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Comparative evaluation of pain in patent and non-patent root canals of patients undergoing endodontic treatment- A systematic review & meta-analysis

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ABSTRACT

Aim: To evaluate and compare the pain after patent root canal and non-patent root canal in patients undergoing endodontic treatment.

Methods: We registered this systematic review and meta-analysis to prospero and based on the protocol data search was conducted on four electronic data bases. The eligibility criteria was decided for the study selection. Data extraction was carried out by two reviewers and the study characteristics were recorded in tables. The data was extracted under specific titles and outcome of interest. A total of 09 studies over the past one decade met the inclusion criteria for full text reading and all 09 were included for further analysis. All the statistical analyses were performed using the statistical software Review Manager version 5.3 (The Nordic Cochrane Centre, Copenhagen, Denmark)

Results: Theoutcome which we assessed was the pain of the tooth after the placement of intervention. When the pain score of was assessed in 02 studies after the injection, the pooled odds ratio was 0.66 (CI: -0.12, 0.39).The mean pain score was assessed by comparing patent canals vs non-patent canals, the heterogeneity was significant I2=50%, hence we applied the fixed effects model. In 07 studies, the cumulative mean difference was 0.01(-0.01,0.03),

Conclusion: In conclusion, we believe that maintaining AP does not increase postoperative pain and may improve it.

Keywords: endodontics, review, root canal, patency, irrigation

INTRODUCTION

Post-operative pain is a frequent complication associated with root canal treatment with a reported incidence ranging between 3–58%.[1] During root canal instrumentation, dentinal and pulpal debris can block access to the apical third, increasing the possibility of transportation or perforation which may lead to post preparation pain .[2-4] Canal patency is performed by pushing small highly flexible files passively through apical constriction without widening it. Considering the rich collateral circulation and healing potential of the attachment apparatus, establishing and maintaining patency are non-harmful biological events.[5] In teeth with necrotic pulp and apical periodontitis, bacterial biofilms may be present not only within the apical part of the root canal system but also within the apical lesion itself.[6-8] In such cases, maintaining patency in the apical region may help remove the bacterial biofilms that are present around the apical foramen.[9]

Maintaining apical patency prevents accumulation of debris in the apical third with the decreased possibility of procedural accidents, like ledges and perforations; which in turn improves the outcome of endodontic treatment.[10,11] In addition, helping to maintain the working length throughout the procedure, it improves tactile sensation, and facilitates irrigation in the apical third of the root canal system.[12,13] Vera et al[14] indicated maintaining AP improves the delivery of irrigants into the apical third. Siqueira[15] reported AP may help remove bacteria present around the apical foramen in teeth with necrotic pulp. Buchanan[16] published that maintaining AP minimizes the risk of loss of the WL. On the other hand, Siqueira[17] suggested that apical extrusion of infected debris, resulting from mechanical instrumentation, is a reason for postoperative pain. It has also been found that the continuous passing of small patency files through the apex can lead to an acute apical inflammatory response. Based on the results of previous research, the debates for maintaining or avoiding AP seem equivocal.

Therefore, the purpose of this systematic review and meta-analysis was to investigate whether currently available evidence supports a relationship between foraminal enlargement during endodontic treatment and postoperative symptoms. The clinical question was structured according to Population, Intervention, Comparator, Outcome, Study (PICOS) design, and the question to be answered was framed as follows: To evaluate and compare the pain after patent root canal and non-patent root canal in patients undergoing endodontic treatment.

MATERIALSANDMETHODOLOGY

Protocol and registration:

The research protocol is designed according to the PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analyses) guidelines 2009 and the detailed protocol was registered at PROSPERO International prospective register of systematic reviews(www.crd.york.ac.uk›prospero) under the registration number CRD42022303027.

Focused question:

To evaluate and compare the pain after patent root canal and non-patent root canal in patients undergoing endodontic treatment.

InclusionCriteria	ExclusionCriteria
1. Studies having direct comparison between patent and non-patent root canal preparations 2. Studies with defined statistical analysis 3. Importance of the pain outcome in the endodontic procedures 4. Publications were in English or foreign language, with full text available in either soft or hard copy.	1. Lack of clear description with regards to the specifications and comparisons of patency details of the root canal preparation 2. Studies not having any justified conclusion 3. Studies having conclusion with any statistical significance 4. Publications were in the form of letters, commentaries, or narratives.

