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Research of the major clinical findings of the use of reciprocant files: a systematic review

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Abstract

Introduction: In the context of root canal treatments, nickel-titanium endodontic rotary instruments fracture due to torsional overload or cyclic fatigue. Channels with bends located closer to the channel orifice and channels with double bends (S-shaped channels) have been shown to increase the risk of fatigue failure of rotating instruments. Thus, Yared was the first to report the use and effectiveness of reciprocating motions for rotary files, as he demonstrated that a single reciprocating file was sufficient to replace several files used in continuous rotation. **Objective:** A concise systematic review was carried out on the main results of clinical studies on the use of reciprocating files, to externalize the scientific evidence of these files to files used in continuous rotations. **Methods:** The present study followed the model of systematic literature review (PRISMA). The research was carried out from January 2022 to March 2022 and was developed based on Google Scholar, Scopus, PubMed, Scielo, and the Cochrane Library. The quality of scientific evidence of the studies was based on the GRADE instrument. The risk of bias was analyzed according to the Cochrane instrument. **Results and Conclusion:** A total of 85 articles were found. After the process of analyzing the quality of scientific evidence, 32 articles were selected. After analyzing the risk of bias, 8 recent clinical studies, from 2019 to 2022, were selected to compose this systematic review. Based on the clinical studies presented in the present study, it was evidenced that there is a significant statistical difference in the number of cycles in and out movement and wear time to failure between reciprocating and continuous rotary files. Furthermore, an endodontic treatment combining a single reciprocating file with a single cone showed similar clinical efficacy to treatment with hand file instrumentation and lateral compaction obturation. However, randomized clinical studies have shown that reciprocating instruments have less resistance to cyclic fatigue when operated in canals with curvatures in the coronal and middle thirds when compared with curvatures in the apical thirds.

Keywords: Files. Reciprocating files. Rotary files. Resistance. Fatigue. Clinical trials.

Introduction

In the context of root canal treatments, nickel-titanium endodontic rotary instruments fracture due to torsional overload or cyclic fatigue [1], with an overall prevalence between 1.7 and 3.3%, with rotary files accounting for 70–85 % of instruments fractured [2–4]. Also, through microscopic and fractographic analysis, about 66 to 93% of the fractures of rotating instruments were due to cyclic fatigue failure, while 7 to 34% were due to shear failure [5,6].

In this respect, fatigue fracture occurs when an instrument rotates freely in a curved channel. Files subjected to cyclic fatigue do not show visible signs of defects or changes in shape, and the fracture will occur at the point of maximum curvature of the canal [1]. Furthermore, the risk of fatigue failure of a nickel-titanium rotary instrument is affected by the root canal anatomy and the cyclic fatigue resistance of the file [1,7,8].

Furthermore, channels with curvatures located closer to the canal orifice and channels with double curvature (S-shaped channels) have been shown to increase the risk of fatigue failure in rotating

instruments [9,10]. As evidence of fatigue cannot be collected by visually inspecting the treatment during filing, clinicians must choose a rotary instrument system with an appropriate fatigue strength for the root canal anatomy.

In this sense, a reciprocating motion was applied to nickel-titanium instruments in 2008. Author Yared [11] was the first to report the use and effectiveness of reciprocating motions for rotary files, as he demonstrated that a single reciprocating file was sufficient to replace various files used in continuous rotation. Alternate files engage and debride dentin by rotating in the cutting direction and disengaging in the opposite direction. Therefore, reciprocal movements seem to decrease the risk of file fracture caused by fatigue failure, when compared to continuous rotation [12,13].

Furthermore, the reciprocal movements cause the file to undergo fewer complete rotations and fewer tensile-compression stress cycles compared to continuous rotation, increasing resistance to cyclic fatigue [12]. As examples, the WaveOne (WO) files (Dentsply Sirona, York, PA, USA) and Reciproc (Rec) (VDW, Munich, Germany) are among the first nickel-titanium rotary files manufactured and intended for reciprocating movements. With the technological evolution, the alternative files received heat treatment, being designated WaveOne Gold (WOG) (Dentsply Sirona) and Reciproc Blue (RecB), demonstrating greater flexibility and a safer alternative in curved canals due to their greater resistance to cyclic fatigue [14-18].

