International Journal of Dentistry and Oral Science (IJDOS)
ISSN: 2377-8075

Antibacterial Effectiveness Of Rotary And Reciprocating Systems On Microbial Load Reduction In Retreatment Cases- A Systematic Review

Review Article

Shree Ranjan[1], Manish Ranjan[2*]

[1] Department of Conservative Dentistry and Endodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences (SIMATS), Chennai-600077, India.
[2] Associate Professor, Department of Conservative Dentistry and Endodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences (SIMATS), Chennai-600077, India.

Abstract

Introduction: One of the significant endodontic challenges is to control the microbial infection after a successful endodontic treatment has been administered. The failure of an endodontic treatment occurs due to post operative microbial leakage causing the reinfection to occur. The remedy to such cases is to perform the endodontic retreatment. One of the commonest retreatment endodontic file system is Protaper Universal retreatment file(DentsplyTulsa,Tulsa) , D-Race retreatment system(FKG Dentaire, Switzerland) , Mtwo retreatment file system(VDW,Munich Germany), R-Endo file system(MicroMega, Besancon , France) or GPR mani files for the retreatment cases. These systems are based on continuous rotary motion. The modern endodontic instruments which focus on the reciprocation method of functioning involve the following systems - Reciproc file system(VDW,Munich Germany), reciproc blue file system(VDW,Munich Germany) , Waveone file system(Dentsply Maillefer,Switzerland) , Waveone Gold file system(DentsplyMaillefer,Switzerland). The current systematic review analyses the effectiveness of Rotary and Reciprocating systems on microbial load reduction in endodontic retreatment cases.

Aim: To assess the reduction in microbial load in cases of endodontic retreatment after the use of common rotary endodontic files and reciprocation based file systems

Search Strategy: A search was performed in electronic database (i.e. PUBMED CENTRAL, Google , Scopus and Hand Search) using following search terms alone and in combination by means of PUBMED search builder from Jan 1980 till Jan 2021.

Selection Criteria: All in vitro studies that involved the criteria of reduction in microbial load in retreatment cases which compared the antibacterial effectiveness following the use of rotary and reciprocating systems.

Data Collection and Analysis: All the studies were based on the data extraction and analysis of the studies for quality. The outcome measure was to evaluate the antibacterial effectiveness when the rotary and reciprocation systems were used in the retreatment cases.

Results: Two studies included for this review had high risk of bias. Of the 2 studies included for this review, both the study involved the use of modern reciprocating filing systems in comparison to continuous rotation, the reduction in the bacterial load was assessed by assessing the CFU units.

Conclusion: This review concludes that the studies reviewed here have a high risk of quality bias. However, Reciprocating retreatment filing systems yielded better results compared to conventional retreatment filing systems. The included studies regarding the bacterial load reduction in retreatment cases were not designed properly with respect to randomization sample size calculation, blinding. Hence further clinical trials need to be conducted with proper sample size calculation, blinding and randomization to obtain accurate results.

Keywords: Reciprocation; Retreatment Files; Systematic Review; D-Race; M-Two; Reciproc; WaveOne Gold; Protaper Universal.

***Corresponding Author**:
Dr. Manish Ranjan,
Associate Professor, Department of Conservative Dentistry and Endodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences (SIMATS), Chennai-600077, India.
Tel: +91-9543445029
E-mail: manish@saveetha.com

Received: May 09, 2021
Accepted: August 5, 2021
Published: August 14, 2021

Citation: Shree Ranjan, Manish Ranjan. Antibacterial Effectiveness Of Rotary And Reciprocating Systems On Microbial Load Reduction In Retreatment Cases- A Systematic Review. *Int J Dentistry Oral Sci.* 2021;8(8):3710-3717. doi: http://dx.doi.org/10.19070/2377-8075-21000761

Introduction

In order to have a successful endodontic outcome the predominant criteria is to eliminate the microbial load from the root canal. The major goals of root canal treatment are to clean and shape the root canal system and seal it in 3 dimensions to prevent reinfection of the tooth. Although initial root canal therapy has been shown to be a predictable procedure with a high degree of success. Failures can occur after treatment. Recent publications reported failure rates of 14%-16% for initial root canal treatment. Lack of healing is attributed to persistent interradicular infection residing in previously uninstrumented canals, dentinal tubules, or in the complex irregularities of the root canal system. The failure of the endodontic treatment is one of the key challenges faced.[1] Post-treatment apical periodontitis can be categorized as persistent (persisted despite treatment), emergent (appeared after treatment), or recurrent (redeveloped after having healed). Conceivably, persistent disease is mainly caused by persistent interradicular infection (bacteria that survived the effects of treatment), whereas emergent disease is caused by secondary infection (contamination during treatment or coronal leakage after treatment) . Recurrent disease quite often represents a late failure of the endodontic treatment, and the cause is allegedly related to a new event arising years after treatment conclusion (eg, a secondary infection because of coronal leakage or root fracture). However, a persistent infection might also play a role in causing disease recurrence provided residual bacteria manage to survive in the canal for years after treatment and, in response to environmental changes, they may be favoured, flourishing again and reactivating infection. Bacteria causing persistent infections are usually located in areas unaffected by instruments and antimicrobial substances, including lateral canals, apical ramifications, and isthmuses [2]. In addition, bacteria may remain even in the main canal, especially on dentinal canal walls that remained untouched by instruments . Bacterial invasion of dentinal tubules has also been regarded as a potential source of persistent infection.[3]

