INPLASY PROTOCOL

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None declared.

Efficacy of sonic activation techniques on tubular dentin sealer penetration: A systematic review and meta-analysis

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Review question / Objective: **Is sonic activation techniques more effective than conventional needle irrigation for the tubular dentin sealer penetration. The included study was a randomized controlled trial.**
Eligibility criteria: **A comprehensive search was conducted for all published studies evaluating efficacy of percentage and maximum depth of sealer penetration, following the use of SI and standardized irrigants (NaOCl and EDTA). Because this can hardly be measured clinically, only confocal laser scanning microscopy (CLSM) studies were selected owing to wide use of this methodology for evaluating tubular dentin sealer penetration. The studies using previously filled roots or animal teeth, artificial debris, and plastic blocks, and studies measuring the penetration of tubular dentin sealers in lateral root canals, isthmus, or artificial grooves were excluded to maintain the standardized sample selecting and measuring (Virdee et al. 2018). The search was limited to articles published between January 2000 and June 2022 to ensure conclusions were drawn from contemporary data. There are no language restrictions on filtering articles to ensure the integrity of included data.**

INPLASY registration number: This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 28 July 2022 and was last updated on 28 July 2022 (registration number INPLASY202270116).

INTRODUCTION

Review question / Objective: **Is sonic activation techniques more effective than conventional needle irrigation for the tubular dentin sealer penetration. The included study was a randomized controlled trial.**

Rationale: **The three-dimensional filling of root canals after cleaning and shaping procedures is very important for the**

success of root canal therapy (Kirici et al. 2019, Gok T et al. 2017). The penetration of sealers into dentinal tubules can improve the effect of root canal filling to eliminate infection (Keskin et al. 2021, Washio et al. 2019). Sealing dentinal tubules with sealers can prevent bacteria from entering the root canal and prevent reinfection (Baras et al. 2019). Moreover, due to the effect of mechanical retention, the deeper the penetration of sealers, the longer the storage time of filling material will have (Elbahary et al. 2020). However, mechanical instrumentation of root canal therapy can produce residual smear layer which can adhere to the surface of dentin tubules and prevent sealers from entering the dentin tubules (Vadachkoria et al. 2019). Therefore, a lots of irrigation techniques have been invented to remove the smear layer and improve the penetration of sealers into dentinal tubules (Haupt et al. 2020).

Conventional needle irrigation (CNI) is the most common and convenient irrigation strategy performed in the clinical practice during the root canal therapy (Dioguardi et al. 2018). However, the irrigation efficiency of CNI can not perfectly meet the clinical demands. For the reason that during the root canal filling process, irrigants in the apical third of root cancal can not be delivered well by CNI where the air bubble can be entrapped to produce a vapor lock effect (Cheung et al. 2021). Therefore, clinicians invented sonic activation (SI) techniques with the aim of overcoming the shortcomings of CNI (Ramamoorthi et al. 2015).

Although there are a large number of reports comparing the efficiency of SI and CNI in increasing the penetration of sealers into dentine tubules, outcomes are often conflicting (Rödig et al. 2021, Aksel et al. 2017, Bolles et al. 2013). In addition, at the time this review was carried out there had been no previous systematic reviews to address the problem whether SI would produce more favorable results than CNI.

Condition being studied: When teeth with pulpitis and other diseases need root canal treatment, the tubular dentin sealer penetration is very important for the anti infection of root canal treatment, which can increase its success rate.

METHODS

Search strategy: In June 2022, five electronic databases related to published research in endodontics were searched. These included PubMed, EMBASE, Cochrane Library, Web of Science and Google Scholar. In addition, the reference list of all included studies , and the 2022 edition of the Journal of Endodontics, International Endodontic Journal and the Australian Endodontic Journal manual were searched manually. For the each database search strategy, firstly, a focused question and search strategy was developed using the PICO method with subject headings of 'root canal','sonic irrigation', 'conventional needle irrigation' and 'tubular dentin sealer penetration'. After that, using the author's knowledge, existing literature and index database to identify and expand upon these heading through synonyms, key words and index words. Finally, a search strategy, accounting for both sensitivity and specificity, was developed using truncations and boolean operators ('OR', 'AND') and adapted for each database.

Participant or population: The extrated teeth of human is object of this study, and studies using previously filled roots or animal teeth, artificial debris, and plastic blocks, and studies measuring the penetration of tubular dentin sealers in lateral root canals, isthmus, or artificial grooves were excluded to maintain the standardized sample selecting and measuring (Virdee et al. 2018).

Intervention: Sonic activation (SI) techniques is the irrigation strategy performed in the clinical practice during the root canal therapy , and SI was invented with the aim of overcoming the shortcomings of CNI (Ramamoorthi et al. 2015).

Comparator: sonic activation (SI) techniques is the irrigation strategy performed in the clinical practice during the root canal therapy , and SI was invented with the aim of overcoming the shortcomings of CNI (Ramamoorthi et al. 2015).

Study designs to be included: Randomized controlled trial.

Eligibility criteria: A comprehensive search was conducted for all published studies evaluating efficacy of percentage and maximum depth of sealer penetration, following the use of SI and standardized irrigants (NaOCl and EDTA). Because this can hardly be measured clinically, only confocal laser scanning microscopy (CLSM) studies were selected owing to wide use of this methodology for evaluating tubular dentin sealer penetration. The studies using previously filled roots or animal teeth, artificial debris, and plastic blocks, and studies measuring the penetration of tubular dentin sealers in lateral root canals, isthmus, or artificial grooves were excluded to maintain the standardized sample selecting and measuring (Virdee et al. 2018). The search was limited to articles published between January 2000 and June 2022 to ensure conclusions were drawn from contemporary data. There are no language restrictions on filtering articles to ensure the integrity of included data.

