

The impact of Distinctive Root Canal Instrumentation Systems on Endotoxin Lessening from the Root Canal: A Systematic Review and Meta-Analysis

Navid Nasrabadi¹, Samira Jamali², Marzieh Ghasemi Vojoodi³, Marzieh Jamali³

¹Department of Endodontics, School of Dentistry, Shahid Beheshti University of Medical Sciences, Tehran, Iran.

²Department of Endodontics, Stomatological Hospital, College of Stomatology, Xi'an Jiaotong University, Shaanxi, PR China.

³School of Dentistry, Kermanshah University of Medical Sciences, Kermanshah, Iran.

Correspondence: Samira Jamali, Department of Endodontics, Stomatological Hospital, College of Stomatology, Xi'an Jiaotong University, Shaanxi 710004, PR China. **E-mail:** samira.jamali90@yahoo.com

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ABSTRACT

Objective: To determine the impact of distinctive instrumentation systems of the root canals on the endotoxin lessening through the root canals. **Material and Methods:** From the electronic databases, MEDLINE, PubMed, Cochrane Library, Embase, ISI, Google Scholar have been used to perform a systematic literature review between 2015 and 2020. Therefore, a software program (Endnote X9) has been utilized for managing electronic titles. Searches were performed with keywords, "root canal," "instrumentation," "endotoxin," "root canal preparation," "biofilm" "endodontics," and "lipopolysaccharide." This systematic review has been conducted on the basis of the key consideration of the PRISMA Statement-Preferred Reporting Items for the Systematic Review and Meta-analysis. **Results:** Hence, 163 potentially important abstracts and research topics have been discovered by electronic searches and three studies (3 RCTs) have been included. According to the outputs, any statistically significant differences have been not found between the rotary files and reciprocation (SMD 0.51, 95% CI [0.11, 0.90], $p=0.011$) ($I^2 = 49.5%$; $p=0.138$). **Conclusion:** Analyses indicated that instrumentation methods decreased the content of endotoxin from the root canals.

Keywords: Endodontics; Root Canal Preparation; Lipopolysaccharides.

Introduction

Root canal therapy has been practiced since 1928, so that the success rate has tremendously increased [1]. In fact, combined instrumentations have been used to clean and shape the canals in the roots [2]. They have also been utilized for removing the infected soft (pulp) as well as hard (dentin) tissues for allowing the irrigating solution exchange across the whole length of the radicular spaces [3]. Moreover, they help the mechanical disruption of bio-films inside the root canal systems [4]. However, these factors' effect on the rate of failure or success of the root canal treatments remained ambiguous [5].

In fact, experts in the field presented a lot of instrumentations regarding the varieties in the cross-sectional plan, kinematics, tapers and tip plan, and the sort of amalgam, aiming to facilitate the handle formation and lower laborious operations [6,7]. Studies reported that microbiota in the root canals is profoundly variable and the population-shift within the microbiome commonly occurs in the endodontic infection bio-films [8]. By definition, the root canal bio-films have been considered the complicated poly-microbial structures following the surface of the root canal shaped by the microorganisms, which invade the teeth' pulpal spaces and are related to the persistent root canal infections [9,10]. Moreover, the gram-negative anaerobic rods are the most common ones [11]. On the one hand, endotoxin has been regarded as one of the components (lipopolysaccharid - LPS) of the cell-walls of the gram-negative bacteria [12] that appeared for the stimulation of the bone resorption [13].

The Cone-beam Computed Tomography Analysis has determined the bone destruction and it has been found that pain has a relationship with the number of endotoxins in the root canals [14,15]. Therefore, endotoxin's lessening has been considered one of the vital measures to diminish the total bone destruction [14]. Furthermore, offering evidence-based outcomes would be imperative to assist in clinical practices' decision-making process [15]. Finally, the aim of this systematic review and meta-analysis has been to determine the impact of distinctive instrumentation systems of the root canals on the endotoxin lessening through the root canals.

Material and Methods

Search Strategy

From the electronic databases, PubMed, Cochrane Library, Embase, ISI have been used to perform a systematic literature between 2015 and 2020. Therefore, a software program (Endnote X9) has been utilized for managing electronic titles. Searches were performed with keywords, "root canal", "instrumentation", "endotoxin", "root canal preparation", "biofilm" "endodontics," and "lipopolysaccharide" (Table1). This systematic review has been conducted on the basis of the key consideration of the PRISMA Statement-Preferred Reporting Items for the Systematic Review and Meta-Analysis [16].

