

Post-Operative Pain in Reciprocating Versus Rotary Kinematics Post-Endodontic Treatment: A Systematic Review

Youssef Algarni^{1*}

¹Department of Restorative Dental Science, College of Dentistry, King Khalid University, Abha Saudi Arabia.

Abstract

Inconsistent findings will be found by practitioners who research the published literature to find answers to their questions about the best procedure to use when treating teeth that may have postoperative pain. Undoubtedly, the available research does not provide a clear roadmap for selecting the ideal kinematic system for automated endodontic treatment that will minimize postoperative discomfort. To thoroughly examine two alternative kinematics of instrumentation—rotary, and reciprocating—about postoperative pain following endodontic treatment. Pubmed, Scopus, Embase, Web of Science, Ovid, Global Health, PsycINFO, etc. were scoured using phrases like root canal treatment, postoperative pain, rotary endodontic file system, reciprocating endodontic file system, clinical trial, endodontic, etc. The researcher gathered pertinent data from the papers, such as pain outcome, follow-up, pain control methods, the technique of evaluating pain, obturation technique application of ultrasonic, the sort of irrigating solution. For this comprehensive assessment, 21 articles were chosen. There was no distinction between the reciprocating and rotary systems in the systematic study examining the frequency of postoperative discomfort. However, the rotational system was shown to be more effective according to the systematic review's findings that evaluated postoperative pain severity. The rotational system significantly reduced postoperative pain, according to analysis of trials that used continuous variables to measure pain intensity. There was no distinction between the investigated (rotary/reciprocating) systems in the systematic study examining the incidence of postoperative discomfort. The rotational system, however, was shown to be more effective according to the findings of the systematic review that evaluated the postoperative pain severity.

Keywords: Rotary kinematics, Reciprocating kinematics, Post-operative pain, Root canal treatment

INTRODUCTION

A conservative approach to managing teeth having pulpal infection is endodontic therapy. Patients are frequently forced to decide between root canal therapies and implant implantation as a result of recent advancements in dental healthcare technologies [1, 2]. While a root canal procedure rather than implant insertion should be the preferred course of action for teeth with a good outlook, the existence of pain following the procedure may indicate an undesirable prognosis [3, 4]. A systematic study by da Silveira *et al.* [5] found that the frequency of pain during root canal therapy ranged from three percent to fifty-eight percent which is consistent with prior studies [5, 6].

In addition, investigations have identified three levels of postoperative discomfort intensity: moderate, slight, and severe [7]. Early on following root canal therapy, for up to 12 hours, the greatest pain after root canal therapy is noted; this may be related to the underlying process of inflammation [8]. During the first 48 hours, the prevalence and intensity of discomfort significantly decrease [9, 10].

This pain following therapy has several pathophysiological causes, including periapical illness, hyper occlusion, inappropriate removal of tissue from the root canal, and expulsion of contaminated matter into the tissues at the periapical region [10, 11]. The final variable has been identified as the main factor causing pain during endodontic therapy [12, 13]. Even without involving the apical foramen, each endodontic intervention approach that is currently in use might cause apical ejection of contaminated matter while chemomechanical cleaning of the root canals [14, 15]. The

Address for correspondence: Youssef Algarni, Department of Restorative Dental Science, College of Dentistry, King Khalid University, Abha Saudi Arabia.
yalgarni@kku.edu.sa

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extrusion of contaminated debris is an unavoidable incident, but it can be prevented by using precise irrigation as well as aspiration procedures, instruments that are restricted to the root canal, and several endodontic files with varied kinematics [16, 17].

The initial version of the rotary Nickel-Titanium (NiTi) instruments entered the marketplace in 1992, and from then, it has been refined by applying new technologies including lower file counts and different heat treatments, which have improved the quality along with resistance of the endodontic files against fracture [18, 19]. The reciprocating endodontic files have a distinct movement that reduces the pressure on the tool via specific anticlockwise and clockwise movements, which are the result of such improvements [20]. According to research assessing rotary as well as reciprocating systems, reciprocating files exhibit comparable shaping abilities to rotary systems but require a shorter instrumentation time duration and experience more cyclic fatigue [21].

According to certain research, utilizing rotary instrumentation utilizing several instruments increases the likelihood of experiencing pain after root canal therapy [22, 23]. On the other side, several studies have shown that reciprocating systems can reduce postoperative discomfort [24, 25]. These results might be explained by variations in cross-sections, variations in the design of cutting-edge, variations in tapers, different types of tips of endodontic files, differences in configurations, variations in flexibility, different alloy types, number of files employed, mechanics, or cutting efficiency [26, 27]. Additionally, the protrusion of debris from the root canal into the periapical region, which contributes to the development of pain, can be influenced by the personality traits, and clinical training of the operator [28]. There is no apparent distinction in pain following the procedure between rotational and reciprocating endodontic file systems, according to several recent studies; as a result, instrumentation biomechanics had no bearing on the severity of pain following the procedure [29].