Literature search:

A comprehensive search was conducted on electronic databases, additionally as by manual search, to spot all relevant studies associated with root perforation. Four electronic databases, Medline, PubMed, google scholar & DOAJ were consulted by looking for the key words pain, endodontic treatment and root canal patency. The combinations of different parameters were used as key words by using the Google search strategies by applying “AND, NOT, OR” as the conjunctions to get more refined output for the search. The search lined all articles printed from 2009 to 2021. Duplicate records were removed. Another search of the four electronic databases for reports of outcome of medical procedure passageway retreatment was conjointly performed within the hope to not miss any potential reports that will be relevant to the present topic. each prospective and retrospective clinical studies printed in Chinese or English language were enclosed.

Data base	Search strategy
PubMed/ google scholar	(P) #1 (patients with pain [MeSH Terms]) OR apical periodontitis [Title/Abstract]) OR irreversible pulpitis [Title/Abstract]) endodontics [Title/Abstract]) OR necrotic pulp[Title/Abstract]) (I) #2 (root canal patency [MeSH Terms]) OR patent [Title/Abstract]) OR apical patency [Title/Abstract

	(C) #3 (non-patent [MeSH Terms]) OR non-patency root canal [Title/Abstract]) (O) #4 (pain [MeSH Terms]) OR post-operative pain [Title/Abstract]) OR VAS [MeSH Terms] OR pain scale [Title/Abstract]) #1 AND #2 AND #3 AND #4 AND free full text AND Randomized controlled trial OR clinical trial

Table 1: Electronic databases and search strategies according to the PICO question components.

Data collection & extraction:

Characteristics of included studies and qualitative data were extracted in duplicate by two reviewers using predetermined and piloted extraction forms. Piloting of the forms was performed during the protocol stage until over 90% agreement was reached. Missing or unclear information was requested by the researchers.

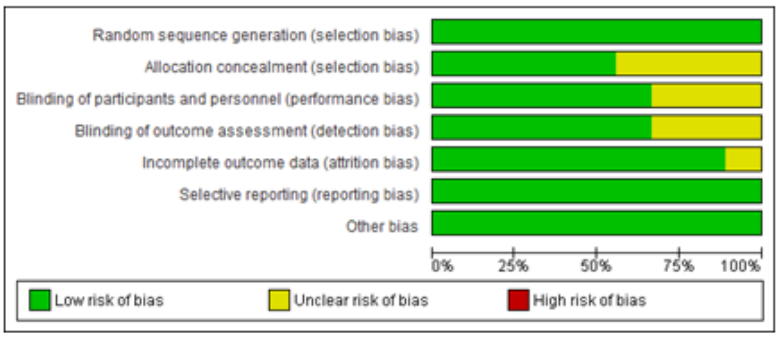
Information on authors' names, year of publications, study design, sample, type of treatment and control, outcome assessment/VAS and result was independently extracted by two reviewers. Data regarding the included studies was also independently extracted by the reviewers based on a previously defined protocol in a specific form in the Microsoft Office Excel 2007 software (Microsoft Corporation, Redmond, WA, USA).

Risk of bias within studies:

The risk of bias was assessed for RCTs using Cochrane collaboration tool[18] and performed using the RevMan software. Risk of bias was assessed by the two independent reviews for RCTs included in the review and discrepancies were resolved by discussion and appropriate consultation with a third reviewer. Thus, the overall risk for individual studies were assessed as low, moderate or high risk based on the domains and criteria. Majority of studies reported performance and detection bias in their methodology. Studies conducted by Ahmed et al. and Arora et al., had methodology that could be followed in future studies.

Figures- Risk of Bias Assessment of Included Studies

Risk of bias summary: review authors' judgements about each risk of bias item for each included study.



Risk of bias graph: review authors judgements about each risk of bias item presented as percentages across all included studies.

