

Assessment of Root Canal Filling Removal Effectiveness Using Micro-computed Tomography: A Systematic Review

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Abstract

Introduction: The removal of obturation materials from the root canal system is a primary objective in root canal retreatment procedures. This systematic review aims to discuss the effectiveness of different instrumentation procedures in removing root-canal filling materials assessed by micro-computed tomography. **Methods:** An electronic search in PubMed and major endodontic journals was conducted using appropriate key words to identify investigations that examined the effectiveness of obturation material removal assessed by micro-computed tomography. **Results:** Among 345 studies, 22 satisfied the inclusion criteria. Seven studies compared hand instrumentation with Nickel-Titanium rotary or reciprocating systems. Three studies investigated rotary systems, and another three studies explored reciprocation. Eight studies compared rotary systems and reciprocation in removing filling materials from the root canal system. Other factors, such as the role of solvents and irrigant agitation, were discussed. **Conclusions:** The application of different instrumentation protocols can effectively, but not completely, remove the filling materials from the root canal system. Only hand instrumentation was not associated with iatrogenic errors. Reciprocating and rotary systems exhibited similar abilities in removing root filling material. Retreatment files performed similarly to conventional ones. Solvents enhanced penetration of files but hindered cleaning of the root canal. The role of irrigant agitation was determined as controversial. (*J Endod* 2016; ■:1–7)

Key Words

Endodontics, instrumentation, micro-computed tomography, obturation materials, retreatment, root canal, solvents

Retreatment is defined by the National Library of Medicine's medical subject headings as "therapy of the same disease in a patient, with the same agent or procedure repeated after initial treatment or with an additional or alternate measure or follow up" (1). In endodontics, further management of teeth with a history of previous completed treatment is associated with several challenges in achieving a predictable outcome. Thus, specialist referral is recommended (2). Among other additional procedures, when compared with primary root canal treatment, the nonsurgical revision of previous root filling procedures routinely requires the removal of previous root canal filling materials (3). This step might be required to enable access to contaminated canal space for recleaning (3) and to eliminate obturation materials possibly contaminated by marginal penetration of microorganisms and microbial toxins (4). The achievement of patency at the canal terminus and the extension of cleaning as near as possible to the apical terminus have been identified as prognostic factors related to periapical healing (5).

Micro-computed tomographic (micro-CT) imaging is a high-resolution research technology that allows the development of accurate 3-dimensional models and the acquisition of quantitative data (6). The micro-CT nondestructive imaging process allows repeated exposures and acquisition of information. As such, this imaging mode renders the assessment of experimental endodontics particularly advantageous, including the assessment of previous canal filling materials (7). A similar sequential analysis of the samples cannot be achieved with clearing or sectioning techniques, whereas the same image quality cannot be attained with other commonly available imaging technologies (6). Hence, this study aimed to conduct a systematic review to identify studies that investigated the effectiveness of different procedures in removing root canal filling materials using assessment by micro-CT imaging.

Literature Search Methodology

An electronic search was conducted in the PubMed database (www.ncbi.nlm.nih.gov) to identify investigations related to the assessment of various instrumentation protocols for the removal of root canal fillings using micro-CT imaging. "Microcomputed tomography" or "Micro-computed tomography," "MicroCT" or "Micro-CT," and "Endodontics" or "Root Canal" were used as key words. The research was limited to

Significance
Adequate removal of root canal filling materials is a fundamental objective during retreatment procedures. The present systematic review aims to help clinicians understand the ability of different preparation procedures for this purpose.

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0099-2399/\$ - see front matter

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<http://dx.doi.org/10.1016/j.joen.2016.12.008>

Review Article

publications written in English. An additional electronic search was performed in the following major endodontic journals: *Australian Endodontic Journal*; *Dental Traumatology* (previously named *Endodontics and Dental Traumatology*); *International Endodontic Journal*; *Journal of Endodontics*; and *Oral Surgery, Oral Medicine, Oral Pathology* (previously published as *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontics* until December 2011). “Microcomputed tomography” or “Micro-computed tomography” and “MicroCT” or “Micro-CT” were used as key words. The search included articles from the date of inception of each source up to March 23, 2016, apart from *Oral Surgery, Oral Medicine, Oral Pathology* as mentioned previously. After the removal of duplicate articles, title review, and abstract selection, full-text articles were used to verify that the article content was relevant.

Results

After the removal of duplicates, the electronic search strategy yielded 345 publications. The initial screening of the retrieved studies was conducted using titles and abstracts. However, when the suitability of a given article was unclear, the corresponding full text was read. The authors evaluated the included studies independently and discussed the results. Among the 345 studies, 22 satisfied the criteria. [Figure 1](#) summarizes the details and results of the search strategy.

