Systematic Review

Endodontic retreatment efficacy with and without solvents: A systematic review

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Abstract

Introduction: This systematic review investigates the crucial need for solvent use in root canal retreatment, as it effectively removes filling materials, reduces apical debris extrusion, and alleviates postoperative pain, ultimately enhancing treatment success. The review aims to assess the success rates, compare outcomes, explore benefits and drawbacks, and identify subgroups where solvent use may be more effective during root canal retreatment.

Materials and Methods: The search was performed in PubMed Central, Scopus, Cochrane, LILAC, ScienceDirect, Google Search, Web of Science, and manually using the search items alone and in combination by means of PUBMED search builder. The studies were assessed for eligibility according to the eligibility criteria by two independent reviewers. Groups containing solvent with nonsolvent groups and randomized control trials were included and *in vitro* studies, retrospective studies, and animal studies were excluded from the study. Quality assessment was performed using the risk of bias (RoB) 2.0 tool.

Results: Out of the 596 articles obtained, 14 were shortlisted for full-text reading and finally two articles were included in the study. The studies were assessed for quality, and data were extracted in a tabulated form. Overall RoB is low, but due to the lack of homogeneity, meta-analysis could not be conducted.

Conclusion: The use of solvent does not cause any significant difference in the postoperative pain levels or analgesic intake for retrieval of gutta-percha in cases of root canal retreatment. Due to the limited number of studies available and the lack of clinician-related outcomes such as time taken to retrieve the gutta-percha, these results should be taken into consideration with caution.

Keywords: Gutta-percha; pain; retreatment; root canal treatment; solvent

INTRODUCTION

Endodontic failure is the inability of primary endodontics (PE) to successfully cure and maintain the root canal system, resulting in chronic or recurring symptoms or illness. Endodontic failure may be split into two categories: technical and biological considerations. Technical problems include difficulties relating to the quality of the original root canal treatment, such as poor filling, insufficient removal of diseased pulp tissue or dentin debris, and anomaly of shape of the root canal system. Biological causes, on the other hand, include persistent or recurring disease caused by bacterial survival or the existence of untreated canals.[1] Inadequate cleaning in endodontic therapy results in the persistence of bacteria in the root canal system, which can lead to recurrent infection, and eventually, treatment failure.[2-5]

Gutta-percha removal is critical in the management of failed endodontic treatment. Gutta-percha removal from the root canal can be accomplished through mechanical, thermal,

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chemical, or ultrasonic procedures.[6,7] Each method has various advantages and disadvantages that must be carefully considered depending on the criteria such as root canal anatomy, the quality of prior filling materials used during initial treatment, and clinician skill.

The use of solvents in endodontic retreatment has been offered as a viable approach to increase the cleaning efficacy and success rate of retreatment operations by easing the removal of remaining filling and debris from the root canal. Several studies have been conducted to compare the effectiveness of endodontic retreatment with and without solvents.[8,9]

These research findings imply that using solvents in endodontic retreatment might increase cleaning efficacy and success rate by boosting gutta-percha clearance.

The review aimed to answer questions such as: (1) what is the overall success rate of root canal retreatment with and without solvent use? (2) does the use of solvents during root canal retreatment result in better outcomes compared to retreatment without solvents? (3) what are the potential benefits and drawbacks of using solvents during root canal retreatment? and (4) are there any subgroups of patients or specific clinical scenarios where one approach may be more effective than the other?

By methodically examining and analyzing the available literature on this issue, the review would give significant insights into the efficacy of root canal retreatment with and without solvent usage, as well as identify any gaps in current knowledge that may merit additional investigation.

Structured question

Does using solvents during root canal retreatment improve efficacy compared to not using solvents, based on randomized controlled trials?

PICOS analysis:

- Population – Endodontically failed teeth/teeth requiring root canal retreatment
- Intervention – Retreatment performed with the use of solvent
- Comparison – Retreatment performed without the use of solvent
- Outcome – Retreatment efficacy (postoperative pain and analgesic intake)
- Study design – Randomized control trials.

