accessory cones and the canal walls. This results in many lateral canals not being filled and in an inadequate dispersion of the sealer[28]. In the present study, this technique was chosen due to the controlled placement of gutta-percha in the root canal, the properties of the filling cement used and the complete control of the operator over the maneuver.

4. CONCLUSION

Considering what has been presented, we concluded that the successful removal of the three fractured endodontic instruments fragments was possible due to the theoretical and practical proficiency of the removal techniques with the aid of a microscope and an ultrasonic device. They should always be performed with minimal damage to the tooth structure and periodontal tissues, allowing for subsequent chemical-mechanical preparation and filling of root canals, in addition to favoring the prognosis.

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