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REMOVAL OF A FRACTURED INSTRUMENT FROM THE ROOT CANAL USING AN OPERATIVE MICROSCOPE – CASE REPORT

ОТСТРАНУВАЊЕ НА ФРАКТУРИРАН ИНСТРУМЕНТ ОД КОРЕНСКИ КАНАЛ СО ПОМОШ НА ЕНДОДОНТСКИ МИКРОСКОП - ПРИКАЗ НА СЛУЧАЈ

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Abstract

An instrument fracture during endodontic treatment is a common complication that can hinder proper cleaning and disinfection of the root canal, negatively affecting the treatment outcome. Removing fractured instruments presents a challenge due to their location, size, and the anatomy of the canal system. The aim of this study is to emphasize the significance of the operative microscope in the conservative removal of fractured instruments from the canal system and the possibility of subsequent successful endodontic treatment through case studies. In the presented cases, fractured instruments were removed from the root canal with minimal removal of the surrounding healthy dentin using ultrasonic tips under an operative microscope. **Keywords:** Operative microscope, ultrasonic tips, fractured instruments.

Апстракт

Фрактурата на инструмент за време на ендодонтскиот третман е честа компликација што може да го попречи соодветното чистење и дезинфекција на коренскиот канал, што негативно влијае на исходот од третманот. Отстранувањето на скршените инструменти претставува предизвик поради нивната локација, големина и анатомијата на каналниот систем. Целта на овој труд ни беше преку приказ на случаи да го потенцираме значењето на оперативниот микроскоп при отстранување на фрактурирани инструменти од каналниот систем на конзервативен начин и можноста за последователен успешен ендодонтски третман. Во прикажаните случаи со помош на примена на ултразвучни продолжетоци и под оперативен микроскоп фрактурираните инструменти беа отстранети од коренскиот канал со минимално одземање на околниот здрав дентин. **Клучни зборови**: Оперативен микроскоп,ултразвучни продолжетоци, скршени инструменти.

Introduction

One of the possible complications during endodontic treatment is the fracture of instruments inside the root canal[1].

This issue is significant both technically and clinically, as it can affect the treatment outcome, increase the risk of endodontic failure, and necessitate additional interventions.

Predisposing factors that may lead to instrument fracture include: the instrument's design, its usage dynamics, the manufacturing process, the canal configuration, the cleaning and sterilization process, and the frequency of use[2].

Additional factors may include complex tooth anatomy (e.g. curved, narrow canals) and possible iatrogenic errors. Proper coronal visualization is essential to enable thesuccessful removal of a fractured fragment from the canal system and to ensure the success of treatment methods.

The dental microscope is one of the key factors for successful endodontic treatment, especially in cases of fractured instruments in the root canal, as it can magnify the structure of an object from 0.2 mm to 0.006 mm (microns), improving visibility[4].

There is no standardized procedure for successfully removing a fractured instrument. Many techniques and

devices have been tested—mostly on fractured manual instruments. These techniques are time-consuming, have limited success,and pose a significant risk to narrow and curved canals[3]. One of the most commonly used techniques for removing fractured instruments from the root canal, both by endodontists and general dentists, is the use of specialized devices or ultrasonic techniques for the removal of fractured instruments[5].

The **aim** of this study is to highlight the importance of the operative microscope in removing fractured instruments from the canal system and the possibility of a subsequent successful endodontic treatment through case studies.

Case Study

Case 1

A 35-year-old patient presented with pain while chewing on the lower right molar (tooth 46). Intraoral examination revealed a large composite restoration with poor marginal adaptation. A periapical radiograph showed inadequate endodontic treatment and a fractured instrument in the mesiolingual canal.

After obtaining informed consent, a rubber dam was placed, and the patient was positioned for treatment using a dental microscope (Zumax OMS2350 with six magnification levels – 0.33x, 0.5x, 0.8x, 1.22x, 2x, and 3x). After removing the restoration, the root canal entry was widened using a Gates-Glidden Drill size 3 for better visualization of the coronal part of the instrument. Once the instrument was located (figure 1), ultrasonic tools (Dentsply Sirona Endo 1 and Endo 5) were used to carefully remove 2-3 mm of dentin apically around the instrument without excessive canal enlargement, using 1.22 x magnification. The ultrasonic tip was positioned around the instrument, first loosening it from the inner wall to facilitate removal. During the ultrasonic procedure, continuous irrigation with 5% NaOCl and 17% EDTA was performed to prevent overheating of the root. After each irrigation, an endodontic probe was used to assess the degree of instrument loosening. Once the instrument was sufficiently loosened, it was successfully extracted using a Loop from the Cerkamed Endo Removal System (figure 2).