Also, reciprocal motion results in a lower fracture incidence of nickel-titanium files compared to continuous rotation. Clinical studies report the fracture incidence of motor-driven nickel-titanium files, showing that the overall fracture incidence of files reaches 2.27%, with a higher incidence in rotary motion (2.43%) than with reciprocating (1) .0%) [19].

Besides, the possible benefit of rotary instrumentation over other instrumentation techniques in terms of cleaning and disinfection effects would be the heating of the irrigant and/or the turbulence caused by the mechanical rotation of the instruments. The reciprocating instrument was introduced for root canal preparation. The reciprocating system uses the single-file instrumentation technique that can shape and clean the canal in a shorter period and together with the least amount of antimicrobial agent [20].

Therefore, the present study aimed to carry out a concise systematic review of the main results of clinical studies on the use of reciprocating files, to externalize the scientific evidence of these files to files used in continuous rotations.

Methods

Study Design

The present study followed the model of systematic literature review, according to the PRISMA rules [21].

Data Sources and Literary Search Strategy

The search strategies for this review were based on the descriptors (MeSH Terms): “Limas. Reciprocating files. Rotary files. Resistance. Fatigue. Clinical trials". The research was carried out from January 2022 to March 2022 and was developed based on Google Scholar, Scopus, PubMed, Scielo and the Cochrane Library.

Quality of Scientific Evidence and Risk of Bias

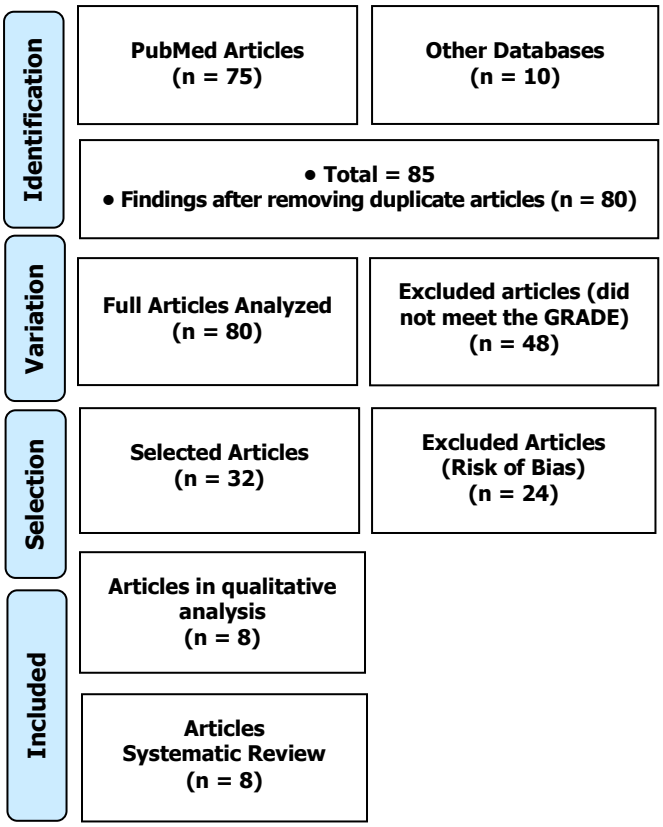
The quality of scientific evidence of the studies was based on the GRADE instrument [22], with randomized controlled clinical studies and prospective controlled clinical studies listed as the studies with the highest scientific evidence, according to the Oxford classification. The risk of bias was analyzed according to the Cochrane instrument [23].

Results and Discussion

A total of 85 articles were found. After removing duplicate articles and following the process of analyzing the quality of scientific evidence based on the GRADE classification, 32 articles were selected. After analyzing the risk of bias using the Cochrane instrument, 8 recent clinical studies, from 2019 to 2022, were selected to compose this systematic review (**Figure 1**).