Table1. Search strategies of MeSH terms.

Search Strategies	Keywords
MeSH Terms	(((((("Dental Pulp Cavity"[Mesh] AND "Root Canal Therapy"[Mesh]) AND "Endodontics"[Mesh]) AND "instrumentation" [Subheading]) AND "Endotoxins"[Mesh]) AND "Root Canal Preparation/instrumentation"[Mesh]) AND "Root Canal Preparation"[Mesh]) AND "Biofilms"[Mesh]) AND "Lipopolysaccharides"[Mesh]

Selection Criteria

The following inclusion criteria were established: 1) Randomized controlled trials studies, controlled clinical trials, and prospective and retrospective cohort studies; 2) In humans; 3) Full data; 4) Patient with root canal treatment; 5) Reciprocating and rotary instruments; 6) Baseline and post-intervention outcome; 7) Article that compared Reciprocating and Rotary instruments for microbial reduction; and 8) In English.

The following exclusion criteria were adopted: 1) In vitro studies, case studies, case reports and reviews; 2) Animal studies; and 3) Lack of the comparison of the instrumentation systems.

Data Extraction and Method of Analysis

The data have been extracted from the research included with regard to the study, years, study design, sample size, intervention, method, and outcome. The quality of the studies included was assessed using The Cochrane Collaboration tool [17]. For Data extraction, three reviewers blind and independently extracted data from the abstract and full text of studies that included. Moreover, means of outcomes have been included in the meta-analysis. Then, the forest plots have been evaluated with the use of a software program (Comprehensive Meta-Analysis Stata V14, Biostat, Englewood, NJ, USA).

Results

A total of 163 potentially relevant titles and abstracts were found during the electronic and manual search. During the first stage of study selection, 71 publications were excluded based on title and abstract. For the second phase, the complete full-text articles of the remaining 89 publications were thoroughly evaluated. A total of 86 papers had to be excluded at this stage because they did not fulfill the inclusion criteria of the present review. Finally, a total of three publications fulfilled the inclusion criteria required for this systematic review (Figure 1).

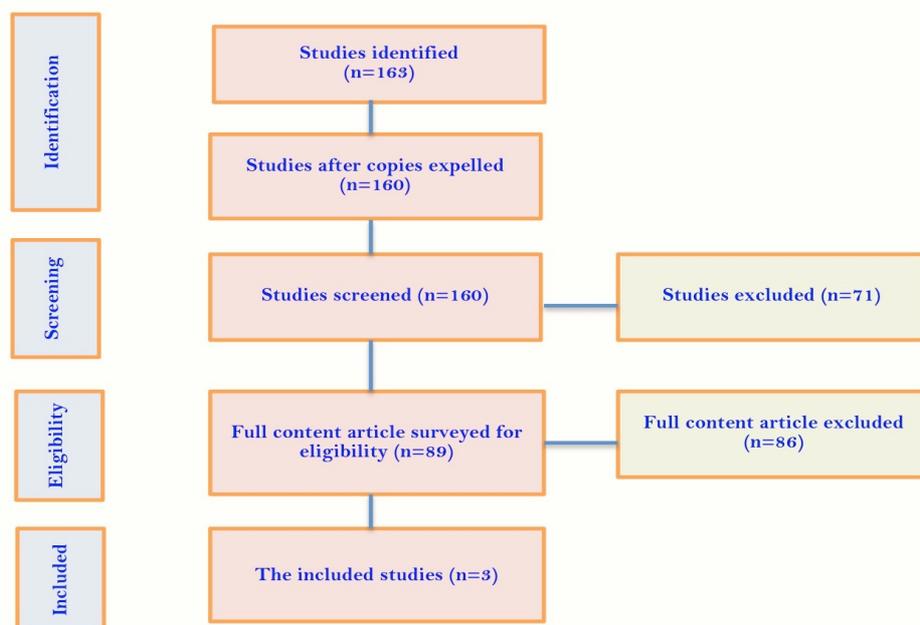


Figure 1. Study attrition diagram (PRISMA Statement).