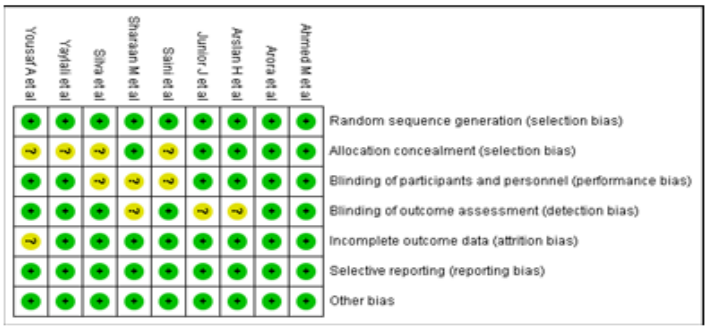


Table2: Demographicdetailsofincludedindividualstudies

Sr. No	Year of publication	Author	Samplesize	Country	Type ofteeth
1	2019	Arslan H[19]	44	Notspecified	Singlerootteeth
2	2020	Yousaf A[20]	240	Notspecified	Mandibularmolars
3	2015	Arora[21]	68	India	Mandibular first molars
4	2018	Ahmed M[22]	200	India	Maxillaryor mandibularmolars
5	2017	Yaylali[23]	320	Turkey	Maxillary and Mandibular molars
6	2016	Saini[24]	70	India	Mandibular first molars
7.	2012	Sharaan M[25]	80	Saudi Arabia	Anterior and Posterior teeth
8.	2015	Junior J[26]	46	Notspecified	Single root teeth
9.	2013	Silva[27]	80	Brazil	Single root teeth

Table3: Characteristic details of included individual studies.

Sr.No	Studydesign	Canal instrumentation and patency file	Obturation	Outcomeassessmentmethod	Conclusion
1	Clinical trial	FlexMaster File system (VDW), Size 10 K file	Lateral Condensation	VAS scale	Maintaining apical patency did not affect endodontic outcomes.
2	RCT	Dentsply ProTaper Next, Size 10 K file	Cold Lateral condensation	VAS scale	Maintaining apical patency in necrosed teeth with asymptomatic apical periodontitis does not significantly reduce postoperative pain after single visit endodontic treatment.
3	RCT	ProTaper instruments (Dentsply Maillefer, Ballaigues, Switzerland), Size 10 K-file	No obturation (CH intracanal medicament)	VAS scale	Maintenance of apical patency during chemo-mechanical preparation had no significant influence on post-operative pain in posterior teeth with necrotic pulps and apical periodontitis.
4	RCT	Not mentioned, Size 10 K file	No Obturation	VAS scale	Maintaining apical patency is associated with significantly less post-operative pain severity score in molars with necrotic pulp and apical periodontitis.
5	RCT	Reciprocating file (R25 and R40; VDW, Munich, Germany), Size 10 K-file	Continous wave	VAS scale	The maintenance of AP in molar teeth with necrotic pulp and apical periodontitis was associated with less postoperative pain when compared with NAP.
6	RCT	Hand filing, Size 10 k file	No obturation	VAS scale	Enlargement of the apical foramen during root canal treatment increased the incidence and intensity of postoperative pain.
7	RCT	Hero Shaper file, Size 10 K-file	No obturation	VAS scale	Apical patency did not increase the post preparation pain significantly.
8	RCT	Reciproc R40, Size 10 K file	Warm condensation	VAS scale	After 24 hours, the FEs resulted in more patients reporting mild pain compared with the control group, but no differences were observed at 72 hours or 1 week.

9	RCT	Hand filing, Size 10 K file	Warm vertical compaction	VAS scale	This may suggest that the use of foraminal enlargement should be performed for endodontic treatment previsibility without increasing postoperative pain.

RESULTS

A total of 09 studies over the past one decade met the inclusion criteria for full text reading and all 09 were included for further analysis. All the statistical analyses were performed using the statistical software Review Manager version 5.3 (The Nordic Cochrane Centre, Copenhagen, Denmark)

Qualitative analysis

The publication year of studies varied from 2012 to 2020. A cumulative total of 1146 patients were included in the nine studies. The male and females were in varying sample size. The sample size ranged from 20-160 patients per group. The studies were conducted all over the globe, most studies took place in Asia[21,22,24], Brazil,[27] Saudi Arabia/Middle East[25] and Turkey[23]. However, three studies[19,20,26] did not mention the study region. The study design was randomized controlled trials. The age of the patients ranged from 16-65 years. Majority of the patients were males.

The apical patency was the primary exposure that we intended to study against the control group. The teeth of interest were majority of posterior teeth which were treated for pulp necrosis or apical periodontitis. The control group was consistent with non-patent root canals for all the included studies.