Discussion

Instrumentation Procedures

Complete removal of obturation materials during retreatment procedures would enable instruments and irrigating solutions to reach a larger portion of the root canal system, consequently promoting better cleaning and disinfection. Several investigations have examined the ability of stainless steel hand, rotary, and reciprocation nickel-titanium (NiTi) systems to optimally achieve this objective.

Hand Versus Mechanical Instrumentation. Seven studies compared hand instrumentation with rotary or reciprocating systems in root canal filling removal ([Table 1](#)) (8–14). Two studies assessed hand files against ProTaper Universal Retreatment (PTUR) files (Dentsply International, York, PA) alone. When PTUR D3 (apical size 20) was used as the final instrument, K-files to size 40 removed gutta-percha (GP) more efficiently from straight canals, which may be because of the initial canal enlargement at a size of F3 ProTaper (PT) (D0 = 30). In such cases, the D3 file engaged the canal walls to a lesser degree than the K-file (D0 = 40) (8). Conversely, when PTUR D2 (apical size 25) was compared with H-files of matching sizes, mechanic instrumentation removed more GP from straight and round canals (9). As such, it can be concluded that the performance of PTUR and hand files is similar as long as their preparation sizes are equivalent. PTUR can also be used for the preliminary removal of root canal contents. Subsequent

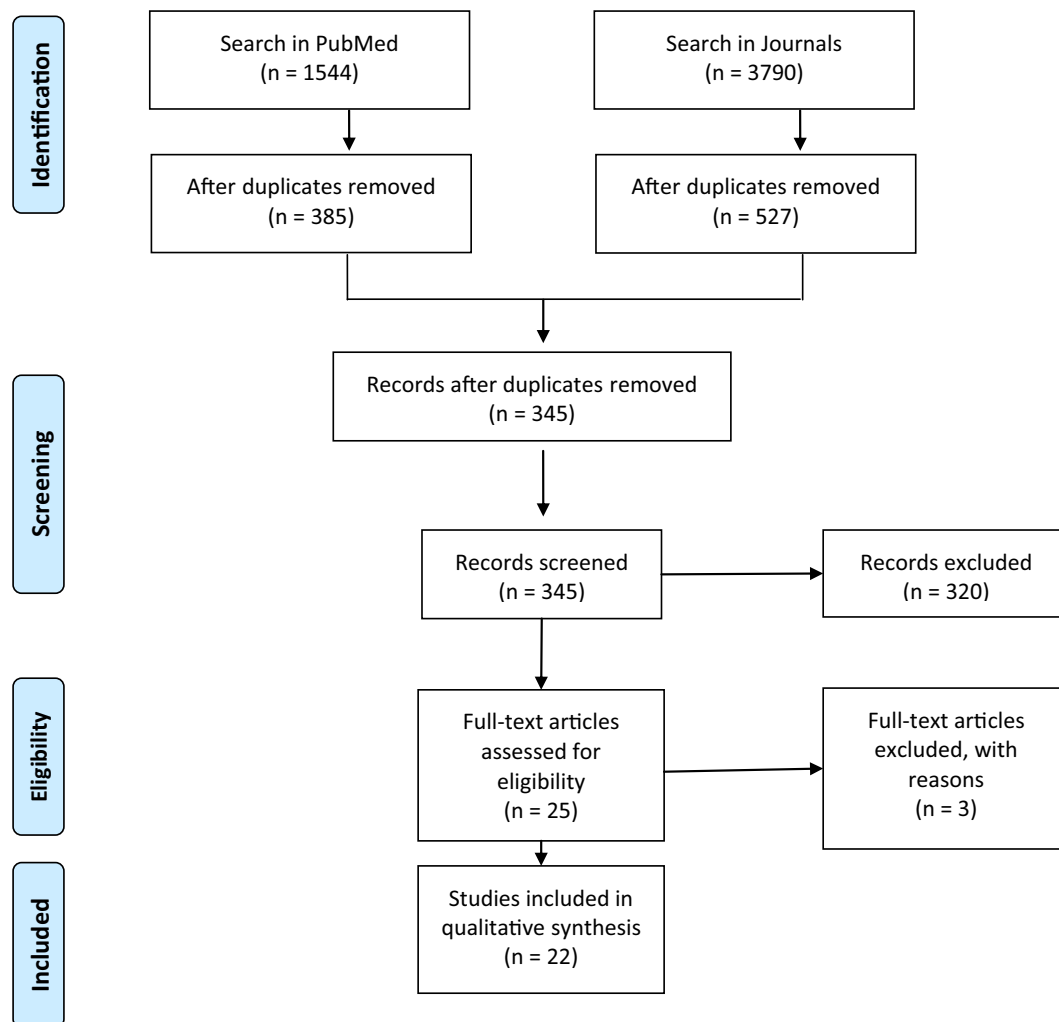


Figure 1. Search retrieval flow diagram.

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