In conclusion, inconsistent findings will be found by practitioners who research the published literature to find answers to their questions about the best procedure to use when treating teeth that may have postoperative pain. Undoubtedly, the available research does not provide a clear roadmap for selecting the ideal kinematic system for automated endodontic treatment that will minimize postoperative discomfort.

This systematic review's main goal was to thoroughly examine two alternative kinematics of instrumentation—rotary and reciprocating—about postoperative discomfort following endodontic treatment. The null hypothesis assumed that the investigated kinematics would not differ in terms of postoperative discomfort.

MATERIALS AND METHODS

Eligibility Criteria

The following guidelines were used to determine which research would be included: (1) randomly regulated studies; (2) root canal treatment publications comparing reciprocating to rotary systems; (3) postoperative pain studies; and (4) studies written in English.

Letters to the editor, editorials, literature reviews, in vitro studies, case series, case reports, and Observational studies were excluded.

About the PICO approach, a particular clinical topic was constructed. The addressed focal issue was: Does endodontic therapy employing an endodontic reciprocating file system produce greater pain compared to a rotational file system? In this procedure,

(P) = endodontically managed teeth = study population

(I) = reciprocating endodontic file system= intervention

(C) = rotary system = comparison

(O) = discomfort following the endodontic procedure= main primary outcome

The additional outcome was pain following the endodontic procedure at twelve hours, 24 hours, and 48 hours.

Sources of Information and Search of Articles

Pubmed, Scopus, Embase, Web of Science, Ovid, Global Health, PsycINFO, etc. were scoured using phrases like root canal treatment, post-operative pain, rotary endodontic file system, reciprocating endodontic file system, clinical trial, endodontic, etc. Extensive searches were performed for all publications using inclusion and exclusion criteria. in the range of August 28th, 2010 and August 28th, 2023.

Study Selection

Before being tasked with the screening activity, reviewers received training in both full-text evaluation and assessment of simply the abstracts. The test was executed in an abstract manner using the Rayyan program. While one observer (AB) looked through all of the search results, three researchers (XX, HH, and JJ) independently reviewed 33.33 percent of the total hits twice. After reading the abstracts, the review committee got together to resolve their differences and create the final list of articles that needed to be evaluated in full. A full-text review was conducted using the Covidence program. Two independent reviewers, WW and YY, read the whole article and rated them according to the criteria. When researchers weren't sure whether or not a certain method was employed in an article, they went straight to the authors to ask for clarification. Members of the panel and reviewers from the scientific committee reached a consensus on the final list of articles to be considered for review. Following that, a manual search was conducted on the reference list, and both researchers examined the publications chosen for inclusion.

Data Collection Process and Data Items

The obtained articles' full texts were then examined. The PICO questions were addressed using the study of these chosen papers. The researcher gathered pertinent data from the papers, such as pain outcome, follow-up, pain control methods, the technique of evaluating pain, obturation technique and temporary filling used, brand regarding endodontic filling cement, application of ultrasonic, the sort of irrigating solution, number of patient visits, teeth with vital pulp, teeth with necrosis, average years of age, gender details of study participants, sample size of teeth, number of patients, type of study, year of study and the author. Subsequently, an additional investigator verified all of the data that had been gathered. Any differences among the researchers were resolved through conversation until an understanding was reached by another researcher. There were no double-reported publications on the same issue in different studies.

Risk of Bias

The Cochrane Collaboration's Software for evaluating Probability of Bias in Randomised Trials was used to determine the likelihood of bias in the research studies that were included [26]. The standards for evaluation follow a

domain-based approach, in which significant judgments are made independently for each of the following fields: sequence of randomized events generation, allocation deception, participant as well as staff blinding, outcome assessment blinding, uncompleted information on outcomes, limited coverage, and other bias [26]. The Cochrane Handbook for Systematic Reviews of Interventions 5.1.0 criteria were used to classify the possibility of bias for each area as low, high, or uncertain [26].

RESULTS AND DISCUSSION

Outcomes of an Extensive Search of Studies

169 research papers were discovered through a literature search using search criteria. 114 research articles were excluded because they were duplicates or similar. 55 different research papers were first chosen. Following an examination of the titles and abstracts, 30 publications were removed. For 25 articles, full-text management was done. Extra two papers were manually retrieved from references. 27 articles with full texts could be read. 6 subpar articles were eliminated from the final evaluation. Finally, for this comprehensive assessment, 21 articles were chosen (**Figure 1**).