The primary outcome assessed was post-operative pain after the endodontic treatment using the Visual Analogue Scale score. (mean/sd OR events)

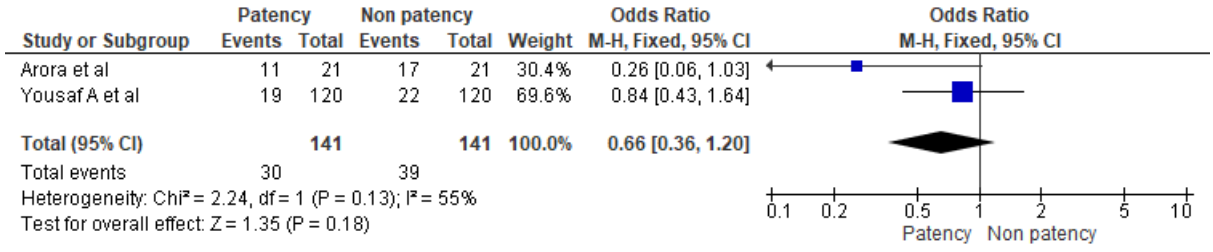
Out of 09 studies, all studies were further included for quantitative analysis and the meta-analysis was interpreted with the forest plot. The outcome which we assessed was the fractional resistance of the tooth after the placement of intervention.

Quantitative analysis

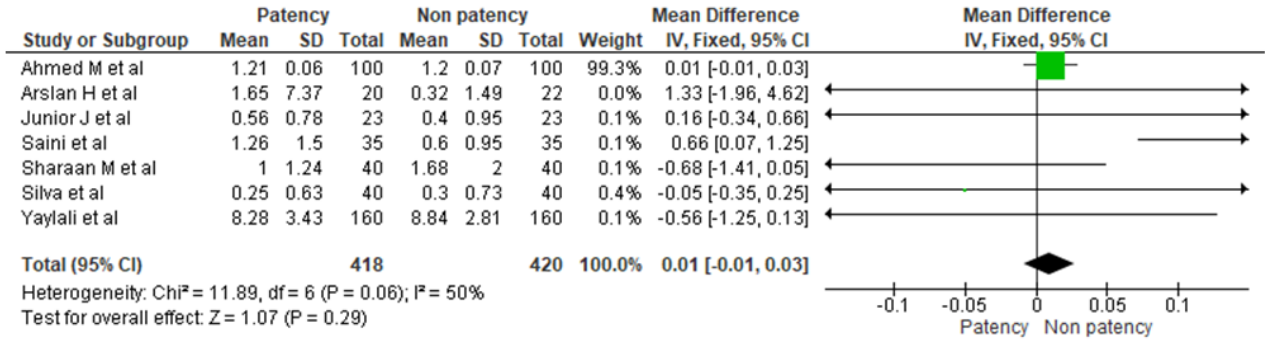
The meta-analysis was conducted on 09 studies which have data outcome that could be used for analysis. The results as forest plot are depicted in figures. After that the meta-analysis conducted for the selected studies, the heterogeneity was analysed based on I^2 values hence fixed or random effect model was applied.

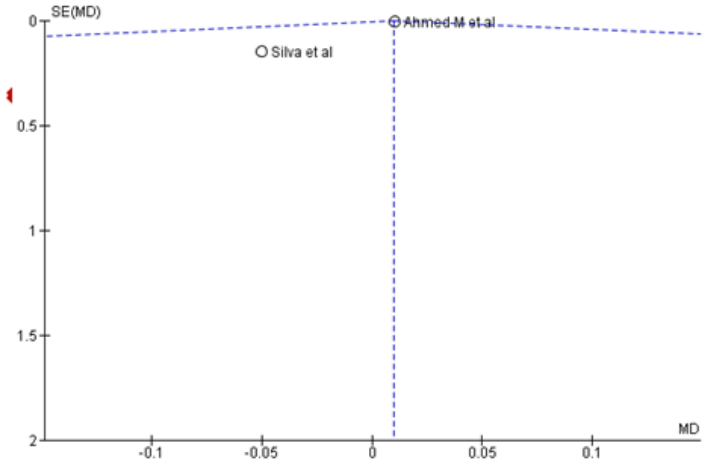
Patent vs Non-patent

When the pain score of was assessed in 02 studies after the injection, the pooled odds ratio was 0.66 (CI: -0.12, 0.39). The heterogeneity was significant I^2=55%, hence we applied the fixed effects model. The odds of having pain post-operatively was higher than the in non-patent root canal as compared to patent root canals.



