Breaking a tool during the preparation of root canals. The methodology of management with a case report

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ABSTRACT

Background: Breaking an endodontic instrument is a complication that really hinders or even makes impossible complete disinfection and tight obturation of the root canal system.
Case presentation: A 74-year-old patient suffered a fracture of the clinical crown of the second incisor in the maxilla. The examination revealed necrotic pulp and the presence of obliteration significantly limiting the lumen of the tooth canal. It was decided to perform root canal treatment and then to do a reconstruction reinforced by crown-root inlay. An endodontic instrument was broken in the lumen of the root canal at the beginning of the endodontic treatment. A broken piece tightly filled nearly 80% of the total length of the canal. It was decided to use endodontic forceps to remove the fragment.
Conclusion: Choosing the right method is a key step in the complication described above. The management technique should entail the least risk of iatrogenic complications because they can greatly affect the long-term maintenance of the tooth. The article discuss on the basis of current literature standards of conduction in the case of tool breakage in the root canal system and presents the problem on the basis of own experience.
Key words: root canal treatment (RCT), mechanical preparation, torsional, stress fracture

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INTRODUCTION

A fragment of an instrument, which was separated during the mechanical cleaning and shaping of the root canal system, significantly hinders the proper endodontic treatment and may lead to its failure. This disturbs the mechanical preparation of the entire canal and the penetration of the chemical fluid along the entire length of the canal. The appearance of Nickel-titanium alloy in the production of canal tools did not reduce the number of breaks during treatment [1]. Statistics show that the complication concerns 0.25-6% of cases prepared by steel tools and 1.3-10% by nickel-titanium rotary instruments [2,3]. This may prove that factors associated with the technique of an operator and the anatomy of the teeth have the greatest impact on the appearance of this complication. It has been demonstrated that the separation of the part of a tool is a combination of the torsional and stress fracture [4]. Torsional fractures occur when the file is stuck in the canal, and the drive still rotates. In the case when the torque is greater than the material plasticity limit the file is broken. Stress fracture results from changes in the structure of the metal during continuous rotation of the file in the curved canal. The causes of endodontic instruments breaks are shown in Table 1.

Table 1. The causes of tools breaks in the root canal [4].

Torsional fracture	Stress fracture
1. use of excessive force, particularly for small instruments, 2. incorrect path of the canal access, 3. narrow radius of the canal curvature, 4. presence of obliteration, 5. removal of hard filling materials as a part of another endodontic treatment.	1. multiple use of instruments, 2. long-term burden of instruments.

Before choosing methods and techniques for the removal of the broken fragment of a tool, it should be considered the following factors: 1) the location of a tool in the root canal, 2) the stage of canal preparation when a break of a tool occurred, 3) the knowledge and skills of an operator and tools available, 4) the risk of potential complications, 5), the strategic importance of the tooth in the stomatognathic system and 6) the presence of changes in the periapical periodontium [5]. The most popular methods of removing the separated endodontic tools are shown in Table 2 [6]. Apart from the removal of a tool, the possibilities of management also include: an attempt to circumvention by using the so-called bypass, the preparation and filling the canal to the level of a broken tool and surgical methods such as radectomy, radisection, hemisection [5].

Case presentation

A seventy four-year-old healthy woman reported at a dentist's office because of a crown fracture of the 22nd tooth, which took place during eating the meal. An oral examination revealed the line of fracture extending around the cervical third of the tooth. An examination of the pulp vitality using ethyl chloride caused no reaction. The preoperative RSV (RadioVisioGraphy, HELIDENT PLUS, Sirona, Bensheim, Germany) picture was taken (Fig.1A). Necrosis of the pulp was an initial diagnosis. A decision was made about the need for endodontic treatment, which would eliminate the infected tissues from the canal and provide stable and durable reconstruction of the tooth.