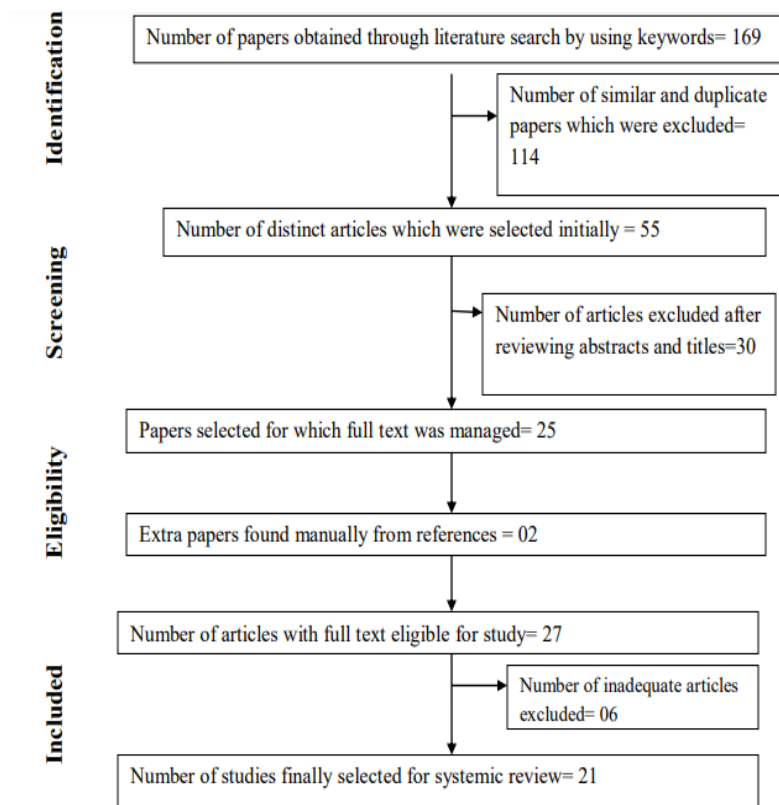


Figure 1. PRISMA flowchart representing a selection of studies in this systematic review

Characteristics of Studies Included

Most of the studies were randomized controlled trials in nature. The scales used for the analysis of pain were the functional pain scale (FPS) [30], visual analog scale (VAS) [10, 22, 27-29, 31-39] verbal rating scale (VRS) (15,26,230,

numerical rating scale (NRS) (25), pain intensity scale (PIS) (24).

Between studies, there was a large variation in the amount of time between endodontic therapy and the assessment of

postoperative discomfort, ranging from 2 hours to 10 days. The majority of trials (n=16) did, however, include a 24-hour window for postoperative discomfort evaluation [10, 15, 22-26, 29-31, 33, 34, 36-40].

In terms of pharmaceutical use, nine research [10, 23, 27-30, 37, 39] solely suggested the administration of emergency medications in cases of pain. Two research studies [36, 40] disclosed the administration of medication right away following endodontic therapy, two [31, 35] stated a

prescription for unlimited consumption, five [22, 25, 26, 31, 32, 38] stated prescriptions solely in the context of extreme pain, and two [15, 24] were silent on a suggestion of drugs use. In eight articles, analgesic consumption was used as a measure of the intensity of postoperative pain [10, 22, 23, 34-36, 38, 40]. Regarding prior pain experiences, nine studies [22, 23, 25, 27, 28, 33-35, 38] considered individuals who experienced preoperative discomfort (**Table 1**).

Table 1. Characteristics of Studies Included in this Systematic Review

Author	Tooth type	Presence of pre-operative pain	Endodontic Irrigant	Instruments evaluated	Outcomes of each study
Neelakantan and Sharma <i>et al.</i> [34]	Mand molars	Yes	3% NaOCl	R OS	Reciprocating file system demonstrated much reduced post-operative pain than O S file system in terms of both duration as well as intensity.
Nekoofar <i>et al.</i> [40]	Premolar and Molars	No	2% Chlorhexidine	WO PTU	PTU endodontic rotary instruments had less post-operative pain compared to the WO endodontic reciprocating solitary-file approach.
Pasqualini <i>et al.</i> [35]	All	Yes	5% NaOCl	PTU WO	More so than rotary endodontic instrumentation, reciprocating endodontic instrumentation had an impact on post-operative quality.
Relvas <i>et al.</i> [15]	Mand molars	No	2.5 % NaOCl	PTU R	Both the reciprocating endodontic procedures and rotational endodontic procedures had equal rates of post-operative discomfort.
Shokraneh <i>et al.</i> [36]	Mand molars	No	5.25% NaOCl	WO PTU K-files (SS)	Compared to the PTU as well as manual endodontic files, postoperative discomfort was greatly reduced with the WO endodontic file system.
Saha <i>et al.</i> [37]	Max/Mand premolars and molars	No	5.25% NaOCl	PTN SAF WOG	SAF system as a whole which causes less post-operative discomfort than PTN and WOG, could turn out to be a more effective approach in the future.
Topçuoğlu <i>et al.</i> [38]	Upper incisor teeth	No	2.5% NaOCl	R PTUR Hand File	Following the non-surgical mode of endodontic retreatment, conventional files produced more noticeable post-operative pain than ProTaper retreatment as well as R endodontic files.
Zand <i>et al.</i> [39]	Mand molars	No	2.5% NaOCl, 17% EDTA in gel-form and normal saline	Race R	In comparison with R files, RaCe files produced a lower level of post-operative discomfort.
Abbreviations: Max = Maxillary; Mand = Mandibular; SS = stainless steel;					
Arslan <i>et al.</i> [22]	Molars	Yes	1.25% NaOCl	150° CCW-30° CW 270° CCW-30° CW 360° CCW-30° CW Continuous rotation	Compared to reciprocating categories, perpetual rotation caused higher post-operative pain on day one of recovery.