MATERIALS AND METHODS

The Preferred Reporting Items for Systematic Reviews and Meta-analyses was used as a guide to conduct our systematic review. Before the start of the review, the methodology was developed based on the counsel of the Cochrane Handbook for Systematic Reviews of Interventions. The systematic review has been meticulously registered in PROSPERO, bearing the official registration identifier CRD42023450519, demonstrating our commitment to transparency and adherence to established research protocols.

Electronic Databases and Hand Search were done (PubMed Central, Scopus, Cochrane, LILAC, ScienceDirect, Google Search, and Web of Science) up to February 2023, using "Medical Subject Heading" (MeSH) terms and keywords for solvent and endodontic retreatment alone and in combination of the PICOs analysis using the PUBMED search builder.

This systematic review included articles describing randomized control trials (RCTs), clinical trials, and prospective clinical trials, but excluded *in vitro* studies, narrative, systematic reviews, animal studies, and studies published which were not in English. Two independent reviewers appraised the research eligibility based on the inclusion criteria.

Screening and selection

Two reviewers independently screened the gathered papers, and their level of agreement in terms of making decisions was assessed using the Cohen's kappa coefficient with a value of 0.81, demonstrating improved agreement between the two reviews. After gathering all the information from the computer search, a screening was conducted, and articles that did not fit our inclusion and exclusion criteria as outlined in the four phases below were deleted [Figure 1]. Step 1 involved eliminating publications and citations that were not relevant. One reviewer completed Stage 2 by reading the titles and abstracts of all the acquired studies and selecting only those that were pertinent. Every study that lacked statistics and facts was instantly disqualified from our examination. The complete article was received and cross-checked with the second examiner for its consideration in the event that there was any remaining uncertainty.

To determine if the articles that were first reviewed in Stage 1 indeed contained information relevant to our review, both examiners double-checked them in Stage 3. Care was taken to eliminate any unfinished or publications with scant data during this phase. The uncited articles were also eliminated. The publications gathered in Stage 3 were carefully examined, and Stage 4 focused on the research that matched our PICOS data.

Data extraction

The required data for our review were obtained from the final articles by the first reviewer, which was then reevaluated by the second reviewer. They were tabulated, and the data were collected according to the headings (author, year of publication, place of study, study

design, age, total sample size, intervention group, control group, type of outcome, method of outcome assessment, postoperative pain values, solvent status, and author conclusions) as characteristics table and summation table [Tables 1 and 2].

Risk of bias assessment

Risk of bias (RoB) was assessed using the RoB 2.0 tool.[10] Two writers analyzed the RoB factors for each included study. The RoB was assessed using the following parameters: random sequence generation; single-operator protocol implementation; the presence of a control group; blinding of the testing machine operator; standardization of the sample preparation; failure mode evaluation; use of materials according to manufacturer's instructions; and clarification of the sample size calculation. The