Enterococci are implicated in infections of the root canal system, however, they make up a small proportion of the initial flora which is dominated by Gram-negative species (Sundqvist 1992, Le Goff et al. 1997). In contrast, it has been reported that enterococci are frequently isolated from obturated root canals of teeth that exhibit chronic periapical pathology (Sundqvist et al. 1998, Molander et al. 1998). Enterococcus faecalis, which is responsible for 80–90% of human enterococcal infections (Ruoff et al. 1990), is the dominant enterococcus species (Molander et al. 1998, Sundqvist et al. 1998) and commonly the only species recovered from the obturated root canal (Sundqvist et al. 1998, Dahlèn et al. 2000). These facts indicate that E. faecalis has a pathogenic role in chronic endodontic treatment failure. It has been suggested that E. faecalis virulence may be related to resistance to intracanal medicaments (Byström&Sundqvist 1985, Haapasalo&Ørstavik 1987, Ørstavik&Haapasalo 1990) and an ability to survive in the root canal as a single organism without the support of other bacteria (Fabricius et al. 1982). For bacteria to act as pathogens they must first colonize the host and this involves a series of interactive events. Initially there is a loose physical association of the organism with the surface of a tissue which allows stronger and more permanent bonds to be established through the binding activities of microbial cell surface adhesins to complementary receptors on the host surface. Once the microbial cells are bound they must be able to utilize available nutrients, compete or cooperate with other bacterial species in the immediate environment, and contend with host defence mechanisms before accumulation of microorganisms can occur by cell division and growth. Once these mechanisms are established at multiple sites, the host becomes colonized (Jenkinson& Lamont 1997). It is well established that viable bacteria can be recovered from the root canal system after it has been treated by effective chemo-mechanical instrumentation (Byström&Sundqvist 1981, 1983, 1985)[4]. E. faecalis can proficiently invade dentinal tubules (Akpata&Blechman 1982, Haapasalo&Ørstavik 1987, Ørstavik&Haapasalo 1990), and it is therefore probable that cells within dentinal tubules surviving chemo-mechanical instrumentation and intracanal medication could colonize the tubules and re-infect the obturated root canal. For this to occur cells would have to be able to adapt to the altered nutrient supply and be able to grow within the tubule. Enterococci possess a number of virulence factors that may allow this to occur, including adherence to host cells (Kreft et al. 1992), expression of proteins to ensure cell survival as a result of altered environmental nutrient supply (Giard et al. 1996, Giard et al. 1997), the ability to compete with other bacterial cells (Gálvez et al. 1991) and to alter the host's response (Miyazaki et al. 1993) and environment (Rosan& Williams 1964, Hase& Finkelstein 1993). Although the constitution of dentinal fluid in non-vital root dentine has not been elucidated, it is probable that it is interstitial fluid originating from alveolar bone and periodontal ligament, and as such would resemble serum (Ganong 1983). It is possible that this fluid may sustain cells within tubules and allow them to cause disease. Little is known about the bacterial mechanisms involved in bacterial invasion of dentinal tubules. However dentinal tubules contain an appreciable amount of unmineralized collagen (Dai et al. 1991), and it has recently been established that dentinal tubule invasion by oral streptococci is associated with cell adhesion to collagen and a collagen-induced morphological growth response (Love et al. 1997). Both of these functions are mediated by streptococcal antigen I/II cell-wall proteins (Love et al. 1997). Additionally, some streptococcal antigen I/II polypeptides are also involved in invasion of other species which do not have the capacity to invade alone. Love et al. (2000) demonstrated that cells of Porphyromonasgingivalis are only able to invade dentinal tubules when they are in co-culture with an invasive cell expressing Streptococcus gordonii antigen I/II polypeptides, a mechanism coined co-invasion.

Retreatment with modern rotary and reciprocating instrumentation helps eliminate the microbial infection by providing the pathway for final cleansing of the canal through the use of antimicrobial agents..ProTaper Universal Tulsa (Dentsply Tulsa, Tulsa, OK) was introduced . With respect to the original kit, the new system was integrated with 3 new ProTaper retreatment files, D1, D2, D3, two new ProTaper finishing files, F4 and F5, and with the ProTaperobturator and gutta-percha points. The 3 ProTaper Universal System retreatment files (PTUS) are designed to facilitate the removal of filling material. Each file has different lengths, tapers,and apical tip diameters. The D1 PTUS instrument has an active tip to facilitate initial penetration into the filling material; the D1 instrument has a length of 16 mm, a tip of 0.30 mm, and a 0.09% taper. The D2 PTUS instrument for removal of filling material at the level of the middle third of the root hasa length of 18mm, atip of 0.25mm, and a 0.08% taper. The D3 PTUS instrument for apical filling removal with a length of 22 mm, atip of 0.20 mm, and a 0.07% taper is used to reach the working length

[5].

Mtwo (VDW, Munich, Germany) and D-RaCe (FKG Dentaire, La Chaux-de-Fonds, Switzerland) systems have instruments that are specifically designed for retreatment. Mtwo retreatment files consist of 2 instruments with active cutting tips: Mtwo R1 (size 25, 0.05 taper) and Mtwo R2 (size 15, 0.05 taper). Both instruments have an S-shaped cross-section as do the files of the basic sequence, but they have a shorter pitch length to enhance the advancement of the file into the filling material. These instruments are characterized by 2 cutting edges, which are claimed to cut dentin effectively.