Comparin <i>et al.</i> [23]	All	Yes	2.5% NaOCl	R Mtwo retreatment	The occurrence, severity, and period of postoperative pain are all affected in the same ways by a reciprocating as well as continuous rotating system.
Çiçek <i>et al.</i> [24]	Mand/single straight root canal	No	5.25% NaOCl+ 2% Chlorhexidine	MSBT hand files WO PTN	When opposed to the rotary & reciprocal procedures, the modified step-back technique was less painful.
Elias <i>et al.</i> [25]	Mand premolars	Yes	2.5% NaOCl	R OS	When compared to reciprocating instruments, uninterrupted rotary instruments had a significantly decreased frequency of pain at twelve hours and twenty-four hours following surgery.
Eyboglu and Özcan [26]	All	No	2.5% NaOCl	OS Revo S WO	The post-operative pain intensity levels were maximum in the WO endodontic file system.
Gambarini <i>et al.</i> [27]	Premolars/ molars	Yes	5% NaOCl	Rotary CDT using TF WO TF (ARCR)	The inflammatory reaction and pain were much worse with a reciprocating single-file approach than with a rotating NiTi crown down biomechanical instrumentation approach (TF).
Gambarini <i>et al.</i> [28]	Premolars/ molars	Yes	5% NaOCl	CDT using TF R	The results of the TF biomechanical instrumentation methodology were noticeably better for those who experienced no pain. The frequency of adverse symptoms was noticeably increased with the reciprocal approach in study participants with serious pain.
Jain <i>et al.</i> [30]	Max/ Mand molar	No	5.25% NaOCl	WO OS SAF	Significantly reduced post-operative pain has been reported by patients managed with the SAF system.
Kherlakian <i>et al.</i> [10]	Premolars and Molars	No	2.5% NaOCl	PTN WO R	The frequency of post-operative pain was similar to the reciprocating endodontic system versus continuous rotary endodontic systems.
Keskin <i>et al.</i> [29]	Max and Mand's teeth	No	5.25% NaOCl	K-files (SS) ProGlider R-Pilot	When compared to manual glide path preparation, the incidence and severity of post-operative discomfort were lower when glide paths were prepared with a rotating endodontic file system or reciprocating NiTi tools. The difference between rotating endodontic instruments and reciprocating endodontic instruments was minimal.
Krithikadatta <i>et al.</i> [31]	Premolars/ Molars	Yes	5% NaOCl+ 2% Chlorhexidine	WO PTU Mtwo	Patients who were treated by utilizing WO files for treatment felt more pain than those who were treated with other endodontic file systems.
Kurnaz [32]	Single root canal teeth	No	2.5% NaOCl	PTN WO	During the first two days of subsequent follow-up, the pain following endodontic treatment in the WO category was considerably more severe than in the PTN category.
Mollashahi <i>et al.</i> [33]	Molar	Yes	2.5% NaOCl	OS R K files (SS)	The degree of pain following endodontic procedure was unaffected by the instrument biomechanics (single endodontic file reciprocating system or single endodontic file rotary system).
Neelakantan and Sharma [34]	Mand molars	Yes	3% NaOCl	R OS	The Reciproc file system demonstrated much reduced post-operative pain than O S file system in terms of both duration as well as intensity.

