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A Review of Endodontic Broken Instrument Removal Techniques

*Abbas Bagheri [1], Mohammad Gharishvandi Abraki [2], Mohsen Khataminia [3], Mohammad Mahdi Kiafar [4]**

[1]*Department of Endodontics, School of Dentistry Shahid Sadoughi University of Medical Sciences, Yazd, Iran*

[2]*Department of Endodontics, School of Dentistry, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran*

[3]*Department of Prosthodontics, School of Dentistry, Shiraz University of Medical Sciences, Shiraz, Iran*

[4] *Department of Endodontics, School of Dentistry, Tehran University of Medical Science, Tehran, Iran*

Abstract

The complex practice of removing broken instruments within the nerve network of canals necessitates a thorough examination and assessment of various methods and tools. The Masserann kit may remove a significant quantity of dentin tissue in posterior teeth and curved canals, whereas ultrasonic instruments in conjunction with a DOM have proven to be particularly successful in removing damaged instruments. The application of modern technology, such as the GentleWave system, might be crucial in the root canal preparation process. However, depending on the approach employed and the length of the instrument, the success rate of removing damaged instruments varies. To efficiently remove damaged tools and retain the original canal form as much as possible, dental practitioners must be aware of a variety of procedures and tools.

Keywords: Endodontics, Broken Instrument, Ultrasonic, DOM

Mini Review article **Corresponding Author*, e-mail: mohammadmahdikiafar@gmail.com

1. Introduction

The success rate of a root canal operation can range from 86 to 98 percent [1]. In order to form and prepare the canal area for filling with inert material, the canals must be thoroughly cleaned of any diseased pulp tissue. But when endodontic therapy does not adhere to accepted clinical best practices, failure results [1]. There are various techniques for removing broken instruments from root canals, none of which have been completely successful, and all have resulted in damage including perforation of the root canal. Through direct vision using a dental microscope, the ultrasonic approach has recently been tested. Many variables affect how well the fracture instrument is removed non-surgically from the root canal. includes the length and placement of the piece, the diameter and curve of the root canal, and the friction of the tool piece against the canal wall [2].

Orthograde endodontic therapy has a poor prognosis when root canal tools break inside the root canal system [4, 5, 6]. Instruments being broken often it may result in the failure of root canal therapy, which would worry the patient [2, 7]. Studies show that damaged instruments are more often than not between 0.5 and 8. Techniques for removing endodontic damaged instruments, such as the Masseran kit [9], Endo Safety System [10], and Endo Extractor [11]. Three treatment options are indicated to remove damaged files from root canals: non-surgical therapy, surgical treatment, or removal. Additionally, more predictable operations are possible when using a dental operating microscope in combination with ultrasonic methods to diagnose dental clinical practice [3-5] .Both general dentists and endodontic experts use the ultrasonic method often [15]. Even if the broken root instrument is successfully removed, the effort might result in ledge creation, over enlargement, and the transfer of the ready root canal. Teeth are more prone to vertical root fracture when the canal is irregularly shaped and/or enlarged [16, 17]. According to two laboratory investigations, the root's strength decreases and it becomes more brittle when the fractured root instrument is removed when the file is in the middle or apical third of the root [6-7]. Sometimes the detached file cannot be removed from the channel, so it may block the channel and cause undesirable effects [8-9].

2. Materials and Methods

The manual search and grey literature searches were used in addition to PubMed, Cochrane, Lilacs, Web of Science, and Scopus for the bibliographic study. The titles and abstracts of 506 papers were examined after the inclusion and exclusion criteria were applied. Ninety of them were

chosen, and they were all read in full. This systematic review includes 31 publications in total.

3. Results and Discussions

3.1. Impact on Prognosis Included and Excluded Studies

34 mandibular incisors in total were chosen for Yajun Meng's study. Of these 34 instances, 26 (76.47%) were broken instruments that were removed using the trepan bur/microtube procedure without the use of DOM. Out of these 26 instances, 20 were retrieved using a microtube device, while six shattered instruments were taken out of the root canal using a trepan bur. 8.55 5.81 minutes, with a minimum of 2.32 minutes and a maximum of 25.57 minutes, were needed to delete the file components [10]. In a different study, two methods for removing broken instruments were compared. In the ultrasonic/microtube method, only one fragment was not removed within 45 minutes, and that fragment was excluded from the study [19, 20]. In contrast, the trepan bur/microtube method successfully removed all broken instruments, but one hole was left behind. Moreover, the root canal width, canal wall thickness, canal volume growth, and time taken were significantly different between the ultrasonic/microtube and trepan bur/microtube procedures (P<.001) [11]. The average root canal volume and diameter in the trepan bur group were smaller after the broken file was removed than in the ultrasonic group (7.58 0.67 mm and 1.08 0.07 mm), with the average minimum thickness of the canal wall's dentin being thinner in the former group (5.31 1.13 cubic mm and 0.93 0.10 mm). The broken file measured 0.60 0.12 mm and 0.66 0.15 mm for the ultrasonic and trepan bur groups, respectively, and it took 25 minutes to remove the broken tool using the ultrasonic approach vs. 9 minutes using the trepan bur method [12].

