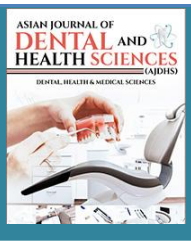

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Instrument Retrieval in Endodontics: A Literature Review

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Abstract

Instrument separation poses a notable challenge in endodontic therapy, with occurrence rates between 2% and 6%. While a separated instrument does not automatically equate to treatment failure, it can hinder complete debridement and obturation, which might result in bacterial survival and inflammatory responses. This review of the literature examines the various factors that contribute to instrument separation, including mechanical fatigue, instrument design, and clinical aspects such as canal curvature and operator experience and evaluates the current methods available for retrieving these instruments. These methods encompass mechanical techniques (e.g., ultrasonics, retrieval kits), chemical solutions (e.g., EDTA), and surgical procedures when non-surgical methods are ineffective. Advances in technology, including improved magnification, ultrasonic devices, and platforms like Endo Rescue, have enhanced retrieval success rates. Additionally, bioceramic materials and CAD/CAM-assisted restorations provide better outcomes following retrieval. Nonetheless, challenges persist, including the risk of root perforation, tooth fractures, and the presence of retained fragments. The success of the retrieval process depends on the position and size of the fragment, the anatomy of the canal, and the clinician's expertise. Research indicates that the presence of a retained instrument may not significantly impact prognosis when apical periodontitis is absent, though outcomes worsen in cases with infection. Ultimately, the clinician's expertise, proficiency, and the integration of modern tools are crucial for effective management. Ongoing research and continuous professional development are vital for enhancing retrieval methods and improving patient results in endodontics.

Keywords: Instrument separation, Endodontic complications, Fractured file removal, Ultrasonic retrieval, Nickel-titanium instruments, Root canal anatomy, Endodontic retreatment, Masserann kit

Introduction

Instrument retrieval is a critical aspect of endodontic treatment. The incidence of instrument separation can range from 2% to 6%, posing a significant challenge for endodontists. Successful retrieval of separated instruments is essential to ensure the continued success of root canal therapy and prevent complications [1]

When an instrument breaks during a cleaning and shaping procedure, the clinician must consider various factors, including the pulp status, root canal infection, anatomy, position, type of the fractured instrument, and potential damage to the tooth structure. The success of nonsurgical removal of a broken instrument depends on the canal anatomy, fragment location, length, diameter, curvature, accessibility, fragment location, and visualization. Approaches for managing the separated instrument include removal, bypassing, sealing the fragment within the root canal, or creating a true blockage.[2]

While a broken instrument may not directly cause treatment failure, the fragment in the root canal can obstruct proper cleaning, shaping, and obturation of the root canal space, leading to the accumulation of bacteria and dentin debris, which leads to inflammation. [3]

Root canal treatment is a cornerstone of modern dentistry, aiming to preserve natural dentition. However, the inherent complexity of root canal anatomy and the delicate nature of endodontic instruments can lead to unforeseen complications, such as instrument separation. This literature review will comprehensively examine current knowledge and techniques pertaining to instrument retrieval in endodontics, encompassing the challenges, available methodologies, and their respective successes and limitations.

Causes of Instrument Separation

Instrument separation can occur due to various factors, including:

- **Mechanical Factors**: Excessive force, improper use, and cyclic fatigue of endodontic instruments can lead to separation. Instruments may also separate due to torsional stress when the tip of the instrument binds in the canal while the shank continues to rotate.
- **Instrument Design**: The design and material of endodontic instruments, such as nickel-titanium (NiTi) files, can influence their susceptibility to separation. NiTi instruments, while flexible, are more prone to cyclic fatigue compared to stainless steel instruments.
- **Clinical Factors**: Root canal anatomy, curvature, and operator experience play a significant role in the likelihood of instrument separation. Complex root canal systems with severe curvatures increase the risk of instrument separation.

Techniques for Instrument Retrieval

Several techniques have been developed for the retrieval of separated instruments, including:

Mechanical Methods:

- **Ultrasonic Devices**: Ultrasonic tips can be used to create vibrations that help dislodge the separated instrument. The use of ultrasonics under magnification allows for precise and controlled removal of the separated fragment.
- **Specialized Retrieval Kits**: Kits such as the Masserann kit and the IRS (Instrument Removal System) are designed specifically for instrument retrieval. These kits include various tools and devices that can be used to grasp and remove the separated instrument.

Chemical Methods:

- Although less commonly used, chemical agents can sometimes aid in the dissolution of separated instruments. For example, EDTA (ethylenediaminetetraacetic acid) can be used to soften dentin and facilitate the removal of the separated instrument.

Surgical Methods:

- In cases where mechanical and chemical methods fail, surgical approaches such as apicoectomy may be necessary to retrieve the separated instrument. This involves surgically accessing the root tip and removing the separated instrument through a retrograde approach.