Nekoofar et al. [40]	Premolar and Molars	No	2% Chlorhexidine	WO PTU	PTU endodontic rotary instruments had less post-operative pain compared to the WO endodontic reciprocating solitary-file approach.
Pasqualini et al. [35]	All	Yes	5% NaOCl	PTU WO	More so than rotary endodontic instrumentation, reciprocating endodontic instrumentation had an impact on post-operative quality.
Relvas et al. [15]	Mand molars	No	2.5% NaOCl	PTU R	Both the reciprocating endodontic procedures and rotational endodontic procedures had equal rates of post-operative discomfort.
Shokraneh et al. [36]	Mand molars	No	5.25% NaOCl	WO PTU SS (K-files)	Compared to the PTU as well as manual endodontic files, postoperative discomfort was greatly reduced with the WO endodontic file system.
Saha et al. [37]	Max/Mand premolars and molars	No	5.25% NaOCl	PTN SAF WOG	SAF system as a whole which causes less post-operative discomfort than PTN and WOG, could turn out to be a more effective approach in the future.
Topçuoğlu et al. [38]	Upper incisor teeth	No	2.5% NaOCl	R PTUR Hand File	Following the non-surgical mode of endodontic retreatment, conventional files produced more noticeable post-operative pain than ProTaper retreatment as well as R endodontic files.
Zand et al. [39]	Mand molars	No	2.5% NaOCl, 17% EDTA gel/normal saline	Race R	In comparison with R files, RaCe files produced a lower level of post-operative discomfort.
Arslan et al. [22]	Molars	Yes	1.25% NaOCl	150° CCW-30° CW 270° CCW-30° CW 360° CCW-30° CW Continuous rotation	Compared to reciprocating categories, perpetual rotation caused higher post-operative pain on day one of recovery.
Comparin et al. [23]	All	Yes	2.5% NaOCl	RMtwo retreatment	The occurrence, severity, and period of postoperative pain are all affected in the same ways by a reciprocating as well as continuous rotating system.
Çiçek et al. [24]	Mand/single straight root canal	No	5.25% NaOCl+ 2% Chlorhexidine	MSBT hand files WO PTN	When opposed to the rotary & reciprocal procedures, the modified step-back technique was less painful.
Elias et al. [25]	Mand premolars	Yes	2.5% NaOCl	R OS	When compared to reciprocating instruments, uninterrupted rotary instruments had a significantly decreased frequency of pain at twelve hours and twenty-four hours following surgery.
Eyboglu and Özcan [26]	All	No	2.5% NaOCl	OS Revo S WO	The post-operative pain intensity levels were maximum in the WO endodontic file system.
Gambarini et al. [27]	Premolars/ molars	Yes	5% NaOCl	Rotary CDT using TF WO TF	The inflammatory reaction and pain were much worse with a reciprocating single-file approach than with a rotating NiTi crown down biomechanical instrumentation approach (TF).
Gambarini et al. [28]	Premolars/ molars	Yes	5% NaOCl	CDT using TF R	The results of the TF biomechanical instrumentation methodology were noticeably better for those who experienced no pain. The frequency of adverse symptoms was noticeably increased with the reciprocal approach in study participants with serious pain.

Jain <i>et al.</i> [30]	Max/Mand molar	No	5.25% NaOCl	WO / OS / SAF	Significantly reduced post-operative pain has been reported by patients managed with the SAF system.
Kherlakian <i>et al.</i> [10]	Premolars and Molars	No	2.5% NaOCl	PTN WO R	The frequency of post-operative pain was similar to the reciprocating endodontic system versus continuous rotary endodontic systems.
Keskin <i>et al.</i> [29]	Max and Mand's teeth	No	5.25% NaOCl	SSK-files ProGlider R-Pilot	When compared to manual glide path preparation, the incidence and severity of post-operative discomfort were lower when glide paths were prepared with a rotating endodontic file system or reciprocating NiTi tools. The difference between rotating endodontic instruments and reciprocating endodontic instruments was minimal.
Krithikadatta <i>et al.</i> [31]	Premolars/Molars	Yes	5% NaOCl+2% Chlorhexidine	WO PTU Mtwo	Patients who were treated by utilizing WO files for treatment felt more pain than those who were treated with other endodontic file systems.
Kurnaz [32]	single root canal teeth	No	2.5% NaOCl	PTN WO	During the first two days of subsequent follow-up, the pain following endodontic treatment in the WO category was considerably more severe than in the PTN category.
Mollashahi <i>et al.</i> [33]	Molar	Yes	2.5% NaOCl	OS R SSK-files	The degree of pain following endodontic procedure was unaffected by the instrument biomechanics (single endodontic file reciprocating system or single endodontic file rotary system).

Modified step-back technique (MSBT); SS = Stainless steel; CDT = Crown-down technique; ARCR = adaptative reciprocation continuous rotation
 WO = Wave one
 PTN = protaper next

Results of Studies About the Type of Endodontic File System Evaluated in the Study and Post-Operative Pain

The endodontic file systems evaluated in studies were one shape (OS); wave one (WO); pro taper next (PTN); Twisted File (TF); Self Adjusting File (SAF); ProTaper Universal (PTU), reciprocating (R); Protaper Universal Retreatment (PTUR),

OS, RACE

Elias *et al.* [25] conducted a study on mandibular premolars having pre-operative pain. The teeth underwent root canal treatment with the R endodontic file system and OS endodontic file system. When compared to reciprocating instruments, uninterrupted rotary instruments had a significantly decreased frequency of pain at twelve hours and twenty-four hours following surgery.