D-RaCe retreatment files comprise 2 retreatment instruments (DR1 and DR2) with various tapers and diameters at the tip (size 30, 0.10 taper and size 25, 0.04 taper)[6]. These 2 retreatment instruments were designed with alternating cutting edges as well as a triangular cross-section. DR1 has an active working tip to facilitate the initial penetration of the filling material. The R-Endo instrumentation system (Micro-Mega, Besanc¸on, France), which is specifically dedicated to retreatment procedures, has also been developed. The system is composed of 4 instruments: Re (size 25, 0.12 taper) to flare the first few millimeters of the canal and 3 files (ie, R1, R2, and R3) dedicated to each root canal third to a size 25 with 0.08, 0.06, or 0.04 tapers, respectively. An optional finishing file Rs (size 30, 0.04) is available if required. The files have a triangular cross-section with 3 equally spaced cutting edges and no radial land; the tip of the files is claimed to be inactive [7]. Reciproc R25 (VDW, Munich, Germany) and WaveOne Primary (DentsplyMaillefer, Ballaigues, Switzerland) are well-known single-file NiTi systems with reciprocating motion .Reciproc and WaveOne have the same tip diameter and taper angle (size 25 tip and size 0.08 taper). The tapers are fixed 3 mm from the apex of the files and decrease in the middle and coronal sections . The Reciprocfile [8] is S-shaped with 2 cutting edges, and the WaveOne file features a modified convex triangular cross section in the apex with a convex triangular cross section in the middle and coronal sections .Both the Reciproc and WaveOne files are made of M-Wire alloy [9]. Recently, WaveOne Gold (DentsplyMaillefer) has been introduced. WaveOne Gold retains the reciprocating motion of the WaveOne file but has modified dimensions and geometry. The file is now a parallelogram with 2 cutting edges. The new WaveOne Gold files also feature the off-center design of ProTaper Next (DentsplyMaillefer) files. The files are manufactured with a gold heat treatment procedure. Gold heat treatment is executed manually by heating the file and then cooling slowly, in contrast to the premanufacturing heat treatment of M-Wire technology. According to the manufacturer, this new heat treatment improves the elasticity of the file [10].

Reciproc Blue files, which are a development of Reciproc M-wire: in fact, these two instruments have the same shape and utilization motion; however, Reciproc Blue has undergone a specific thermal treatment that results in a thin blue titanium oxide layer on its surface (Plotino et al. 2018). This heat treatment improves the flexibility and cyclic fatigue resistance of the files (De-Deus et al. 2017). Reciproc Blue can be precurved during clinical use due to its martensitic phase (Plotino et al. 2018).[11]

This systematic review assesses the reduction in the microbial load by comparison between the rotary and the reciprocating endodontic filing systems in selectively retreatment cases using a systematic approach to present evidence.

Previously our team has a rich experience in working on various research projects across multiple disciplines[12-26]. Now the growing trend in this area motivated us to pursue this project.

Aim

The aim of this systematic review is to assess the effectiveness of rotary and reciprocating files on the reduction of microbial load in retreatment cases.

Structured Question

Is there a difference in the microbial load while using rotary and reciprocation files in endodontic retreatment cases ?

Pico Analysis

Population - Patients undergoing root canal retreatment Intervention - Retreatment with reciprocating retreatment system Comparison - Continuous rotation rotary retreatment files Outcome - Reduction in microbial load.

Null Hypothesis

There is no significant difference in reduction of microbial load in retreatment cases done by reciprocating system and continuous rotary system.

Alternate Hypothesis

There is a significant difference in reduction of microbial load in retreatment cases done by reciprocating system and continuous rotary system.

Materials And Methods

Sources used

For identification of studies included or considered for this review, detailed search strategies were carried out on the following databases.

- PUBMED Advanced Search (until January 2021)
- Google Search
- Scopus Search
- Hand Search

No limits and language restrictions were applied during the electronic search to include the search phase of the systematic review. No time restriction was applied. Reference list of reviews and of the identified in vitro studies were also checked for possible additional studies.

Hand Search

- International Endodontic Journal
- Journal of Endodontics

Inclusion Criteria

Criteria for considering studies for this review:

- In vitro studies involving the endodontic retreatment
- Usage of rotary and reciprocating file system for such retreatment cases
- Studies where the reduction in the microbial load is detected.
- Studies where there is comparison of rotary and reciprocating files systems in assessing the microbial load

Exclusion Criteria

The following studies were excluded

- Studies that assessed the manual retreatment files.
- Studies that assessed other modes of guttapercha retrieval like ultrasonic instrumentation etc.
- Studies not assessing the microbial load reduction.
- Studies where the comparison of conventional and reciprocated retreatment files was not done.
- In Vivo / Clinical trials

Results

Description Of Studies

The search identified 27 publications out of which 24 were excluded after reviewing the title and the abstract and 1 were excluded after reading the full article. A total of 2 publications fulfilled all criteria and were included in this review

Risk of Bias of Included Studies

The assessment for the four main methodological quality items is shown in the table. The study was assessed to have a 'high risk' of bias if it did not record a 'Yes' in three or more of the main four categories, 'Moderate' if two out of four categories did not record a 'Yes' and 'Low' if randomization assessor blinding and completeness to follow up were considered adequate.

Quality Assessment

(Higgins and Green. Cochrane reviewer's Handbook 2009)
The quality assessment of included trials was undertaken independently as a part of the data extraction process. Four main criteria were examined.

1. Method of Randomization, recorded as

- Yes- Adequate as describes in the text
- No- Inadequate as recorded in the text
- Unclear in the text

2. Allocation Concealment, recorded as

- Yes- Adequate as described in the text
- No- Inadequate as recorded in the text
- Unclear in the text

3. Outcomes assessors blinded to intervention, recorded as

- Yes- Adequate as described in the text

Figure 1. Search Flowchart.

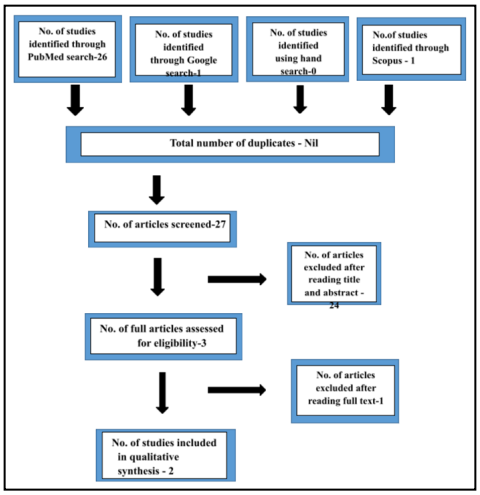


Figure 2. Quality Assessment Results Using Risk Bias Assessment Tool Outlined In The Cochrane Handbook For Systematic Reviews Of Interventions (version 5.1.0): A) Risk Bias Summary And B) Overall Assessment Of Risk Of Bias.