Advances in Technology

Recent advancements in technology have significantly improved the success rates of instrument retrieval:

1. Ultrasonics and Magnification:

a) Ultrasonics: Ultrasonic devices have revolutionized instrument retrieval by generating high-frequency vibrations that help loosen the separated instrument from the canal walls. This facilitates its removal and reduces the risk of further iatrogenic damage.

b) Magnification: The use of dental operating microscopes provides magnified views of the working field, enabling clinicians to visualize better the separated instrument, its orientation within the canal, and the surrounding anatomical structures. This enhanced visualization significantly improves the precision and effectiveness of retrieval attempts.

2. New Devices and Techniques:

a) Endo Rescue System: This innovative system utilizes a micro-motor with specialized retrieval tips to engage and remove broken instruments with minimal risk of further fracture or canal wall perforation.

b) Bioceramic Materials: Bioceramic materials, such as Mineral Trioxide Aggregate (MTA), play a crucial role in sealing the root canal after instrument retrieval and promoting tissue healing. The MTA's excellent biocompatibility and sealing properties help prevent post-treatment complications, such as infection and microleakage.

Additional Technological Advancements:

Computer-Aided Design/Computer-Aided Manufacturing (CAD/CAM): CAD/CAM technology allows for the fabrication of customized posts and restorations, which can be particularly beneficial in cases where instrument retrieval has altered the root canal anatomy. The incorporation of advanced technologies has significantly enhanced the predictability and success of instrument retrieval in endodontics. By combining ultrasonic devices, magnification, innovative retrieval systems, and biocompatible materials, clinicians can address this challenging complication more effectively, improving patient outcomes and preserving natural dentition.

Challenges and Complications

Despite advancements, instrument retrieval remains challenging and can be associated with complications such as:

- **Root Perforation**: The risk of perforating the root during retrieval attempts. This can compromise the structural integrity of the tooth and lead to treatment failure.
- **Tooth Fracture**: The potential for tooth fracture due to excessive force or stress during retrieval. Careful and controlled techniques are essential to minimize this risk.
- **Residual Fragments**: In some cases, small fragments of the separated instrument may remain in the root canal, posing a risk for future complications.

Discussion

Intracanal separation of instruments usually prevent access to the apex and impede thorough cleaning and shaping of the root canal, and thus may compromise the

outcome of endodontic treatment and reduce the chance of successful retreatment[4]

The following factors influence the removal of detached instruments: the fragment's diameter, length, and location inside the canal. The circumferential diameter, thickness of the remaining dentin, and depth of an external concavity of the root determine the diameter, length, and curvature of the canal architecture. Generally, a stressed instrument such as when the flutes appear unwound, it is more likely to split in the canal and hence it is not recommended to press or wedge instruments No. 8 and No. 10 within the canal; they should only be used once.

Removal is not feasible if the broken instrument section is apical to the canal's curve and safe access cannot be obtained. If symptoms are present, surgery or extraction may be necessary.

Files made of stainless steel are typically easier to remove since they don't break when being removed. During ultrasonic removal, the NiTi instrument can shatter again. Hence, the most crucial element for a successful instrument removal is knowledge, training, and ability.

According to YaShen et al., the tooth's curve influences how the separated instrument is removed.[5] Hulsmann et al. discovered that the shattered instrument was easiest to remove from the coronal third and had the lowest success rate in the apical third.[6] In curved canals, Souter et al. demonstrated a reduced success rate when removing an instrument from the apical third.[7]

Fors and Berg concluded that separated instruments in the apical third should remain in place, as removal attempts could cause perforation, which would worsen the prognosis of the endodontic treatment. The canal can be prepared and filled to the point where instrumentation is possible if the fragment cannot be retrieved. Apical surgery is not required as long as the tool fragment is not sticking through the apex. The remaining tooth structure shouldn't be weakened by removing the detached portion.

Several general outcome studies have linked the success rate of endodontic therapy with the presence or absence of Apical periodontitis.[8,9,10] A new meta-analysis and systematic review examined the endodontic results of keeping an instrument in the root canal system.[11] The prognosis of endodontic therapy in the absence of apical periodontitis is not considerably lowered by a retained fractured tool; nevertheless, in the presence of apical periodontitis, the prognosis is lowered by a fractured instrument. This review solely considered de novo cases. Notably, it was proposed that, as long as the treatment was performed to the most superb technical standard, a fractured file would have little effect on canal disinfection.

Conclusion

Instrument retrieval is a vital component of endodontic treatment, and advancements in technology have significantly improved success rates. However, challenges and complications still exist, and further research is needed to develop more effective and less invasive retrieval techniques. Continued education and training for endodontists are essential to ensure the successful management of separated instruments.

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