Table 1: removal techniques and their success rate in different studies

Study	Removal techniques	Success rate(%)
Meng Y[21]	trepan bur/microtube	76.47
Yang Q[23]	ultrasonic/microtube trepan bur/microtube	95.23 100
Gencoglu N[24]	ultrasonic approach Masserann Kit traditional method	95.2 47.6 80.9
Wohlgemuth P[29]	GentleWave system	83.3(midroot) 61.3(apical)

Among the 90 samples studied, 74 cases of broken instruments were successfully removed, which resulted in 82.2% success rate. In general, the ultrasonic approach had a success rate of 95.2%, the Masserann Kit method had a success rate of 47.6%, and the traditional method had a success rate of 80.9% for removing damaged instruments from direct canals. As a result, the Masserann approach is less successful than conventional and ultrasonic procedures for removing damaged tools from straight canals [24]. The Masserann kit's primary benefit is the extractor's locking mechanism, which offers significant retention; nevertheless, one of its drawbacks is the need to remove the dentin around the item [13]. In comparison to the currently used cyanoacrylate composite or chemically cured composite, it has also been claimed that the usage of light-cured composite within the microtubule is preferable [26]. The apical portion of the root canal can be cleaned using GentleWave technology, according to Molina et al. [27]. Additionally, according to Charara et al., using the GentleWave technology prevented teeth from extruding [28]. The success rates for removing disconnected instruments from the apical and midroot areas using the GentleWave technique were 61.3% and 83.3%, respectively. The GentleWave technique took 10 minutes and 44 seconds on average to remove instruments [13-14]. There are several methods and tools for removing damaged instruments from the root canal system [3], and they should do it with the least amount of harm to the tooth and the tissues around it [20]. The original canal form should be retained as much as possible while removing fractured root instruments [30]; in fact, expanding the channel by 40 to 50% of the root width enhances the vertical fracture. In curved canals and posterior teeth, the Masserann kit removes a significant quantity of dentin tissue [9, 31]. For the most effective removal of damaged instruments, combine a DOM with ultrasonic tools [15-20]. The only time loops that are useful are when the instrument that is damaged may be seen beneath the DOM. It is only possible to remove invisible broken instruments if a tiny ultrasonic tip [length: <4.6 mm] can be inserted into the gap between the inner wall and the invisible broken instrument. The preparation step is crucial for effective tool removal because, following the preparation phase, most broken tools (94%) shorter than 4.6 mm may be removed using ultrasonic waves in less than 10 seconds [19]. Rotary instruments like the XP-endo Shaper can be used to remove invisible broken instruments bigger than 4.5 mm if it is feasible to make a little gap between the canal wall and the broken instrument by applying ultrasonic waves or by bypassing the fractured instrument. A longer fracture tool also needs more preparation time before removal. Suter claimed that there was a negative correlation between the rate of instrument recovery and the length of the recovery process [38]. The elimination of invisible broken instruments longer than 4.5 mm that reach over the curve may be lessened by two characteristics:

First, due to major changes in root canal preparation methods, instrument fractures in the root canal may go undetected. Sonendo, Inc.'s Gentle Wave technology is crucial in the root canal preparation process. The Gentle Wave system uses a variety of sonic irrigation techniques to clean canals with or without the need for tools [21]. Studies have extensively explained the mechanism of action of this technology [21-22]. In the first six and twelve months, the first therapy was 97% successful [40]. The Gentle Wave System and other commercially available effective irrigation methods and techniques, however, were not shown to completely remove any remaining obturation materials from the canals during retreatment. Additionally, there was no appreciable difference in debridement between the GentleWave System and other irrigation methods. The second, potential new instrument-removal file system consists of a number of rotational files for the removal of all different kinds of shattered instruments, including invisible long instruments beyond the curve. The major files might be utilized for canal preparation for the removal of shattered

instruments. Rotating it clockwise releases a little area where the secondary files may remove the broken instrument. The employment of DOM and ultrasonic may become redundant by extending the removal instrument files. It is simpler to remove a broken instrument from a straight root canal than from a curved root canal. However, to prevent the formation of bulges or canal migration, the use of ultrasonic waves may be necessary for some cases [23].

The best strategy is straightforward removal of isolated instruments and subsequent correct contouring of the root canal system. Because one of the most challenging situations in root canal therapy is disconnected instruments. Additionally, when root canal therapy fails, it causes worry in both patients and clinicians. The combination of ultrasonic devices with DOM has greatly helped in the removal of instruments [8-24-25]. Combining a trepan bur with a microtube approach can limit secondary instrument fracture by preventing the ultrasonic tip from coming into direct contact with the instrument components and removing less dentin structure than is necessary [44]. According to Yang et al. [23], the burr/microtube terpan method is also carried out in a DOM. In the dentin trephine procedure, Radel stated that DOM gives a clear view of the ultrasonic tips [22]. Due to the canines' and incisors' great size, Hülsmann M's study [3] found that 92.9% of the time [13 out of 14] it was successful in extracting broken instruments from these teeth. This is in accordance with Shen et al.'s [45, 46] and Cujé et al.'s results [15]. Second, the fractured SS tool could not penetrate the dentinal walls easily because it had a relatively smaller taper. Third, due to the small size of the experimental sample. Without a DOM, the trepan bur/microtube approach for removing damaged tools from straight canals is generally safe. The drawbacks of this technique include excessive dentin removal and root erosion, particularly in the area 1.5 mm apical to the fragment's coronal end [26-27].

4. Conclusions

The evidence from laboratory research that endodontic broken tool removal strategies work is presented in this systematic review. The ultrasonic approach was the one that received the most research and produced generally positive outcomes. Using the Masserann approach in conjunction with a microscope and ultrasonic equipment might help solve some really challenging instances.

Conflict of interest

All the authors hereby declare that there is no conflict of interest regarding this research.

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