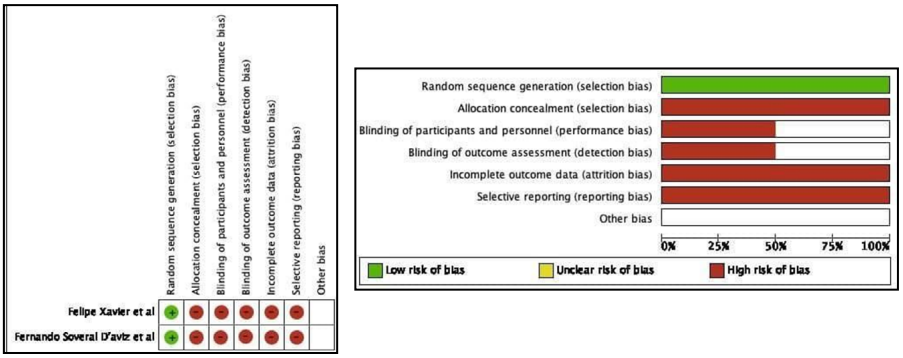
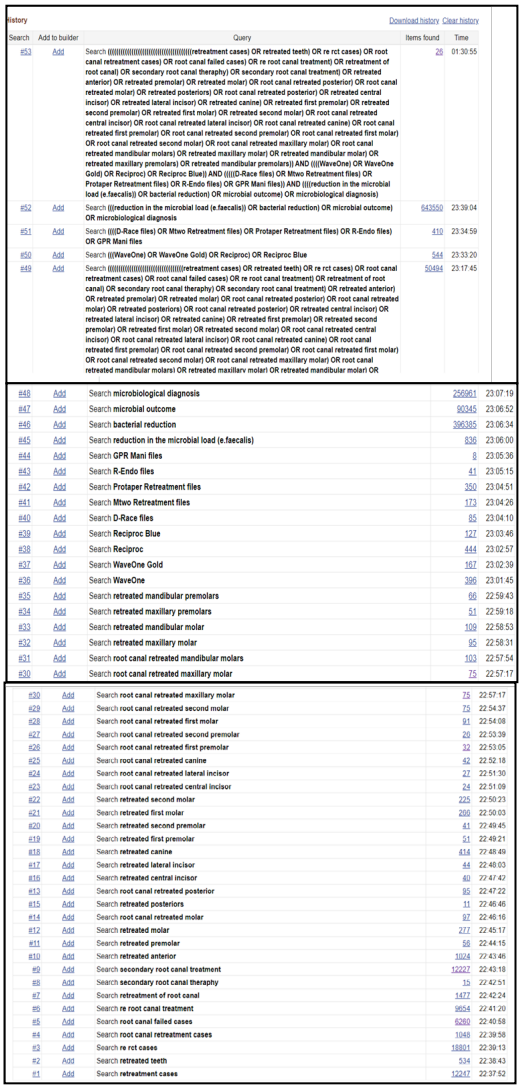


Table 1. Search Methodology.