The operated area was isolated with a Hygenic® rubber dam (Coltene/Whaledent, Langenau, Germany). Tooth pulp necrosis was confirmed after providing an endodontic access to the oral cavity. The cleaning and shaping of root canal was initiated. The patency of the canal was restored using a finger file C Pilot (VDW, München, Germany size 12.5 according to ISO – International Organization for Standardization) using EDTA (Ethylenediaminetetraacetic acid) formulation in the form of File-Eze gel (Ultradent, USA). The working length of 16mm was confirmed by a measurement procedure using apex locator Raypex (VDW, München, Germany) [7].

Then, the canal was rinsed with 2.5% sodium hypochlorite solution and further actions were undertaken to chemo-mechanically prepare the canal using the finger file K (VDW, München, Germany size 15 according to ISO). Next, the canal started to be prepared using MTwo (VDW, München, Germany) rotary tools with endodontic micromotor Endo-Mate TC (NSK, Nakanishi Inc., Tochigi, Japan) (the speed of 300 rotations per minute). An operator began the work with the file 10/04 according to ISO. After an introduction to the full working length, it was separated and 10mm of the working fragment remained in the canal. A RVG control image was taken (Fig. 1B) and the broken piece of the tool started to be removed. Obliteration of the canal very much hampered the attempts to introduce tools between the canal wall and the broken piece.

Table 2. Description of methods for removing broken tool from the root canal [6]

Method name	Indication	2/	Procedures
Braiding	Long fragments Lentulo spirals	Files H ISO 15/20	Enter 2 or 3 files into the space between the canal wall and the broken fragment of the tool, twist them together causing an increase in tension, and pull.
Tube	Long fragments	Masseran set Needle with paste–bonding technique System Removal	Provide the rectilinear access to the broken fragment, reveal 2-3 mm of the broken tool at the entire circumference, and enter a cannula. This will lead to the mechanical anchoring of the fragment in a cannula, and then pull a cannula with a fragment of the tool.
Ultrasound (by Ruddle)	All	Ultrasonic endodontic ends e.g. CPR tips: 6-8	Provide the rectilinear access to the broken tool, take a few circular movements in the anti-clockwise direction in the contact with the tool using a running ultrasound tip, introduce the fragment of the tool in vibration, generously rinse the canal, use an endodontic aspirator.
Loop	All visible fragments located in the middle and apical part of the canal	Wire with a thickness of 0.14 mm rolled up in a loop and inserted into a thin cannula	Lead the loop beyond the fragment of the broken tool, tighten the wire drawing the fragment into a cannula, and remove a cannula with the fragment of the tool.
Endodontic forceps	All fragments that are visible in the crown part	Forceps	Provide around the fragment the space enough to fit open beaks of forceps, slightly to catch the fragment, grab the broken tool, tighten beaks, and pull out the broken tool.

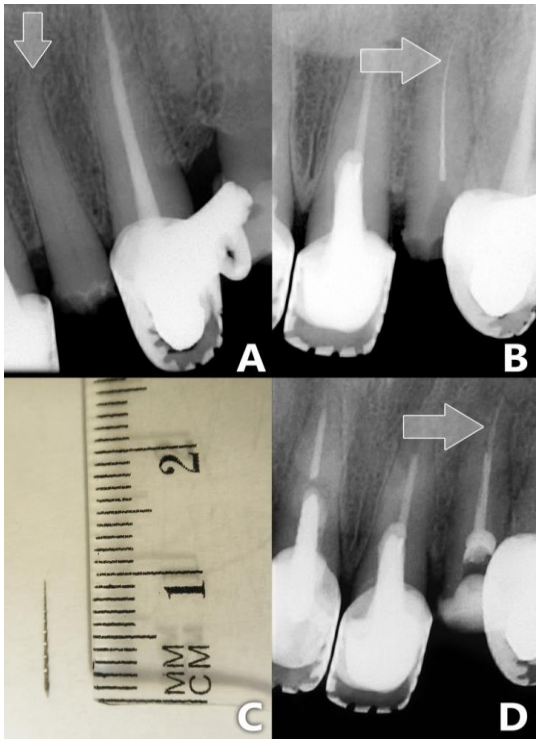

Fig.1. A-control test; B-broken piece of the tool; C-removed fragment in its whole entirety; D-filled canal.