Mollashahi *et al.* [33] conducted a study to compare the postoperative pain in teeth undergoing root canal treatment with a reciprocating file system, OS file system, and stainless steel k files. It was found that the degree of pain following the endodontic procedure was unaffected by the instrument biomechanics (single endodontic file reciprocating system or single endodontic file rotary system).

Zand *et al.* [39] researched mandibular molars to compare pain following root canal treatment with the Reciprocating

endodontic file system and Race endodontic file system. In comparison with R files, RaCe files produced a lower level of post-operative discomfort.

PTN, PTU, PTUR

Çiçek *et al.* [24] carried out a study on mandibular teeth having a single straight root canal having no preoperative pain. The teeth underwent root canal treatment with the WO endodontic file system, PTN endodontic file system, and modified step back technique using stainless steel hand files and evaluated the pain following the endodontic procedure. When opposed to the rotary & reciprocal procedures, the modified step-back technique was less painful.

Kherlakian *et al.* [10] conducted a study evaluating postoperative pain after root canal treatment with PTN endodontic file system, WO file system, and reciprocal system in premolars and molars having no preoperative pain. 2.5% NaOCl was taken as an irrigating solution. It was observed that the frequency of postoperative pain was similar to the reciprocating endodontic system versus continuous rotary endodontic systems.

Relvas *et al.* [15] conducted a study to compare the reciprocating endodontic file system and PTU endodontic file system regarding pain following root canal treatment in mandibular molars with no preoperative pain. 2.5 % NaOCl was used as an endodontic irrigating solution. It was observed

that both reciprocating endodontic procedures and rotational endodontic procedures had equal rates of post-operative discomfort.

Topçuoğlu *et al.* [38] conducted research involving maxillary incisor that underwent root canal treatment using a Reciprocating endodontic system, PTUR, and hand file to compare the pain following root canal treatment. Following the non-surgical mode of endodontic retreatment, conventional files produced more noticeable post-operative pain than ProTaper retreatment as well as R endodontic files.

Arslan *et al.* [22] conducted a study to compare rotary endodontic file systems and reciprocating endodontic file systems regarding post-operative pain. Compared to reciprocating categories, perpetual rotation caused higher post-operative pain on day one of recovery.

Mtwo Retreatment, TF Adaptative - Reciprocation/Continuous Rotation, Crown Down Technique, ProGlider

Comparin *et al.* [23] conducted a study on teeth with preoperative pain that underwent root canal treatment with reciprocating endodontic file system and Mtwo retreatment to compare the pain following the endodontic treatment. The occurrence, severity, and period of postoperative pain are all affected in the same ways by a reciprocating as well as continuous rotating system.

Gambarini *et al.* [27] performed research to compare pain following root canal treatment involving the Rotary crown-down technique using TF, WO, and TF adaptative-reciprocation/continuous rotation. It was found that the inflammatory reaction and pain were much worse with a reciprocating single-file approach than with a rotating NiTi crown-down biomechanical instrumentation approach (TF).

Gambarini *et al.* [28] conducted a study to compare postoperative pain in teeth undergoing root canal treatment involving crown down technique using TF and reciprocating endodontic file system. The results of the TF biomechanical instrumentation methodology were noticeably better for those who experienced no pain. The frequency of adverse symptoms was noticeably increased with the reciprocal approach in study participants with serious pain.

Keskin *et al.* [29] conducted a study involving stainless steel K files, ProGlider, and R-pilot regarding post-operative pain. When compared to manual glide path preparation, the incidence and severity of post-operative discomfort were lower when glide paths were prepared with a rotating endodontic file system or reciprocating NiTi tools. The difference between rotating endodontic instruments and reciprocating endodontic instruments was minimal.

SAF, WO, OS PTN, WOG

Jain *et al.* [30] conducted a study to compare pain following root canal treatment in molars of the maxilla and molars of the mandible using the SAF, OS, and WO endodontic file system. Significantly reduced post-operative pain has been reported by patients managed with the SAF system.

Saha *et al.* [37] compared pain following root canal treatment in teeth treated with SAF, PTN, and WOG endodontic file systems. It was concluded that the SAF system as a whole which causes less post-operative discomfort than PTN and WOG, could turn out to be a more effective approach in the future.

Eyboglu and Özcan [26] analyzed pain following root canal treatment in teeth treated with OS file system, WO file system, and Revo S. It was observed that the post-operative pain intensity levels were maximum in the WO endodontic file system.