Table 2 reports the individual studies in this meta-analysis. Therefore, three studies (3 RCTs) have been included (Table 2). The sample size of the study equaled 109 (Reciprocating = 60, Rotary = 49). Notably,

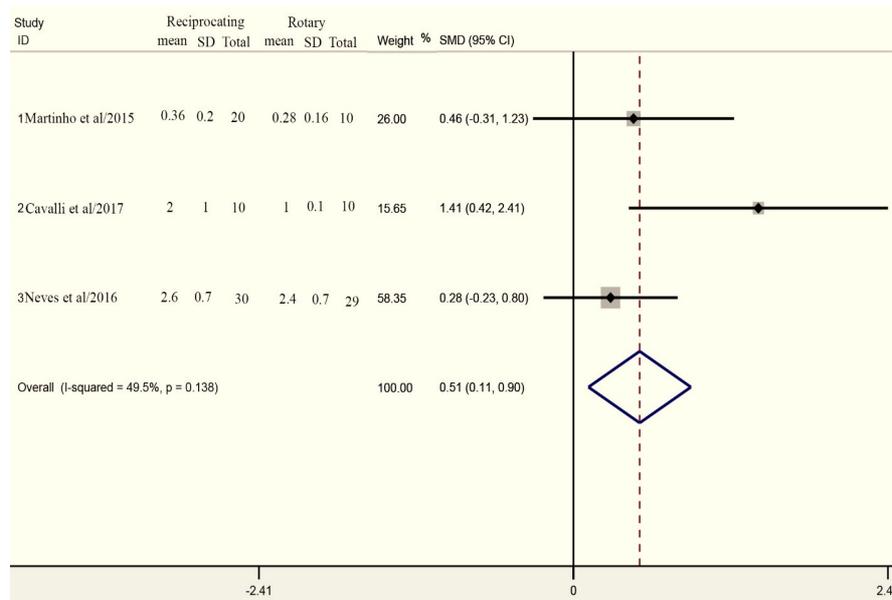
one study [18] investigated two Reciprocating instruments versus one Rotary instrument and the other two studies [19,20] examined one Rotary instrument versus one Reciprocating instrument.

Table 2. Studies selected for systematic review and meta-analysis.

Study	Design	Sample Size	Intervention	Method	Decreased Endotoxin Content [†]		Outcome	
					REC	ROT		
Martinho et al. [18]	RCT	30	Wave One: 10 Reciproc instrument: 10 Retreatment system: 10	Two Reciprocating instruments vs. one Rotary instrument	CLALA	94%	94.98%	No significant difference between instruments
Neves et al. [19]	RCT	59	Reciproc = 29 BioRace =30	Reciproc + BioRace	CLALA	55%	50%	No significant difference between instruments
Cavalli et al. [20]	RCT	20	Mtwo = 10 Reciproc = 10	One Rotary instruments vs. one Reciprocating instrument	CLALA	95.05%	91.85	No significant difference between instruments

CLALA: Chromogenic Limulus Amebocyte Lysate Assay; [†]Instrumentations declined the endotoxin content compared to the baseline.

All studies exhibited a considerable decline in endotoxin content following treatments with the rotary and reciprocating instruments. In any case, there has been not any significant difference between the instrumentation groups for reducing endotoxin in each study. Therefore, the three papers have been included in our meta-analysis and then range and median have been used to estimate the standard deviation (SD) as well as the mean. According to the analyses, any statistically significant differences have been not observed between the rotary and reciprocation files (SMD 0.51, 95% CI [0.11, 0.90], p=0.011) (I² = 49.5%; p=0.138) (Figure 2). Moreover, all papers' power analysis indicated fewer documents and a low quality randomized clinical trial with low control (Table 3).



Heterogeneity chi-squared = 3.96 (d.f. = 2), p=0.138; I-squared (variation in SMD could be attributed to heterogeneity) = 49.5%; SMD test = 0: z = 2.53, p=0.011.

Figure 2. Forest plots showed effectiveness of rotary and reciprocating systems on microbial reduction.

Table 3. Risk of bias.