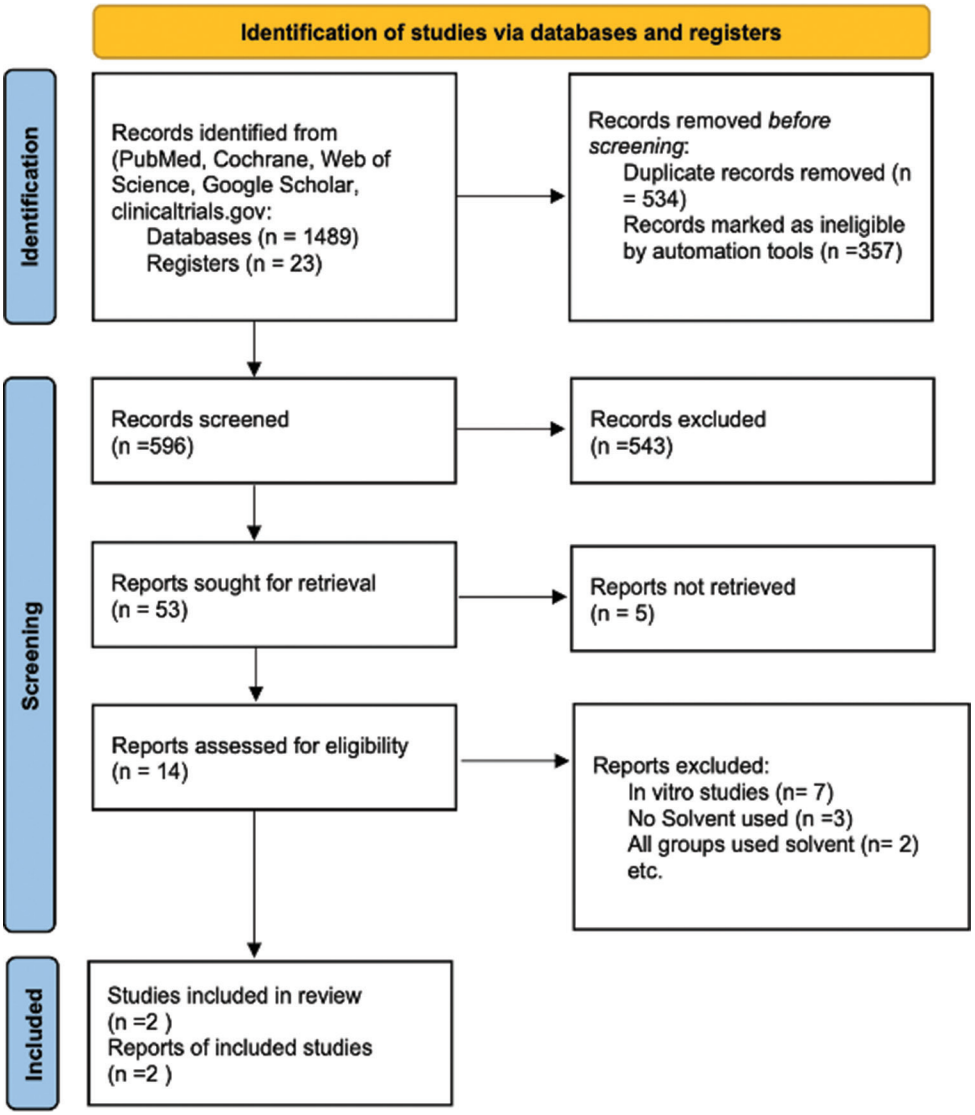

Figure 1: PRISMA flowchart of the search strategy

Table 1: Data extraction table

Author/year	Location	Study design	Total sample size	Age (years)	Inclusion	Visits	Intervention	Control	Type of outcome
Genc sen ozgur 2019[11]	Turkey	RCT	90 patients	18–59	Asymptomatic teeth with PAI score 4 and previous PE at least 4 year old	Single visit	ProTaper with solvent (*n*=45)	ProTaper without solvent (*n*=45)	Postoperative pain (24, 48, 72 h) NRS values Analgesic intake
Sirijindamai 2023[12]	Thailand	RCT	60 patients	>18	Previously treated PE, 1–3 mm short of apex	Multiple visit	Solvent group (*n*=30)	Nonsolvent group (*n*=30)	Postoperative pain (0, 6, 12, 24, 48, 72 h) Reduced to "pain" and "no pain" Analgesic intake

RCT: Randomized controlled trail

study obtained a "YES" if the investigated parameter was reported by the author. If the information was missing, the parameter received a "NO". Each study's RoB was assessed based on the aggregate of "YES" responses: 1–3 equated to a high RoB, 4–6 to a medium RoB, and 7–8 to a low RoB.

RESULTS

Search and selection

From the electronic databases and manual search, a total of 596 articles were obtained. Fourteen studies were shortlisted for full-text screening, and finally, two randomized controlled trials[11,12] were identified to undergo quantitative analysis.

Twelve articles were excluded due to the following reasons: *in vitro* study, no solvent group present, and nonsolvent group is unavailable.

Variable of interest

Postoperative pain-11 levels numeric rating scale (NRS) is a segmented numeric variant of the visual analog scale (VAS) that consists of numbers 0–10 on a horizontal line. The respondent chooses a number that best indicates the level of discomfort he is experiencing. The number "0" denotes "no pain, whereas the number "10" denotes the most agonizing pain imaginable.