Krithikadatta *et al.* [31] performed research involving teeth managed with WO endodontic file system, PTU endodontic file system, and Mtwo endodontic file system regarding pain following root canal treatment. Patients who were treated by utilizing WO files for treatment felt more pain than those who were treated with other endodontic file systems.

Kurnaz [32] compared the pain following root canal treatment with file system PTN and file system WO in teeth having a single root canal with no preoperative pain. It was observed that during the first two days of subsequent follow-up, the pain following endodontic treatment in the WO category was considerably more severe than in the PTN category.

There was no distinction between the reciprocating and rotary systems in the systematic study examining the frequency of postoperative discomfort. However, the rotational system was shown to be more effective according to the systematic review's findings that evaluated the severity of postoperative pain. Comparin studies that measured the frequency of pain employing an ordinal variable did not reveal any statistically significant differences. The rotational system was found to significantly reduce postoperative pain, according to an analysis of trials that used continuous variables to measure pain intensity.

Results for Risk of Bias

The random pattern development was not described in three investigations [27, 28, 40]. Drawing lots [10], random number table [33], and Coin tossing [24], were each talked about in one study while discussing the randomization process. Five research [26, 29, 32, 34, 38] documented the process of flipping envelopes, and eight other investigations [15, 22, 23, 25, 32-37, 40] employed software to generate random numbers. Only one study [30] was uncertain about inadequate outcome data, while five studies [22-24, 27, 28, 30] had questions about the allocation disguise strategy. Regarding participant and staff

blindness, five research [26, 29, 30, 36, 37] lacked clarity. Regarding the blinding of outcome evaluation, eleven research [10, 22, 26-28, 30, 34, 35, 37, 38, 40] had some questions.

Biological along clinical variables frequently play a role in the onset of pain, even though it is a subjective experience [23, 24]. A root canal procedure may leave anyone more likely to experience discomfort if you use rotary instrumentation or numerous different tools [10, 14]. The use of reciprocating systems, on the other hand, has been demonstrated to lessen postoperative discomfort in several trials [23, 26, 27]. These findings could be explained by variations in cross-sections, cutting-edge designs, tapers, tip designs for endodontic files, configurations, flexibility, types of alloys used, number of files used, mechanics, or cutting efficiency [26, 27]. Additionally, the personality qualities and clinical training of the operator might have an impact on the protrusion of debris from the root canal into the periapical region, which adds to the development of discomfort [28, 30]. According to various recent research, there is no obvious difference in postoperative pain between rotational and reciprocating endodontic file systems; therefore, equipment biomechanics did not affect the degree of postoperative pain [11, 13, 15, 28].

Therefore, practitioners who examine the available literature for answers to their queries concerning the best method to employ while treating teeth that could be in postoperative discomfort will discover inconsistent results.

Choosing the best kinematic system for automated endodontic treatment that will minimize postoperative discomfort is undoubtedly difficult given the current body of research. This systematic review's main goal was to thoroughly examine two alternative kinematics of instrumentation—rotary and reciprocating—about postoperative discomfort following endodontic treatment. The null hypothesis assumed that the investigated kinematics would not differ in terms of postoperative discomfort. We carried out a thorough investigation into how endodontic instrumentation movements affected pain during recovery following non-surgical treatment of root canals.

There was no distinction between the reciprocating and rotary systems in the systematic study examining the frequency of postoperative discomfort. However, when there was an analysis of the intensity of postoperative pain after the endodontic procedure, the rotational system was found to have reduced intensity of postoperative pain, according to the analysis of trials that used continuous variables to measure pain intensity. The null hypothesis was thus partially rejected. The current analysis's findings show that rotary endodontic file systems are associated with less severe pain following root canal therapy than reciprocating endodontic systems. The mechanics of continual rotation may enhance the elimination of debris by working as a screw conveyor to increase the possibility of removal via the crown and reduce apical protrusion [6]. The frequency of apical protrusion is

increased by reciprocation because the movement is uneven. No significant variance was found between levels of pain following root canal therapy at 12 hours, 24 hours, or 48 hours, according to our data. Additionally, there was no difference in the overall dosage of painkillers taken into consideration in the comparison of the two endodontic instrumentation movements.

Regarding the clinical question of whether there is a connection between the instrument's kinematics and the frequency of postoperative discomfort, there is no universal agreement. Nekoofar *et al.*'s study [40] concluded that employing reciprocating devices increased the likelihood of pain following an endodontic procedure. But Kherlakain *et al.* [10] and Molashashi *et al.* [33] confirmed that there was no connection between the usage of kinematics and the existence of pain. A comprehensive review was conducted to compare postoperative pain following endodontic instrumentation with rotary endodontic file system and reciprocating endodontic file systems to better understand this clinical difficulty, and it discovered fewer complaints of pain at 48 hours with the reciprocating method [28].