An operator did not decide to use ultrasound because of the risk of separation/cracking of the broken part of the instrument. It was decided to use endodontic forceps Chifa (AESCULAP CHIFA Sp. z o.o.|, Nowy Tomyśl, Poland) to remove the fragment. The procedure was performed in magnification using an operating microscope (Seliga Microscopes Sp. z o.o., Łódź, Poland).

An access was provided to the broken fragment with the help of Munce burs (CJM ENGINEERING INC, USA) # ¼ and ½ #. A place for beaks of endodontic forceps was prepared in the root canal dentin (around the fragment of the tool) whose diameter did not exceed 1 mm (a diameter of the working part with closed beaks is 0.8 mm). The fragment was removed in its whole entirety, which enabled continuation of the treatment (Fig. 1C).

The canal was prepared using MTwo tools at the length of 16 mm to the MAF size of 30/05. It was rinsed using 2.5% sodium hypochlorite solution, saline and 2% chlorhexidine solution. The canal was filled by lateral condensation of gutta-percha and AHPlus (Dentsply, DeTrey GmbH, Konstanz, Germany) paste (Fig. 1D).

The crown of the tooth was restored by using a direct technique with standard crown-root inlay OverPost (Overfibers S.r.l., Mordano, Italy) made up of fibreglass, adhesive cement Build-it

(Perntram Clinical, Wallingford, USA) and composite material IPS Empress Direct (Ivoclar Vivadent, Schaan, Liechtenstein).

DISCUSSION

According to Arnold [8], the removal of separated fragments of instruments held in the crown part, is classified as a first degree of difficulty. Studies show that the most predictable results of removing a broken tool from the canal can be obtained in the frontal teeth of the upper jaw, the presence of a broken tool in the one third of the coronal part of the canal, the location of a broken tool before the curvature of the canal, rectilinear canals or those with mild curvature [5]. The worst prognosis is for the tool breakage at an early stage of preparation of the root canal system, before thorough cleaning of areas located laterally and apically to the separated fragment, and in periapical lesions yet before the surgery. Tools technically most difficult to remove are those found in the 1/3 apical part of the canal, and those below the curvature. Here, the risk of iatrogenic complications is the greatest and includes: perforation, *via falsa* and significant weakening of the tissues, which may in the future result in a vertical root fracture [6,8].

The best method to remove tools located in the crown part and the crown extending to the central area is the use of ultrasound or Braiding technique [9]. Tube and Braiding are the methods of choice in the case of tools extending to the apical or periapical part. The most important step is to reveal the broken fragment on the entire circumference to a minimum length of 2-3 mm. Such a length determines the appropriate anchor of a cannula. In the case described above, an operator decided to use endodontic forceps, because their design allows capturing tools exposed at the shorter length. A positive result was obtained by removing the exposed fragment of 1mm. This allowed less extensive preparation. Leaving as much patient's own tooth tissues as possible is crucial for the long-term maintenance of the tooth.

CONCLUSION

In case of complications such as a break of an endodontic instrument, we should carefully consider the possibility of removing the separated fragment, choose the appropriate method and assess the associated risk. The priority in our case included minimising the possibility of further iatrogenic damage and weakening of the hard dental tissues and adjacent structures. We decided that the removal of a broken fragment from the endodontic system is the optimal management. Our ultimate goal was the eradication of infection from the tooth cavities, tight filling of the structures and rebuilding of the tooth with the restoration of its aesthetic and functions in tight occlusion.

Consent section

Written informed consent was obtained from the patient for publication of this Case report and any accompanying images. A copy of the written consent is available for review by the Editor of this journal.

Abbreviations

RVG – RadioVisioGraphy, ISO - International Organization for Standardization, EDTA - Ethylenediaminetetraacetic acid, mm - millimeters, e.g. – for exemple.

Conflicts of interest

The authors declare that they have no competing interests.

Authors' Contributions

PK examined and treated the patient and collected the data. PK, MWB discussed the case and data. PK wrote the manuscript. MWB conducted a substantive assessment and verification, made adjustments and translated into English. All authors read and approved the final manuscript.

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