Search	Add to builder	Query	Items found	Time
#53	Add	Search ((((((((((((((((((((((((((((((((((((retreatment cases) OR retreated teeth) OR re rct cases) OR root canal retreatment cases)) OR root canal failed cases) OR re root canal treatment) OR retreatment of root canal) OR secondary root canal theraphy) OR secondary root canal treatment) OR retreated anterior) OR retreated premolar) OR retreated molar) OR root canal retreated posterior) OR root canal retreated molar) OR retreated posteriors) OR root canal retreated posterior) OR retreated central incisor) OR retreated lateral incisor) OR retreated canine) OR retreated first premolar) OR retreated second premolar) OR retreated first molar) OR retreated second molar) OR root canal retreated central incisor) OR root canal retreated lateral incisor) OR root canal retreated canine) OR root canal retreated first premolar) OR root canal retreated second premolar) OR root canal retreated first molar) OR root canal retreated second molar) OR root canal retreated maxillary molar) OR root canal retreated mandibular molars) OR retreated maxillary molar) OR retreated mandibular molar) OR retreated maxillary premolars) OR retreated mandibular premolars)) AND ((((WaveOne) OR WaveOne Gold) OR Reciproc) OR Reciproc Blue)) AND ((((D-Race files) OR Mtwo Retreatment files) OR Protaper Retreatment files) OR R-Endo files) OR GPR Mani files)) AND ((((reduction in the microbial load (e.faecalis)) OR bacterial reduction) OR microbial outcome) OR microbiological diagnosis)	28	01:30:55
#52	Add	Search (((reduction in the microbial load (e.faecalis)) OR bacterial reduction) OR microbial outcome) OR microbiological diagnosis	643550	23:39:04
#51	Add	Search ((((D-Race files) OR Mtwo Retreatment files) OR Protaper Retreatment files) OR R-Endo files) OR GPR Mani files	410	23:34:59
#50	Add	Search (((WaveOne) OR WaveOne Gold) OR Reciproc) OR Reciproc Blue	544	23:33:20
#49	Add	Search ((((((((((((((((((((((((((((((((((((retreatment cases) OR retreated teeth) OR re rct cases) OR root canal retreatment cases)) OR root canal failed cases) OR re root canal treatment) OR retreatment of root canal) OR secondary root canal theraphy) OR secondary root canal treatment) OR retreated anterior) OR retreated premolar) OR retreated molar) OR root canal retreated posterior) OR root canal retreated molar) OR retreated posteriors) OR root canal retreated posterior) OR retreated central incisor) OR retreated lateral incisor) OR retreated canine) OR retreated first premolar) OR retreated second premolar) OR retreated first molar) OR retreated second molar) OR root canal retreated central incisor) OR root canal retreated lateral incisor) OR root canal retreated canine) OR root canal retreated first premolar) OR root canal retreated second premolar) OR root canal retreated first molar) OR root canal retreated second molar) OR root canal retreated maxillary molar) OR root canal retreated mandibular molars) OR retreated maxillary molar) OR retreated mandibular molar) OR	50494	23:17:45
#48	Add	Search microbiological diagnosis	256961	23:07:19
#47	Add	Search microbial outcome	60345	23:06:52
#46	Add	Search bacterial reduction	396385	23:06:34
#45	Add	Search reduction in the microbial load (e.faecalis)	836	23:06:00
#44	Add	Search GPR Mani files	8	23:05:36
#43	Add	Search R-Endo files	41	23:05:15
#42	Add	Search Protaper Retreatment files	350	23:04:51
#41	Add	Search Mtwo Retreatment files	173	23:04:26
#40	Add	Search D-Race files	85	23:04:10
#39	Add	Search Reciproc Blue	127	23:03:46
#38	Add	Search Reciproc	444	23:02:57
#37	Add	Search WaveOne Gold	167	23:02:39
#36	Add	Search WaveOne	396	23:01:45
#35	Add	Search retreated mandibular premolars	66	22:59:43
#34	Add	Search retreated maxillary premolars	51	22:59:18
#33	Add	Search retreated mandibular molar	109	22:58:53
#32	Add	Search retreated maxillary molar	95	22:58:31
#31	Add	Search root canal retreated mandibular molars	103	22:57:54
#30	Add	Search root canal retreated maxillary molar	75	22:57:17
#30	Add	Search root canal retreated maxillary molar	75	22:57:17
#29	Add	Search root canal retreated second molar	75	22:54:37
#28	Add	Search root canal retreated first molar	91	22:54:08
#27	Add	Search root canal retreated second premolar	20	22:53:39
#26	Add	Search root canal retreated first premolar	32	22:53:05
#25	Add	Search root canal retreated canine	42	22:52:18
#24	Add	Search root canal retreated lateral incisor	27	22:51:30
#23	Add	Search root canal retreated central incisor	24	22:51:09
#22	Add	Search retreated second molar	225	22:50:23
#21	Add	Search retreated first molar	266	22:50:03
#20	Add	Search retreated second premolar	41	22:49:45
#19	Add	Search retreated first premolar	51	22:49:21
#18	Add	Search retreated canine	414	22:48:49
#17	Add	Search retreated lateral incisor	44	22:48:03
#16	Add	Search retreated central incisor	40	22:47:42
#13	Add	Search root canal retreated posterior	95	22:47:22
#15	Add	Search retreated posteriors	11	22:46:46
#14	Add	Search root canal retreated molar	97	22:46:16
#12	Add	Search retreated molar	277	22:45:17
#11	Add	Search retreated premolar	56	22:44:15
#10	Add	Search retreated anterior	1024	22:43:46
#9	Add	Search secondary root canal treatment	12227	22:43:18
#8	Add	Search secondary root canal theraphy	15	22:42:51
#7	Add	Search retreatment of root canal	1477	22:42:24
#6	Add	Search re root canal treatment	9654	22:41:20
#5	Add	Search root canal failed cases	6280	22:40:58
#4	Add	Search root canal retreatment cases	1048	22:39:58
#3	Add	Search re rct cases	18801	22:39:13
#2	Add	Search retreated teeth	534	22:38:43
#1	Add	Search retreatment cases	12247	22:37:52

Table 2. Variables Of Interest.

S.NO	VARIABLES OF INTEREST
1	Reduction in microbial load

Table 3. Characteristics Of Excluded Articles.

S.No	AUTHOR	YEAR	REASON FOR EXCLUSION
1	Frederico C. Martinho	2014	Invivo study design

- No- Inadequate as recorded in the text
- Unclear in the text

4. Completeness of follow up (was there a clear explanation for withdrawals and drop outs in each treatment group) assessed as:

- Yes- Dropouts were explained
- No- Dropouts were not explained
- None- No dropouts or withdrawals

Other methodological criteria examined included

1. Presence or absence of sample size calculation
2. Comparability of groups at the start
3. Clear inclusion/exclusion criteria.

The purpose of this review was to evaluate the reduction in the microbial load after the use of rotary and the reciprocating systems in retreatment systems . Two invitro studies fulfilled the criteria for being included in this review. (Fernando SoveralD'aviz et al, Felipe Xavier et al).

In the study conducted by Fernando SoveralD'aviz et al , the sample size involved 50 maxillary molar roots contaminated with E.faecalis . The root canals were divided into four groups as follows:

Reciproc R25 (n = 20) and Reciproc R25 combined with Mtwo

Table 4. General Information Of Selected Articles.

S.No	Author	Year	Country	Study design	Sample size	Time of assessment	Method of evaluation	Statistical test done	Outcome
1	Fernando SoveralD'aviz et al	2018	Brazil	Invitro	Total = 45 1. Reciproc R25 (tip size 25, 0.08 taper) N = 20 2. Reciproc R25 + Mtwo (tip size 40 and 0.04 taper) N=20 3. Negative controls N= 5	- Before treatment - After Bacterial inoculation (E.faecalis)	CFU evaluation Culture inoculated with E.faecalis Assessed after 30 days	Paired t test, One way ANOVA	Bacterial reduction in R25 group = 59% Bacterial reduction in R25 +Mtwo = 74% None of the technique gave 100% microbial reduction
2	Felipe Xavier et al	2018	Iran	Invitro	Total = 58 D-Race /Bio Race= n = 23 Reciproc – n = 23 Positive control=n = 6 Negative = n=6	Before gutta-percha removal , After guttapercha removal	CFU evaluation	F test (ANOVA)	Bacterial reduction D-Race – 84.3% Bacterial reduction Reciproc – 72.3%

Table 5. General Information Of Variables Of Interest And Interpretation.