Relvas *et al.* [15] conducted a study to compare the reciprocating endodontic file system and PTU endodontic file system regarding pain following root canal treatment in mandibular molars with no preoperative pain. 2.5 % NaOCl was used as an endodontic irrigating solution. It was observed that both reciprocating endodontic procedures and rotational endodontic procedures had equal rates of post-operative discomfort. Jain *et al.* [30] conducted a study to compare pain following root canal treatment in molars of the maxilla and molars of the mandible using the SAF, OS, and WO endodontic file system. Significantly reduced post-operative pain has been reported by patients managed with the SAF system.

Saha *et al.* [37] compared pain following root canal treatment in teeth treated with SAF, PTN, and WOG endodontic file systems. It was concluded that the SAF system as a whole which causes less post-operative discomfort than PTN and WOG, could turn out to be a more effective approach in the future. Eyboglu and Özcan [26] analyzed pain following root canal treatment in teeth treated with OS file system, WO file system, and Revo S. It was observed that the post-operative pain intensity levels were maximum in the WO endodontic file system.

Krithikadatta *et al.* [31] performed research involving teeth managed with WO endodontic file system, PTU endodontic file system, and Mtwo endodontic file system regarding pain following root canal treatment. Patients who were treated by utilizing WO files for treatment felt more pain than those who were treated with other endodontic file systems. Kurnaz [32] compared the pain following root canal treatment with file system PTN and file system WO in teeth having a single root canal with no preoperative pain. It was observed that during the first two days of subsequent follow-up, the pain following

endodontic treatment in the WO category was considerably more severe than in the PTN category.

The pain following therapy has several pathophysiological causes, including periapical illness, hyper occlusion, inappropriate removal of tissue from the root canal, and expulsion of contaminated matter into the tissues at the periapical region. The final variable has been identified as the main factor causing pain during endodontic therapy [16, 17]. Even without involving the apical foramen, each endodontic intervention approach that is currently in use might cause apical ejection of contaminated matter while chemomechanical cleaning of the root canals [7]. The extrusion of contaminated debris is an unavoidable incident, but it can be prevented by using precise irrigation as well as aspiration procedures, instruments that are restricted to the root canal, and several endodontic files with varied kinematics [22, 23].

The initial version of the rotary Nickel-Titanium (NiTi) instruments entered the marketplace in the early nineties and from then, it has been refined by applying new technologies including lower file counts and different heat treatments, which have improved the quality along with resistance of the endodontic files against fracture [12, 13]. The reciprocating endodontic files have a distinct movement that reduces the pressure on the tool via specific anticlockwise and clockwise movements, which are the result of such improvements [19]. According to research assessing rotary as well as reciprocating systems, reciprocating files exhibit comparable shaping abilities to rotary systems but require a shorter instrumentation time duration and experience more cyclic fatigue [20].

Elias *et al.* [25] conducted a study on mandibular premolars having pre-operative pain. The teeth underwent root canal treatment with the R endodontic file system and OS endodontic file system. When compared to reciprocating instruments, uninterrupted rotary instruments had a significantly decreased frequency of pain at twelve hours and twenty-four hours following surgery. Zand *et al.* [39] researched mandibular molars to compare pain following root canal treatment with the Reciprocating endodontic file system and Race endodontic file system. In comparison with R files, RaCe files produced a lower level of post-operative discomfort.

Jain *et al.* [30] conducted a study to compare pain following root canal treatment in molars of the maxilla and molars of the mandible using the SAF, OS, and WO endodontic file system. Significantly reduced post-operative pain has been reported by patients managed with the SAF system. Saha *et al.* [37] compared pain following root canal treatment in teeth treated with SAF, PTN, and WOG endodontic file systems. It was concluded that the SAF system as a whole which causes less post-operative discomfort than PTN and WOG, could turn out to be a more effective approach in the future. Eyboglu and Özcan [26] analyzed pain following root canal treatment

in teeth treated with OS file system, WO file system, and Revo S. It was observed that the post-operative pain intensity levels were maximum in the WO endodontic file system

Limitations

Even though systematic reviews are a helpful research technique, comparisons might be challenging due to variations in the study design or patients' perceptions of pain [2]. The goal of the current review was to standardize the decision-making process of study designs, reduce variation among variables, and produce a more meaningful comparison. It is important to take into account the study design parameters' variability. Variability within the included research was also demonstrated by earlier investigations. To determine the frequency and severity of postoperative discomfort following root canal therapy with mechanical instruments, additional controlled research is required.

CONCLUSION

There was no distinction between the reciprocating and rotary systems in the systematic study examining the frequency of postoperative discomfort. However, the rotational system was shown to be more effective according to the systematic review's findings that evaluated the severity of postoperative pain. To determine the frequency and severity of postoperative discomfort following endodontic treatment with mechanical instruments, additional controlled research is required.

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