After the selection process and integral analysis of the articles that composed the present study, it was observed that a study compared the influence of two new reciprocating movements on the resistance to cyclic fatigue of endodontic reciprocating files. 30 Procodile® files (Komet Medical, Lemgo, Germany) were selected in this study and distributed according to the following study groups, depending on the movements to be performed, being ReFlex Dynamic (n=10), ReFlex Smart (n=10), and Reciproc (n=10). Statistically significant differences were found when the number of cycles of in and out movement and the time to failure of the ReFlex Dynamic and Reciproc reciprocating movement ($p<0.001$) and between the ReFlex Smart and Reciproc reciprocating movement ($p<0.001$) were compared in pairs. However, no statistically significant differences were observed between the time to failure and the number of entry and exit motion cycles of the ReFlex Dynamic and ReFlex Smart reciprocating motion ($p=0.253$) [24].

Figure 1. Flowchart showing the article selection process.



Also, one study evaluated postoperative pain and healing of apical periodontitis after endodontic therapy with a reciprocal system compared with a crown technique with hand files and lateral compaction obturation. One hundred and twenty non-vital anterior teeth with apical periodontitis were randomly treated using a single alternative file followed by single-cone filling or a manual file and lateral compaction filling. Postoperative pain was assessed during the 7 days after treatment, using a visual analogue scale and a verbal scale. Apical healing was assessed by the periapical index score after 12 months of follow-up. There was no difference in incidence (38%-43% in the first 24h), intensity of postoperative pain and incidence of outbreaks (≈ 3%) between the two endodontic protocols. Both protocols resulted in a similar healing rate for apical periodontitis. After 12 months, the success rate ranged from 73% to 78% and the difference between treatments was within the pre-established equivalence margin (-0.1; -0.41 to 0.2). Therefore, endodontic treatment combining a single reciprocating file with matching single cone cone showed similar clinical efficacy to treatment with hand file instrumentation and lateral compaction obturation [25].

Besides, a study determined the effect of channel curvature location on the fatigue strength of WO, WOG, Reciproc (Rec) and Reciproc Blue (RecB) files, and examined the transformation behaviors of files phase. The instruments were subjected to fatigue tests in five artificial canals with 60° curvature and 3 mm radius. The curvature location was unique for each channel. Each file was inserted 16 mm into the canal and operated until fracture occurred. Fracture time was recorded and fragment length was measured. Differential scanning calorimetry was used to characterize the thermal behavior of the files. The instruments showed significantly lower fatigue strength in canals with curvatures in the middle and coronal canals compared to those with apical curvatures ($p<0.05$). At all tested bending locations, RecB showed superior fatigue strength compared to WO and Rec ($p < 0.05$). There were no significant differences between WOG and Rec in canals with curvatures in the middle and coronal canals. Therefore, reciprocating instruments present lower resistance to cyclic fatigue when operated in canals with curvatures in the coronal and middle thirds when compared with curvatures in the apical thirds [26].

In this context, a randomized clinical trial compared the effectiveness of a reciprocating file (Reciproc) and a rotary retreatment file (Mtwo retreatment [Mtwo-R]) for the removal of filling material during root canal retreatment. A total of 30 mandibular molars with mesial root curvature between 20° and 40° were selected and prepared with a Reciproc R25 file. The canals were filled by the technique of lateral condensation and endodontic cement. The specimens were randomly divided into 2 groups according to the retreatment technique used (n=15), a Reciproc R25 file or Mtwo-R 15/.05 and 25/.05 files. After retreatment, the specimens were sectioned longitudinally and photographed with a surgical microscope under 10x magnification. No statistically significant difference was observed between the 2 groups ($p=0.87$) or in the percentage in either third of the root canals ($p>0.05$) after re-instrumentation. In both groups, there was a significantly greater amount of material remaining in the apical third ($p<0.05$). Therefore, the results suggested that there is no difference between the 2 systems in their effectiveness in removing filling material [27].