S.No	Author and year	Study type	Study design	Outcome variable	Time of assessment	Statistical test	Intervention	Overall interpretation
1	Fernando SoveralD'aviz et al 2018	In vitro	Sample Size = 50 (Reciproc n = 20, Reciproc R25 + Mtwo n = 25) Negative controls – n =5	Microbial load reduction	Before treatment - After Bacterial inoculation	Paired t test, One way ANOVA	Reciproc n = 20, Reciproc R25 + Mtwo n = 25 20 samples filed with reciproc file system 25 samples filed with reciproc R25 + Mtwo file system	Addition of mtwo file system does not increase the decontamination capability
2	Felipe Xavier et al 2018	In vitro	Sample size = 58 D-Race /Bio Race= n = 23 Reciproc – n = 23 Positive control=n = 6 Negative = n =6	Microbial load reduction	Reciproc = 74 min D- Race = 107.53 min	Success or failure rates were compared using F test (ANOVA) Time duration for the onset of anesthesia was compared using Mann–Whitney U test.	D Race / Bio Race n = 23 Reciproc – n = 23	Both techniques were able to significantly reduce the number of bacteria in the root canal after the removal of gutta-percha

Table 6. Summation Tables For Individual Parameters.

AUTHOR AND YEAR	INTERVENTION	EVALUATION PERIOD	OUTCOME
Fernando SoveralD'aviz et al 2018	(Reciproc n = 20, Reciproc R25 + Mtwo n = 25) Negative controls – n =5	-Before treatment - After Bacterial inoculation (E.faecalis	Bacterial reduction in R25 group = 59% Bacterial reduction in R25 +Mtwo = 74% None of the technique gave 100% microbial reduction
Felipe Xavier et al 2018	D-Race /Bio Race= n = 23 Reciproc – n = 23 Positive control=n = 6 Negative = n =6	Reciproc = 74 min D- Race = 107.53 min	Both techniques were able to significantly reduce the number of bacteria in the root canal after the removal of gutta-percha

Table 7. Evidence Level Of Selected Articles.

AUTHOR	YEAR	STUDY DESIGN	LEVEL OF EVIDENCE
Fernando SoveralD'aviz et al	2018	In vitro	Level 5
Felipe Xavier et al	2018	In vitro	Level 5

Table 8. Risk Of Bias- Major Criteria.

S.No	Author	Year	Randomization	Allocation concealment	Assessor blinding	Risk of bias
1	Fernando SoveralD'aviz et al	2018	Yes	No	Unclear	High
2	Felipe Xavier et al	2018	Yes	No	No	High

40.04 instrument (n = 20). The negative controls consisted of five uncontaminated root canals and the positive control consisted of five contaminated roots that were not subjected to any decontamination procedure. Irrigation was performed using sodium chloride. After instrumentation, samples were collected with paper cones and the rate of bacterial reduction was calculated. Microbiological testing (colony-forming units [CFUs]) was performed to quantify the decontamination obtained by the proposed protocols. Statistical analysis was performed by paired t-test and analysis of variance test.[27]

Table 9. Risk Of Bias- Minor Criteria.

S.No	Author	Year	Sample justified	Baseline comparison	I/E criteria	Method error
1	Fernando Sover-alD'aviz et al	2018	Yes	Yes	Yes	No
2	Felipe Xavier et al	2018	Yes	Yes	Yes	No

Bacterial count reduction rates were 59% for R25 and 74% for R25 + Mtwo 40.04.

This reduction can be considered low. However, sodium chloride was used as an endodontic irrigant the main objective was to evaluate the effectiveness of the technique without the influence of an antimicrobial substance. This fact reaffirms that mechanical preparation alone is not enough to eradicate bacteria and that it is necessary to combine it with the use of an auxiliary chemical substance (either sodium hypochlorite [NaOCl] or chlorhexidine gel) to achieve an effective disinfection protocol. However, further studies should be conducted to evaluate the effectiveness of single files with different auxiliary chemical substances, such as NaOCl, chlorhexidine, and natural substances, such as grape seed extract.

In the study conducted by Felipe Xavier et al Extracted human single-root maxillary incisors with lengths ≥ 20 mm and fully formed apices were selected. Only teeth with this instrument adjusted with resistance to the apical foramen were selected. The total sample consisted of 58 roots. The teeth were numbered and randomly placed in two experimental groups (n=23), and positive (n=6) and negative (n=6) control groups. All procedures were conducted in a laminar flow chamber. In the negative control group, no contamination was induced and the teeth were submerged in sterile BHI until they were filled. A suspension of E.f. (American Type Culture Collection 29212) was prepared and standardised to tube 1 on McFarland scale and injected into the root canal in experimental and positive control groups. The teeth were incubated at 37ºC for 30 days, and the root canal contents were replaced every two days with fresh BHI broth.[28]

The apical third is the most critical portion requiring cleaning in retreatment procedures .The presence of bacteria in this section is directly related to persistent infection . The initial apical diameter of the upper incisor in WL can vary from 0.30 to 0.45 mm .In the present study, the removal of gutta-percha was performed up to 0.50 mm diameter, similar to previous work . Although the final shaping of the root canal was concluded with the same tip size in both groups, it was not possible to standardize the tapers. R50 instrument (50/0.05) is more tapered than BR6 instrument (50/0.04). It was expected that the greater is the cutting of dentin and the apical diameter enlargement, the higher is the reduction in the amount of bacteria .Nevertheless, theresults indicated the opposite. the results showed that the taper showed no influence on the results. Our institution is passionate about high quality evidence based research and has excelled in various fields [29-39].

Implications for Practice: Modern filing systems for the selective management of the retreatment cases are upcoming continuously. These systems have to be verified for the ability to decontaminate the already diseased root canal. The gold standard for these tests are the DNA polymerase based CFU tests to check the reduction in microbial load. The modern systems have a reciprocating type of action which is far more superior than the conventional rotary action in the management of retreatment cases.

Implications for Research: The current studies involved in this systematic review after detailed level of evidence based study revealed that these studies had low quality of evidence. All the studies had one or the other short comings. Evaluation of the microbial load post operatively in endodontic retreatment technique has to be standardized. In teeth undergoing endodontic retreatment, the modern retreatment systems have multitude of variations . Therefore further studies have to be carried out to standardize the assessment of reduction in the microbial load for these studies.