The mean pain score was assessed by comparing patent canals vs non-patent canals, the heterogeneity was significant I^2=50%, hence we applied the fixed effects model. In 07 studies, the cumulative mean difference was 0.01(-0.01,0.03), hence this was indicative that there was no significant difference in the patency and non-patency canal when post-operative pain was the primary outcome.





DISCUSSION

The idea of apical patency was first advocated by Buchanan, describing a patency file as a small K-file, which would passively move through the minor apical diameter and beyond the apical foramen without widening it.[28] Over the years, numerous authors have advocated the use of a patency file because it causes less apical leakage, prevents bacterial inoculation of peri-apical tissues, and helps in debridement and irrigation of the apical third of the root canal system, ultimately reducing the probability of postoperative pain.

The present systematic review and meta-analysis aimed to assess a possible correlation between Apical Patency and postoperative pain using the available data in published articles and assess postoperative pain while maintaining apical patency. The meta-analysis revealed no significant difference between AP and NAP, except the odds ratio showed higher prevalence of post-operative pain in non-patent canals. An odds ratio (OR) is a measure of association between an exposure and an outcome and it represents the odds that an outcome will occur given a particular exposure, compared to the odds of the outcome occurring in the absence of that exposure. Odds ratios are most commonly used in case-control studies; however, they can also be used in cross-sectional and cohort study designs as well.[35]

All articles included in this systematic review presented the simplest experimental study design. In the methodology of the selected articles, one group was regarded as the treatment group, which received the foraminal enlargement treatment, and one as the control group, which received no variable treatment and was used as a reference. This design determines that any deviation in results from the treatment group is indeed a direct result of the variable.

Previous literature concerned the penetration of irrigating solution into the apical third. Vera et al[29] studied the effect of maintaining AP on the penetration of an irrigating solution into the apical 2 mm of large root canals using radiographic analysis. They derived that AP improves the delivery of an irrigating solution into the apical third of root canals of teeth. Moreover, Vera et al[29] and Kamra et al[30] reported that maintaining AP improved the delivery of passive ultrasonic irrigating solution into the apical third of root canals, which improved cleaning of the canals and decreased postoperative pain. The variability in the methodologies of the included studies may passively affect the treatment outcomes or may confirm and strengthen them. Therefore, the interpretation of the review findings has to be considered with caution because of some variations of the methodology of the included studies.

Generally, women tend to exhibit lower pain thresholds and tolerances than men [31,21], and women have been shown to report more acute pain than men [33]. For the same reasons, we included only asymptomatic patients because the inclusion of teeth with pain might have influenced the results[34].Similarly, Arslan et al.[19] stated that majority of the study population in their article was female (59.5%). However, there was no significant difference between the male and female groups in term of the outcomes of the root canal treatment(P=.700). These findings are in accordance with those of previous reports on this topic by Rucci D et al and Liang YH et al.[35]

During the quantitative analysis, the pain score of was assessed in 02 studies after the injection, the pooled odds ratio was 0.66 (CI: -0.12, 0.39). The heterogeneity was significant I^2=55%, hence we applied the fixed effects model. The odds of having pain post-operatively was higher than the in non-patent root canal as compared to patent root canals.

This systematic review also had few limitations. First, the evidence in this review was classified as low due to restricted accessibility to databases. This could be considered as the most significant limitation of this review. Second, some included studies had small sample sizes. Third, a meta-analysis could have been more concrete with larger number of studies and less variations between study characteristics.

Assessing a variable as a factor responsible for postoperative pain is difficult owing that pain is a subjective phenomenon and is dependent on multiple factors. It is influenced by psychological, emotional, cultural and social behaviors. All individuals respond differently to varying degrees of pain depending on their threshold for it. The preoperative pain also influences postoperative pain in endodontics.[36] Pain can also be strongly influenced by the element of fear. The dental treatment is often a fear and anxiety provoking event for many patients that could influence their current treatment outcome and response to that treatment in the future.[37]

CONCLUSION

We believe that maintaining AP does not increase postoperative pain and may improve it. However, this conclusion should be considered with caution due to the limitations mentioned above and because the heterogeneity statistics based on small number of studies could be imprecise. Therefore, further well-designed randomized controlled trials that assessed the effect of AP are highly recommended with a large sample size with control of all confounding variables. To our knowledge there was a scarcity of literature which analyzed the individual studies quantitatively, we intended to fulfil that through this study.

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