Still in this scenario, it is noteworthy that the endodontic treatment of apical periodontitis (AP) without surgical intervention presents a clinical challenge. Thus, a case series study analyzed the changes in the scale size of periapical lesions and healing in the post-treatment of AP by cone-beam computed tomography using WOG reciprocating file with a single-cone treatment approach. A total of 20 patients with 20 teeth (9 M, six premolars, one canine, and four incisors) with AP underwent cone-beam computed tomography before and after nonsurgical endodontic treatment or nonsurgical retreatment.

Standardized chemodebridement of the root canal and instrumentation with WOG reciprocating files were used. The canals were filled using epoxy-based cement (EC Plus) with a unique WOG gutta-percha cone technique. After one year, evaluation with cone-beam computed tomography images showed that the success rate and healing using (EC Plus) with the single-cone technique was very high [28].

In addition, a randomized clinical trial with 164 healthy children, aged 6 to 8 years with asymptomatic necrotic maxillary second molars due to caries, compared the intensity and duration of postoperative pain of two single-file systems with different kinetics (OneShape file with continuous rotation versus WOG with reciprocal movement) after pulpectomy of deciduous molars. The children were divided into two equal groups. Group "1" was instrumented with the OneShape rotary system (Micro Mega, Besancon, France), and group "2" was instrumented with the alternative WOG system (Dentsply Maillefer, Ballaigues, Switzerland). During the follow-up, no significant difference was found in the pain felt between the two groups ($p>0.05$). The comparison between postoperative pain after instrumentation with both files was inconclusive after the first 48 hours, therefore, it does not guarantee a statement of the superiority of OneShape SF [29].

Finally, a randomized clinical trial compared microcrack formation in roots of extracted teeth after shaping straight and curved root canals with hand, rotary, and reciprocating files using micro-computed tomography (micro-CT) analysis. Thirty straight mandibular incisors and 30 severely curved mesial roots of mandibular molars were randomly divided into 6 experimental groups (n=10) according to the systems used for root canal preparation and root canal curvature: ProTaper Universal for Hand Use (Dentsply Sirona, Ballaigues, Switzerland), HyFlex EDM files (Coltene-Whaledent, Altstätten, Switzerland) and Reciproc Blue (VDW, Munich, Germany) used in lower incisors (straight canals) and mesial roots of lower molars (curved canals). The roots were photographed with a micro-CT scan at an isotropic resolution of 14 µm before and after root canal preparation, and the cross-sectional images generated were evaluated to detect microcracks. All dentinal defects identified after root canal preparation were already present before instrumentation and no new microcracks were detected. Dentinal microcracks were present in 19% (ProTaper Universal for Hand Use), 11% (Hyflex EDM), and 23% (Reciproc Blue) of the transverse sections when instrumentation was performed on lower incisors. Instrumentation of the lower molars revealed microcracks in 15% (ProTaper Universal for Hand Use), 16% (Hyflex EDM), and 17% (Reciproc Blue) of the cross-sections. Therefore, the preparation of straight and curved root canals with the ProTaper Universal for Hand Use, HyFlex EDM, and Reciproc Blue systems did not produce microcracks in extracted teeth when evaluated with micro-CT [30].

Conclusion

Based on the clinical studies presented in the present study, it was evidenced that there is a statistically significant difference in relation to the number of inward and outward movement cycles and the time of use to failure between reciprocating and continuous rotary files. Furthermore, endodontic treatment combining a single reciprocating file with a single cone showed similar clinical efficacy to treatment with hand file instrumentation and lateral compaction obturation. However, randomized clinical studies have shown that reciprocating instruments have less resistance to cyclic fatigue when operated in canals with curvatures in the coronal and middle thirds when compared with curvatures in the apical thirds.

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Ethics approval

Not applicable.

Informed consent

Not applicable.

Data sharing statement

No additional data are available.

Conflict of interest

The authors declare no conflict of interest.

Similarity check

It was applied by Ithenticate@.

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