Summary

The aim of this systematic review is to assess the reduction in the microbial load while using the rotary and the reciprocating files in the retreatment cases. An electronic search was carried out on PUBMED Advanced Search, Scopus, Google Search and Hand Search for articles which could be used to evaluate the effectiveness of rotary and reciprocating filing systems for the management of retreatment cases. Article search was narrowed down based on the inclusion and exclusion criteria The search identified 27 publications out of which 24 were excluded after reviewing the title and the abstract and 1 were excluded after reading the full article. A total of 2 publications fulfilled all criteria and were included in this. All the studies included in this review had high risk of bias & hence further studies are warranted. The included studies in this review, indicated the effectiveness of reciprocating filing systems for endodontic retreatment cases.

Conclusion

This review concludes that the studies reviewed here have a high risk of quality bias. However, Reciprocating retreatment filing systems yielded better results compared to conventional retreatment filing systems. The included were not designed properly with respect to randomization sample size calculation, blinding. Hence further clinical trails need to be conducted with proper sample size calculation, blinding and randomization to obtain accurate results.

References

[1]. Torabinejad M, Corr R, Handysides R, Shabahang S. Outcomes of nonsurgical retreatment and endodontic surgery: a systematic review. J Endod. 2009 Jul 1;35(7):930-7.

[2]. Ruddle CJ. Nonsurgical retreatment. J Endod. 2004 Dec 1;30(12):827-45.
[3]. Carr GB, Schwartz RS, Schaudinn C, Gorur A, Costerton JW. Ultrastructural examination of failed molar retreatment with secondary apical periodontitis: an examination of endodontic biofilms in an endodontic retreatment failure. J Endod. 2009 Sep;35(9):1303-9.Pubmed PMID: 19720237.
[4]. Davis JM, Maki J, Bahcall JK. An in vitro comparison of the antimicrobial effects of various endodontic medicaments on Enterococcus faecalis. J Endod. 2007 May 1;33(5):567-9.
[5]. Giuliani V, Cocchetti R, Pagavino G. Efficacy of ProTaper universal retreatment files in removing filling materials during root canal retreatment. J Endod. 2008 Nov 1;34(11):1381-4.
[6]. Merrett SJ, Bryant ST, Dummer PM. Comparison of the shaping ability of RaCe and FlexMaster rotary nickel-titanium systems in simulated canals. J Endod. 2006 Oct;32(10):960-2.Pubmed PMID: 16982273.
[7]. Crozeta BM, Lopes FC, Menezes Silva R, Silva-Sousa YTC, Moretti LF, Sousa-Neto MD. Retreatability of BC Sealer and AH Plus root canal sealers using new supplementary instrumentation protocol during non-surgical endodontic retreatment. Clin Oral Investig. 2021 Mar;25(3):891-899.Pubmed PMID: 32506324.
[8]. Marinho AC, Martinho FC, Gonçalves LM, Rabang HR, Gomes BP. Does the Reciproc file remove root canal bacteria and endotoxins as effectively as multifile rotary systems? IntEndod J. 2015 Jun;48(6):542-8.Pubmed PMID: 25070009.
[9]. Lopes HP, Gambarra-Soares T, Elias CN, Siqueira Jr JF, Inojosa IF, Lopes WS,et al. Comparison of the mechanical properties of rotary instruments made of conventional nickel-titanium wire, M-wire, or nickel-titanium alloy in R-phase. J. Endod. 2013 Apr 1;39(4):516-20.
[10]. Webber J. Shaping canals with confidence: WaveOne GOLD single-file reciprocating system. Roots. 2015;1(3):34-40.
[11]. Romeiro K, de Almeida A, Cassimiro M, Gominho L, Dantas E, Chagas N, et al. Reciproc and Reciproc Blue in the removal of bioceramic and resin-based sealers in retreatment procedures. Clin Oral Investig. 2020 Jan;24(1):405-416.Pubmed PMID: 31104115.
[12]. Govindaraju L, Gurunathan D. Effectiveness of Chewable Tooth Brush in Children-A Prospective Clinical Study. J ClinDiagn Res. 2017 Mar;11(3):ZC31-ZC34.Pubmed PMID: 28511505.
[13]. Christabel A, Anantanarayanan P, Subash P, Soh CL, Ramanathan M, Muthusekhar MR, et al. Comparison of pterygomaxillarydysjunction with tuberosity separation in isolated Le Fort I osteotomies: a prospective, multi-centre, triple-blind, randomized controlled trial. Int J Oral Maxillofac Surg. 2016 Feb;45(2):180-5.Pubmed PMID: 26338075.
[14]. Soh CL, Narayanan V. Quality of life assessment in patients with dentofacial deformity undergoing orthognathic surgery--a systematic review. Int J Oral Maxillofac Surg. 2013 Aug;42(8):974-80.Pubmed PMID: 23702370.
[15]. Mehta M, Deeksha, Tewari D, Gupta G, Awasthi R, Singh H, et al. Oligonucleotide therapy: An emerging focus area for drug delivery in chronic inflammatory respiratory diseases. ChemBiol Interact. 2019 Aug 1;308:206-215.Pubmed PMID: 31136735.
[16]. Ezhilarasan D, Apoorva VS, Ashok Vardhan N. Syzygiumcumini extract induced reactive oxygen species-mediated apoptosis in human oral squamous carcinoma cells. J Oral Pathol Med. 2019 Feb;48(2):115-121.Pubmed PMID: 30451321.