Risk of bias assessment

The authors of the review evaluated the RoB for each included study and offered a summary of the RoB percentages across all studies. In addition, Figure 2 depicts the RoB of each individual research, providing a visual depiction of the summary. Both investigations revealed a minimal probability of bias in all categories.

Due to the small number of included studies and the variability of research design, sample sizes, and outcomes evaluated, meta-analysis was not possible. The absence of standardized techniques and limited sample numbers hampered the capacity to conduct a thorough meta-analysis.

DISCUSSION

The VAS and NRS are widely employed methods to assess pain intensity. Many research studies have favored the VAS due to its ease of use and its high sensitivity, validity, and reliability.[13] However, the VAS has some drawbacks, particularly in certain patient populations such as children and the elderly, who may find it challenging to respond to the scale.[13,14] In contrast, both studies included in this research opted for the NRS because of its simplicity and convenience, utilizing both verbal and written formats.

Table 2: Summation of included studies

Author/year	Intervention	Control	Type of outcome	Postoperative pain				Author conclusions
				24 h NS	24 h S	48 h NS	48 h S	
Genc sen ozgur 2019[11]	ProTaper with solvent Eucalyptol	ProTaper without solvent	Postoperative pain 24, 48, 72 NRS values Analgesic intake	2.33±3.22	1.44±2.14	2.05±3.27	1.22±2.57	The overall prevalence of flare-ups in this study was 12.5%. In terms of flare-up rates, the nonsolvent (13.5%) and solvent (11.1%) groups were statistically similar
Sirijindamai 2023[12]	Solvent group GuttaClear	Nonsolvent group	Postoperative pain (0, 6, 12, 24, 48, and 72) Reduced to "pain" and "no pain" -analgesic intake	16.67%	13.33%	16.67%	6.67%	Fewer patients in the solvent group had postoperative pain compared with the nonsolvent group, corresponding to Genc Sen *et al*.

NRS: Numeric rating scale

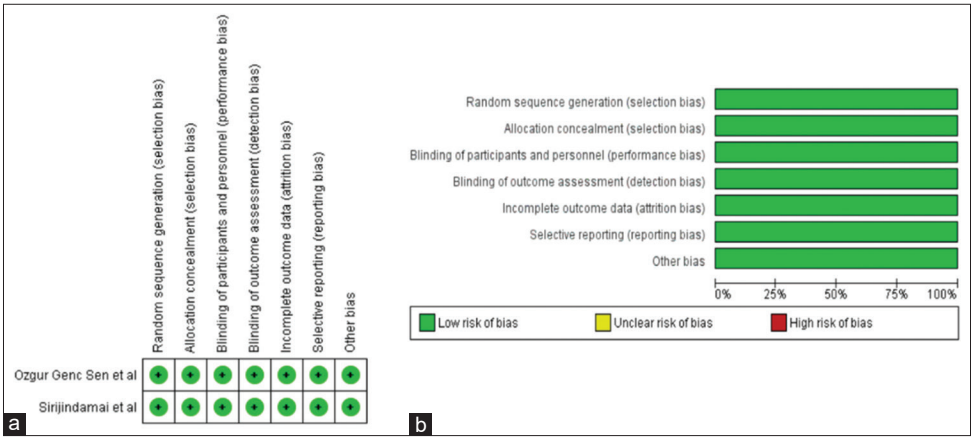

Figure 2: (a) Risk of bias of included studies using the Cochrane risk of bias tool. (b) Risk of bias graph

In accordance with the findings of Genc Sen *et al*.,[11] a lower number of patients in the solvent group reported postoperative pain when compared to the nonsolvent group. This observed reduction in pain among the solvent group may be attributed to the use of an endodontic solvent for the removal of root canal filling materials, which has been demonstrated in *in vitro* studies to decrease the amount of debris extruded apically.[15-17] In addition, retreatment in the group that used solvent might require less time compared to the group that did not use solvent, resulting in reduced discomfort due to shorter treatment duration.[18] However, it is worth noting that, despite these observations, the difference in postoperative pain between both the groups was not statistically significant in both studies.