Information sources: In June 2022, five electronic databases related to published research in endodontics were searched. These included PubMed, EMBASE, Cochrane Library, Web of Science and Google Scholar. In addition, the reference list of all included studies , and the 2022 edition of the Journal of Endodontics, International Endodontic Journal and the Australian Endodontic Journal manual were searched manually.

Main outcome(s): Extracted data included information on the study setting and sample studied, sample size of CNI and SI, how the canal system was closed, irrigant concentration, instrumentation system, surgical diameter, type of sealer, CLSM magnification, outcomes for percentage and maximum depth of sealer penetration in the coronal, middle and apical thirds of canals.percentage and maximum depth of sealer penetration.

Additional outcome(s): None.

Data management: A narrative synthesis was conducted on all studies that met the inclusion criteria whilst a meta-analysis was limited to those where outcomes were quantitatively presented as means and standard deviations, or in a form allowing for manual calculation (i.e. frequency tables) via Excel 2010 (Microsoft Corporation, Washington, USA) . The studies reporting the outcomes as median and one or both of (i) the minimum and maximum values and (ii) the first and third quartiles but do not report the mean or standard deviation will be used the method by McGrath et al. (2020) to estimate the sample mean and standard deviation from the reported summary data. If this was not possible, then raw data were requested from principle authors. The raw data presented in the form of graphs and not provided by the authors of the included studies were obtained using the ImageJ 1.38e software (Wayne Rasband, National Institutes of Health, USA). For each canal segment, an overall meta-analysis, that included all studies, was performed for SI with respect to CNI. As the values of mean and standard deviation of percentage (%) and maximum depth (μm) of sealer penetration in the included studies have the same measurement units, weighted mean difference (WMD) were calculated to allow direct comparisons between studies. Results were presented in forest plots where the middle of the diamond represented the WMD point estimate and the edges of the diamond indicated the 95% confidence interval (95% CI). The point estimate and 95% CI for individual studies are displayed as a central symbol and a horizontal line, respectively, alongside percentage weighting (% W). Homogeneity was established using I2 scores and chi-squared analyses. Random-

effects models were used for the meta-analysis. All calculations were carried out through Review Manager 5.4.

Quality assessment / Risk of bias analysis: The quality of individual studies was scored independently based on the standardized Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Experimental Studies. This critical appraisal tool was adapted for evaluating CLSM experimental studies, as per Felipe et al. (2021). It consists of thirteen questions requiring a yes/no/unclear response . The following questions were used for the assessment: Q.1)Was the sample size calculated?; Q.2) Was randomization used when assigning samples to SI and CNI groups?; Q.3) Was adopted the blind to allocate the SI and CNI groups?; Q.4) Were SI and CNI groups similar at baseline?; Q.5) Were the experimental operations of SI and CNI groups completed by the same person?; Q.6) Were those performing CNI and SI on tooth samples blind to the groups design?; Q.7) Were SI and CNI treated identically other except the intervention of variables?; Q.8) Were outcomes of percentage and maximum depth of sealer penetration assessed by the same evaluator?; Q.9) Were outcome evaluator blind to groups design?; Q.10)Were outcomes of percentage and maximum depth of sealer penetration measured in the same manner for SI and CNI?; Q.11) Was appropriate statistical analysis used?; Q.12) Were results of all tooth samples reported? If not, were the losses fully described and analysed?; and Q.13) Was the study design appropriate and apparently free of other biases? An 'unclear' judgement was considered when insuffificient details were reported to answer the question properly. The risk of bias for a study was classifified as 'high' when up to five of the answers were 'yes', 'moderate' when six to eight of the answers were 'yes' and 'low' when greater than eight of the answers were 'yes'.

Strategy of data synthesis: A narrative synthesis was conducted on all studies that met the inclusion criteria whilst a meta-analysis was limited to those where outcomes were quantitatively presented as means and standard deviations, or in a form allowing for manual calculation (i.e. frequency tables) via Excel 2010 (Microsoft Corporation, Washington, USA) . The studies reporting the outcomes as median and one or both of (i) the minimum and maximum values and (ii) the first and third quartiles but do not report the mean or standard deviation will be used the method by McGrath et al. (2020) to estimate the sample mean and standard deviation from the reported summary data. If this was not possible, then raw data were requested from principle authors. The raw data presented in the form of graphs and not provided by the authors of the included studies were obtained using the ImageJ 1.38e software (Wayne Rasband, National Institutes of Health, USA). For each canal segment, an overall meta-analysis, that included all studies, was performed for SI with respect to CNI. As the values of mean and standard deviation of percentage (%) and maximum depth (μm) of sealer penetration in the included studies have the same measurement units, weighted mean difference (WMD) were calculated to allow direct comparisons between studies. Results were presented in forest plots where the middle of the diamond represented the WMD point estimate and the edges of the diamond indicated the 95% confidence interval (95% CI). The point estimate and 95% CI for individual studies are displayed as a central symbol and a horizontal line, respectively, alongside percentage weighting (% W). Homogeneity was established using I2 scores and chi-squared analyses. Random-effects models were used for the meta-analysis. All calculations were carried out through Review Manager 5.4.

Subgroup analysis: None.

Sensitivity analysis: A sensitivity analysis was performed by omitting each study from the meta-analysis.

Language restriction: There are no language restrictions on filtering articles to ensure the integrity of included data.

Country(ies) involved: China.

Other relevant information: None.

Keywords: sonic activation techniques, root canal therapy, irrigation, sealer penetration, systematic review.

Contributions of each author:

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