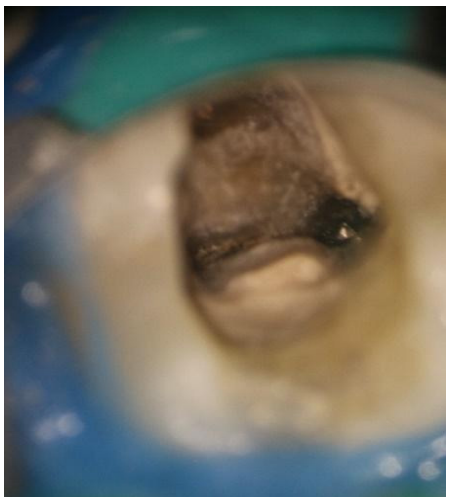

Figure 1. *Examination of the cavity of tooth 46 using an operative microscope, visualizing the fractured instrument under 2x magnification*

Figure 2. *Instrument for the removal of fractured instruments from the root canal (Loop, Cerkamed Endo Removal System).*

After the instrument removal, the working length of the root was determined using a K-file #8 (DiaDent) and an apex locator (Woodpecker Woodpex III). Retreatment of the remaining canals was performed by softening the gutta-percha with orange oil (Cerkamed), determining the working length of each root canal, and proceeding with final canal preparation using machine endodontic instruments (Soco – SC Niti File). The distal canal was prepared up to size 35/.04, the mesiobuccal canal up to size 25/.04, and the mesiolingual canal up to size 30/.04.

During the procedure, irrigation was performed using 5% NaOCl and 17% EDTA, followed by activation with an endo-activator (Woodpecker Endo 3 Ultrasonic Endo Activator). The irrigation protocol before obturation was as follows:

Figure 3. *Visualization of activated 5% NaOCl under a microscope with 2x magnification.*

- 1-minute activation of 5% NaOCl per canal (5ml),
- 1-minute activation of 17% EDTA per canal (5ml),
- 1-minute activation of 5% NaOCl per canal (5ml) (figure 3), followed by rinsing with distilled water (5 ml).

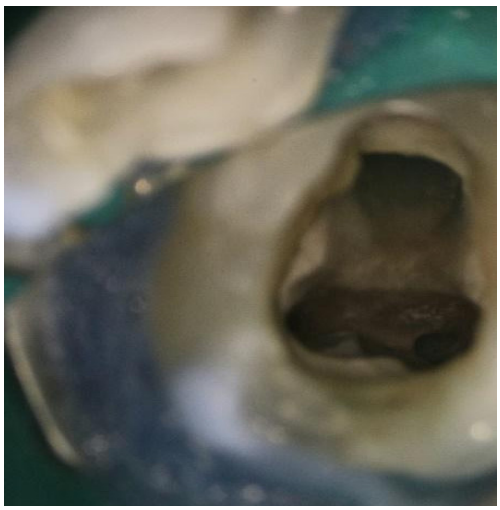

Figure 4. *Examination of the cavity after the removal of the fractured instrument, showing the prepared three root canals under a microscope with 2x magnification.*

After the final preparation of all three root canals (figure 4), they were dried with paper points (DiaDent) and definitively obturated with gutta-percha cones corresponding to the prepared sizes (distal canal with a 35/.04 gutta-percha cone, mesiobuccal canal with a 25/.04 cone, and mesiolingual canal with a 30/.04 cone – DiaDent), using AH Plus (Dentsply Sirona) as the sealer and applying the single cone technique (Figure 5).

Figure 5. *Radiographic view of tooth 46 before and after the final obturation.*

Case 2

A 30-year-old female patient presented with pain in the maxillary left lateral incisor (tooth 22). A periapical radiograph (Figure 1a) revealed the presence of a fractured instrument in the root canal of the left lateral maxillary incisor, with a peri-apical lesion affecting the lateral incisor and the canine (teeth 22 and 23). Since the lateral incisor was also an abutment for a bridge construction, the intervention was performed through the crown with the aid of a dental microscope.

After obtaining informed consent from the patient, a rubber dam was placed,and a retreatment of the endodontic therapy was performed using a dental microscope (Zumax OMS2350) with six magnification levels: 0.33x, 0.5x, 0.8x, 1.22x, 2x, and 3x.

The canal access was widened with a Gates-Glidden Drill #2 to improve visibility and access to the instrument. In the next phase, removal of the instrument was initiated

Figure 1. *Radiograph of teeth 22 and 23 before the start of the intervention.*

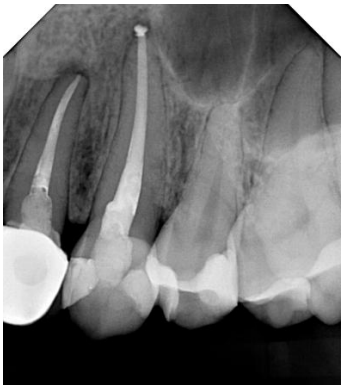

Figure 2. *Radiograph of teeth 22 and 23 after 3 months.*

Figure 3. *Radiograph of teeth 22 and 23 after 6 years.*

using an ultrasonic instrument (Dentsply Sirona Endo 1 and Endo 5). The working protocol was the same as in the previous case. Once the fractured instrument was successfully removed, final canal preparation was performed.