Study	Randomization	Allocation Concealment	Blinding	Blinding of Outcome Assessment	Incomplete Outcome Data	Selective Reporting
Martinho et al. [18]	Low	Unclear	High	High	Low	Low
Neves et al. [19]	Low	Unclear	Low	High	Low	Low
Cavalli et al. [20]	Low	Unclear	High	High	Low	Low

Discussion

The present systematic review and meta-analysis surveyed the impact of distinctive instrumentation systems of the root canals on the endotoxin lessening from the root canals. Analyses assessed the adequacy of the mentioned instrumentations on various parameters of the root canal treatments. However, the precise contribution of the kind of instrumentation on the clinical results is still ambiguous [21,22].

Only three articles satisfied our inclusion criteria for doing a systematic review; therefore, the rotary and reciprocating mechanisms have been compared in the two essential root canal treatments and retreatment. It is notable that all three studies utilized chromogenic kinetic LAL assay. In addition, the microbiological consideration showed high sensitivity at each arrangement of assessment. Moreover, the baseline values and sterility check have been considered the crucial factors utilized to improve the research plan's accuracy and approve the outcome validity [23].

However, one of the critical parameters, which should be attended, would be the volume of irrigant utilized in the selected articles. As these articles compared the multi-file rotary systems and the single file reciprocating systems and a multi-file hybrid system, we could conceive that the irrigant volume may be variable amongst the intervention groups because of the utilization time of the mentioned instrumentations has been different [24].

Results demonstrated that the single-file reciprocating system and the full-sequence rotary system had a comparative impact on the microbial reduction [21,25,26]. In this regard, Marinho et al. [18] revealed that Mtwo, Reciproc, Race, and ProTaper instruments created a largely considerable decline in the bacterial loads; however, there has not been any significant difference in the content of endotoxin. In any case, limited information has been published about the impact of the pure reciprocating movement on bacterial reduction.

Moreover, Reciproc and BioRaCe showed significant bacterial reductions though some bacteria have been identified by qPCR in 55% and 50% of the canals. Few investigations utilized various instrumentation methods as well as NaOCl irrigation [27,28]. This bacterial count may still be sufficient to maintain the infection. In addition, bacteria may stay in the root canal system due to the canal morphology such as lateral canals, apical ramifications, and isthmi, which could not be reachable by the instrument and irrigant [29].

Mechanical instrumentation could disturb the bacterial biofilm and had the potential to reduce the presence of bacteria within the primary root canal [30]. Furthermore, the rotary systems, ProTaper Universal, and Mtwo provided satisfactory geometry [31] and significant bacterial reduction in the root canal [32]. For example, Siddique et al. [33] systematic review evaluated the antibacterial efficacy of the rotary and reciprocating system in microbial reduction. It has been found that OES did not provide concrete evidence to show the increased antibacterial efficacy of the reciprocating system as compared to the rotary system. Moreover, clinical trials would be required to evaluate various instrumentation systems' efficacy in reducing bacteria from the root canal system. In addition, Neelakantan et al. [15] systematic review and meta-analysis evaluated the effects of diverse root canal instrumentations on decreasing the content of endotoxin from the

root canal systems. They found that the instrumentation methods compared in the present review decreased endotoxin content from the root canals; however, there have been no significant differences between them. Finally, these two studies' results are consistent with the present review, with only the difference being in the systematic review and meta-analysis.

Conclusion

According to the analyses, the meta-analysis did not exhibit any statistically significant differences between the reciprocating and the rotary files. Therefore, instrumentation methods decreased the content of endotoxin from the root canal. Since just three studies (RCT) from 2015 to 2020 have been found on the topic of the study, it is necessary to have several researches for making a comparison between the current instrumentations.

Authors' Contributions

NN  <https://orcid.org/0000-0002-6365-6619> Formal Analysis and Writing – Review and Editing.
SJ  <https://orcid.org/0000-0003-3803-1235> Conceptualization, Methodology, Formal Analysis, Writing – Original Draft Preparation, Writing – Review and Editing and Supervision.
MGV  <https://orcid.org/0000-0003-0966-2759> Writing – Review and Editing.
MJ  <https://orcid.org/0000-0001-8536-6447> Writing – Review and Editing.
All authors declare that they contributed to critical review of intellectual content and approval of the final version to be published.

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Conflict of Interest

The authors declare no conflicts of interest.

Data Availability

The data used to support the findings of this study can be made available upon request to the corresponding author.

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