Indeed, an important distinction between the *in vitro* studies and the clinical studies included for review is the length of the root canal filling in relation to the apical foramen. The root canals in the *in vitro* experiments were obturated 1 mm short of the apical foramen, but the root canal in the clinical trials was 2–4 mm short of the root apex. The substantial distance between the root canal filling and the root apex may have impacted the amount of material extruded into the periapical tissues.

Sirijindamai D *et al*.[12] conducted a unique study that stands out as the only one to include immediate postoperative pain assessment alongside five other time points. In contrast, Topçuoğlu and Topçuoğlu[19] reported that the highest pain levels at all time points occurred 6 h after treatment, which differs from the present study's findings indicating the highest pain immediately after the procedure. The difference in pain reporting between the studies might be attributed to the fact that the authors of the previous study used local anesthesia, whereas the present study performed the treatment without it, enabling data collection immediately after the procedure. As a result, this study becomes the first to report on pain levels at the immediate postoperative time point, revealing higher pain compared to 6 h after treatment. However, pain incidence significantly decreased from the 0 h (immediate postoperative) to 24 h later, likely due to the resolution of acute inflammation. In addition, discomfort caused by extended chair time, and the use of a rubber dam clamp may contribute to pain occurrence.[18]

Regarding postoperative analgesic use, Genc Sen *et al*.[11] reported higher analgesic consumption compared to Sirijindamai D *et al*.[12] This discrepancy could be attributed to the treatment protocols used in the respective studies. Genc Sen *et al*.[11] employed a single-visit retreatment approach, whereas Sirijindamai D *et al*.[12] followed a multi-visit approach. The difference in analgesic use might be related to the presence of intracanal medication during the multiple-visit treatment, which helps in eradicating postoperative pain resulting from persistent intracanal microorganisms.[20] The intracanal medication likely contributes to reduced pain levels, making patients less reliant on postoperative analgesics in the multivisit approach.

Genc Sen *et al*.[11] utilized Gutta-Solv, a 100% organic eucalyptol-based solvent, known for its effective gutta-percha dissolving properties. Previous studies by Pécora *et al*.[21] and Chutich *et al*.[22] have highlighted its balance between efficiency and low toxicity, making it a commonly used solvent without harmful effects. In contrast, Sirijindamai D *et al*.[12] employed a different composition for gutta-percha removal called GuttaClear, which consists of essential oils and d-limonene. This new natural solvent was found to dissolve the filling material more effectively compared to the eucalyptol-based solvent. Studies conducted by Jantarat *et al*.,[23] Oyama *et al*.,[9] and Uemura *et al*.[24] have supported the superior dissolving properties of GuttaClear over eucalyptol-based solvents.

Despite the high level of evidence in both trials, many issues raise questions regarding the quality of accessible data and the capacity to make well-informed judgments. One important concern in both research is the small sample size, which may restrict the findings' generalizability. Furthermore, the lack of detailed and standardized methodologies in these studies contributes to the results' ambiguity.

Furthermore, the solvent evaluation was confined to a few possibilities, despite the fact that a large range of solvents are accessible in clinical practice. Given the possible differences in efficacy and safety across different solvents, a larger range of solvents for investigation would give more in-depth information.

To increase the quality of future research, it is critical to incorporate a greater number of clinically relevant and clinician-oriented outcomes. Measuring the time required for retreatment, for example, and conducting radiographic assessments of remaining root canal filling materials are critical in establishing the efficiency and efficacy of the retreatment. These extra metrics would increase the study's applicability and significance in real-world therapeutic settings.

CONCLUSION

Finally, pain evaluation is critical in endodontic retreatment. The VAS and NRS are routinely used to assess pain severity, with the VAS being preferred for its simplicity of use. Gutta-Solv and GuttaClear solvents have a minor impact on postoperative pain levels. Immediate pain evaluation might indicate higher degrees of discomfort. More studies

on a larger spectrum of solvents, as well as standardized techniques, are required. Time taken and radiographic examinations can be used to improve treatment efficiency. Larger sample numbers and clinically meaningful outcomes will boost future research for informed endodontic retreatment decision-making.

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Conflicts of interest

There are no conflicts of interest.

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