[17]. Campeau PM, Kasperaviciute D, Lu JT, Burrage LC, Kim C, Hori M, et al. The genetic basis of DOORS syndrome: an exome-sequencing study. Lancet Neurol. 2014 Jan;13(1):44-58.Pubmed PMID: 24291220.
[18]. Sneha S. Knowledge and awareness regarding antibiotic prophylaxis for infective endocarditis among undergraduate dental students. Asian J Pharm Clin Res. 2016 Oct 1:154-9.
[19]. Christabel SL, Linda Christabel S. Prevalence of type of frenal attachment and morphology of frenum in children, Chennai, Tamil Nadu. World J Dent. 2015 Oct;6(4):203-7.
[20]. Kumar S, Rahman R. Knowledge, awareness, and practices regarding biomedical waste management among undergraduate dental students. Asian J Pharm Clin Res. 2017;10(8):341.
[21]. Sridharan G, Ramani P, Patankar S. Serum metabolomics in oral leukoplakia and oral squamous cell carcinoma. J. Cancer Res. Ther. 2017 Jul 1;13(3):556-61.
[22]. Ramesh A, Varghese SS, Doraiswamy JN, Malaiappan S. Herbs as an antioxidant arsenal for periodontal diseases. J IntercultEthnopharmacol. 2016 Jan 27;5(1):92-6.Pubmed PMID: 27069730.
[23]. Thamaraiselvan M, Elavarasu S, Thangakumaran S, Gadagi JS, Arthie T. Comparative clinical evaluation of coronally advanced flap with or without platelet rich fibrin membrane in the treatment of isolated gingival recession. J Indian SocPeriodontol. 2015 Jan;19(1):66-71.
[24]. Thangaraj SV, Shyamsundar V, Krishnamurthy A, Ramani P, Ganesan K, Muthuswami M, et al. Molecular Portrait of Oral Tongue Squamous Cell Carcinoma Shown by Integrative Meta-Analysis of Expression Profiles with Validations. PLoS One. 2016 Jun 9;11(6):e0156582.Pubmed PMID: 27280700.
[25]. Ponnulakshmi R, Shyamaladevi B, Vijayalakshmi P, Selvaraj J. In silico and in vivo analysis to identify the antidiabetic activity of beta sitosterol in adipose tissue of high fat diet and sucrose induced type-2 diabetic experimental rats. ToxicolMech Methods. 2019 May;29(4):276-290.Pubmed PMID: 30461321
[26]. Ramakrishnan M, Shukri M. Fluoride, Fluoridated Toothpaste Efficacy And Its Safety In Children-Review. Int J Pharm Res. 2018 Oct 1;10(04):109-14.
[27]. D'aviz FS, Farina AP, Souza MA, Cecchin D. Does adding an instrument after root preparation with Reciproc® R25 increase bacterial reduction? J Conserv Dent. 2018 May-Jun;21(3):269-273.Pubmed PMID: 29899628.
[28]. Nevares G, Romeiro K, Albuquerque D, Xavier F, Fogel H, Freire L, et al. Evaluation of apically extruded debris during root canal retreatment using ProTaper Next and Reciproc in severely curved canals. Iran Endod J. 2017;12(3):323-8.
[29]. VijayashreePriyadharsini J. In silico validation of the non-antibiotic drugs acetaminophen and ibuprofen as antibacterial agents against red complex pathogens. J Periodontol. 2019 Dec;90(12):1441-1448.Pubmed PMID: 31257588.
[30]. Pc J, Marimuthu T, Devadoss P, Kumar SM. Prevalence and measurement of anterior loop of the mandibular canal using CBCT: A cross sectional study. Clin Implant Dent Relat Res. 2018 Apr 6;20(4):531-4.
[31]. Ramesh A, Varghese S, Jayakumar ND, Malaiappan S. Comparative estimation of sulfiredoxin levels between chronic periodontitis and healthy patients - A case-control study. J Periodontol. 2018 Oct;89(10):1241-1248.Pubmed PMID: 30044495.
[32]. Ramadurai N, Gurunathan D, Samuel AV, Subramanian E, Rodrigues SJ. Effectiveness of 2% Articaine as an anesthetic agent in children: randomized controlled trial. Clin. Oral Investig. 2019 Sep;23(9):3543-50.
[33]. Sridharan G, Ramani P, Patankar S, Vijayaraghavan R. Evaluation of salivary metabolomics in oral leukoplakia and oral squamous cell carcinoma. J Oral Pathol Med. 2019 Apr;48(4):299-306.
[34]. Ezhilarasan D, Apoorva VS, Ashok Vardhan N. Syzygiumcumini extract induced reactive oxygen species-mediated apoptosis in human oral squamous carcinoma cells. J Oral Pathol Med. 2019 Feb;48(2):115-121.Pubmed PMID: 30451321.
[35]. Mathew MG, Samuel SR, Soni AJ, Roopa KB. Evaluation of adhesion of Streptococcus mutans, plaque accumulation on zirconia and stainless steel crowns, and surrounding gingival inflammation in primary molars: randomized controlled trial. Clin Oral Investig. 2020 Sep;24(9):1-6.Pubmed PMID: 31955271.
[36]. Samuel SR. Can 5-year-olds sensibly self-report the impact of developmental enamel defects on their quality of life? Int J Paediatr Dent. 2021 Mar;31(2):285-286.Pubmed PMID: 32416620.
[37]. R H, Ramani P, Ramanathan A, R JM, S G, Ramasubramanian A, et al. CYP2 C9 polymorphism among patients with oral squamous cell carcinoma and its role in altering the metabolism of benzo[a]pyrene. Oral Surg Oral Med Oral Pathol Oral Radiol. 2020 Sep;130(3):306-312.Pubmed PMID: 32773350.
[38]. Chandrasekar R, Chandrasekhar S, Sundari KKS, Ravi P. Development and validation of a formula for objective assessment of cervical vertebral bone age. ProgOrthod. 2020 Oct 12;21(1):38.Pubmed PMID: 33043408.
[39]. VijayashreePriyadharsini J, SmilineGirija AS, Paramasivam A. In silico analysis of virulence genes in an emerging dental pathogen A. baumannii and related species. Arch Oral Biol. 2018 Oct;94:93-98.Pubmed PMID: 30015217.