After determining the canal length with an apex locator (Woodpecker Woodpex III) and a K-file #10 (DiaDent), the canal was prepared using machine-driven expanders (Soco – SC Niti File) up to size 35/.04.

Final irrigation was performed according to the established protocol:

- 1-minute activation of 5% NaOCl (5ml),
- 1-minute activation of 17% EDTA (5ml),
- 1-minute activation of 5% NaOCl (5ml), followed by rinsing with distilled water (5ml).

After thorough cleaning and preparation, the canal system was dried with paper points (35/.04 – DiaDent) and definitively obturated with gutta-percha cones (35/.04 – DiaDent) and AH Plus (Dentsply Sirona) as a sealer using the single-cone technique.

During the same visit, an endodontic treatment of the upper left canine (tooth 23) was also performed. After forming an access cavity and entering the root canal, the working length was determined using a K-file #10 (DiaDent) and an apex locator (Woodpecker Woodpex III). The canal system was instrumented using machine-driven expanders (Soco – SC Niti File 35/.04) and an endo-motor (Dentsply X-Smart Plus Endo Motor). Irrigation followed the pre-established protocol, with activation performed using an ultrasonic activator (Woodpecker Endo 3 Ultrasonic Endo Activator).

After the canal preparation and cleaning, the system was dried with paper points (DiaDent 35/.04) and definitively obturated with gutta-percha cones (DiaDent 35/.04) and AH Plus (Dentsply Sirona) as a sealer using the single-cone technique (Figure 2).

Discussion

Instrument separation is a frustrating and undesirable complication in endodontics[6]. Most stainless-steel instruments fracture due to repeated use[7]. Fractures can also occur due to aggressive movements, such as rushing through the canal or applying excessive force to the instrument beyond its intended working length or around sharp curvatures[7].

The ability to safely remove a fractured fragment depends on the complexity of the canal anatomy, including the thickness of the root dentin, its curvature, and the dimension and location of the fragment within the canal.8

Managing a case with a fractured instrument may involve either an orthograde or a surgical approach. The three orthograde approaches are:

(a) attempting to remove the instrument,

(b) attempting to bypass the instrument, and

(c) preparing and obturating up to the fractured segment.

Successful retreatment can be performed when these instruments can be removed. If the instrument can be removed or bypassed, and the canal can be properly cleaned and filled, the non-surgical endodontic procedure is the more conservative approach. While many fractured instruments can be removed from the root canal, there are cases where removal is not possible due to limited access, especially when the fracture occurs around a curvature. The fractured instrument typically obstructs access to the root apex, which may impair the operator's ability to properly prepare, disinfect, and obturate the entire root canal system[9].

The use of ultrasound under magnification is one of the most conservative techniques for instrument removal compared to alternative methods.1 However, ultrasonic techniques are much simpler and less invasive[10].

Ultrasonic tips can be used in deeper parts of the canal due to their contra-angle design and have shown a success rate of 55%-79%[11].

The introduction of the dental microscope has truly revolutionized endodontic practice. The microscope improves theaccuracy of identifying anatomical features of the root canal, which is crucial for successful treatment and long-term outcomes.

With the microscope’s magnification and illumination, clinicians can better observe the coronal aspects of fractured instruments and remove them without causing perforation[12]

According to Fors and Berg, the location of the instrument plays a crucial role in managing fractured instruments. Objects fractured in the coronal third of the canal can be removed using an instrument extractor or small forceps, whereas instruments fractured in the middle third of the canal should ideally be bypassed to prevent excessive removal of surrounding dentin and weakening of the tooth root[13].

Research by Fu et al. has shown that the ultrasonic removal of instruments from the middle third of the canal significantly increases canal volume and may lead to the formation of micro cracks, reducing resistance to vertical root fracture. Therefore, even though the success rate of instrument removal from the middle third of the canal is reportedly high, clinicians should make efforts to minimize the amount of dentin removed around the instrument to improve the tooth's long-term prognosis[14].

In the first case presented in this study, since the fractured instrument was located deeper in the middle third of the root canal, the use of a dental microscope was particularly significant. The combination of ultrasonic tips and an operative microscope allowed for controlled dentin removal around the fractured instrument, loosening it, and ultimately extracting it using an instrument extractor.

In the second case, the instrument fracture was in the coronal third of the root canal, which led us to opt for its removal from the canal. The removal of the instrument enabled proper canal preparation, disinfection, and obturation, creating favorable conditions for adequate healing and repair of the surrounding periapical tissues.

Conclusions

Based on the presented cases, we can conclude that the use of ultrasonic instruments in combination with an operative microscope allows for the successful removal of fractured instruments from the root canal, whether the fracture occurs in the coronal or middle third of the canal while maintaining a controlled removal of surrounding dentin. However, in cases of fractured instruments in the middle third, special attention should be given to avoid excessive removal of root dentin and weakening of the tooth root.

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