SEYBOLD Report
ISSN: 1533 - 9211
DOI: 10.5281/zenodo.7095016

COMPARING THE EFFECTIVENESS OF SONIC , ULTRASONIC , LASER ACTIVATED IRRIGATION WITH CONVENTIONAL NEEDLE IRRIGATION ON POSTOPERATIVE PAIN DURING ROOT CANAL TREATMENT -A SYSTEMATIC REVIEW.

Keerthika. R
Department of Conservative dentistry and Endodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical And Technical Sciences, Saveetha University, Chennai, India, Mail id : keerthikar91@gmail.com

Dr.Sandhya Raghu
Professor, Department of Conservative Dentistry and Endodontics, Saveetha Dental College and hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University Chennai-77, India, Email id: sandhya.sdc@saveetha.com

ABSTRACT
Root canal treatment aims at complete elimination of vital and necrotic pulp tissues, microorganisms and their by-products from the root canal system. Thus in order to reach the inaccessible areas various irrigants and irrigant activation systems have been used.Activation of irrigant has been proposed as the most therapeutic solution which has led to the development from manual dynamic activation to laser activation systems**.**The aim of this systematic review is to evaluate the effect of Sonic irrigation , Ultrasonic irrigation Laser activated irrigation vs Conventional needle irrigation on postoperative pain reduction during endodontic treatment.A detailed literature search was made in the PubMed database. Randomized Controlled Clinical Trials, studies on activated irrigation compared with conventional needle irrigation were included in this systematic review. The risk of study bias was analyzed through the Cochrane Handbook of systematic reviews of interventions and the level of evidence by the Oxford Center for Evidence- based Medicine, 2009.The studies were selected if the studies were in vivo studies done as clinical trials. The outcome measure was to comparatively evaluate the postoperative pain after sonic, ultrasonic, laser activated irrigation and /or conventional needle irrigation.Six studies were identified and included in the systematic review. It has been observed that there is reduction of postoperative pain in all the studies using sonic irrigation,ultrasonic irrigation and laser activated irrigation when compared to conventional needle irrigation.In conclusion,activated irrigation has better control over postoperative pain than conventional needle irrigation.
Keywords: Root canal,Irrigation,post operative pain,activated irrigation.

INTRODUCTION:
Root canal irrigation plays a pivotal role in Endodontics, to facilitate instrumentation by lubrication, remove debris, microorganisms, smear layer and prevent apical debris packing. Irrigants exert their effects, by mechanical, chemical and biological actions..(Çiçek et al.,

DOI: 10.5281/zenodo.7095016

2017).(Varela et al., 2019).(Caron et al., 2010)(Rosenberg, 2014; Susila & Minu, 2019)

Conventional irrigation with syringes has been followed as the gold standard method of irrigant delivery system for decades. Ease of use, control of depth penetration and volume of irrigant used are its major advantages.(Gu et al., 2009) Inorder to achieve greater depth penetration various other systems such as sonic, ultrasonic, laser activated systems have been developed.

The incidence of endodontic pain during or after endodontic treatment has been a major concern for decades .(Gondim et al., 2010) The incidence rate of postoperative pain ranges from 3% to 58%.(Sathorn et al., 2008) Endodontic pain is due to acute inflammatory reaction of the apical periodontal ligament which could be due to injury to vital nerve or pulp tissue, over instrumentation, forcing of debris or medicament beyond the apex or due to occlusal trauma .(Seltzer & Krasner, 1988) Many studies have been conducted to rule out the cause of pain but the results have been variable.(Çiçek et al., 2017)(Rosenberg, 2014)

Many irrigation activation methods have been recommended for increasing the irrigation's efficiency within the root canal system.(Gündoğar et al., 2020)Manual irrigation system using needles is still widely accepted by both general practitioners and endodontists. In this technique the dispensing of an irrigant into a canal through needles/cannulas of variable gauges, either passively or with agitation.The EndoActivator System is a more recently introduced sonically driven canal irrigation system. Vibrating the tip, in combination with moving the tip up and down in short vertical strokes, synergistically produces a powerful hydrodynamic phenomenon,to optimize debridement and promote disruption of the smear layer and biofilm.(Gu et al., 2009)

Ultrasonic irrigation can be used as an intermittent irrigation or a continuous ultrasonic irrigation. In intermittent flushed ultrasonic irrigation, the irrigant is delivered to the root canal by a syringe needle. The irrigant is then activated with the use of an ultrasonically oscillating instrument.(Carver et al., 2007) Laser activated irrigation (LAI) uses extremely low energy levels of laser light with short microsecond pulse duration to generate a photo-acoustic shock wave and where the tip is not positioned in the root canal itself .It can stream irrigants throughout the entire root canal system.(Dagher et al., 2019)
A constant quench for the safe delivery system that prevents periapical damage, reduced postoperative pain has given the insight for the formulation of this systematic review.Previously our team has a rich experience in working on various research projects across multiple disciplines (Azeem & Sureshbabu, 2018; Felicita, 2017; Felicita et al., 2012; A. R. Jain, 2017; Krishnan & Lakshmi, 2013; Kumar et al., 2006; Mp, 2017; Patturaja, 2016; Rao & Kumar, 2018; Sekar et al., 2019; Sivamurthy & Sundari, 2016). Now the growing trend in this area motivated us to pursue this project.

SEYBOLD Report
ISSN: 1533 - 9211
DOI: 10.5281/zenodo.7095016

Aim

The aim of this systematic review is to evaluate the effect of Sonic irrigation ,Ultrasonic irrigation Laser activated irrigation vs Conventional needle irrigation on postoperative pain reduction during endodontic treatment

Structured question

Is there any difference in postoperative pain reduction during endodontic treatment after Sonic irrigation ,Ultrasonic irrigation ,and Laser activated irrigation Vs Conventional needle irrigation?

Null hypothesis

There is no significant reduction in pain after root canal treatment with the use of different irrigation systems .

Alternate Hypothesis

There is significant reduction in pain after root canal treatment with the use of different irrigation systems .

MATERIALS AND METHODS

PICOS Analysis

P- Endodontically treated teeth

I- Sonic irrigation, Ultrasonic irrigation,Laser activated irrigation

C- Conventional needle irrigation

O- Postoperative pain

S- Randomized clinical trials, Prospective studies, Cohort studies

Inclusion Criteria

Criteria for considering studies for this review

- In vivo studies on patients undergoing primary endodontic therapy in permanent teeth
- Studies which compared the efficacy of sonic ,ultrasonic,laser activated irrigation and/or conventional needle irrigation
- Clinical trials, prospective studies, cohort studies

Exclusion Criteria

The following studies were excluded,

- Case reports
- Case series
- In vitro studies
- Studies comparing other irrigation activation techniques such as alternation in pressure and temperature and in Lasers low level lasers were excluded
- Studies done in primary dentition were excluded

SEYBOLD Report
ISSN: 1533 - 9211
DOI: 10.5281/zenodo.7095016

Sources used

For identification of studies included or considered for this review, detailed search strategies were carried out on the following databases.The search queries in the database were formulated with the basis of PICO questions in combination with various Boolean operators.(Table 1)

- PUBMED Advanced Search
- Cochrane search
- Google 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
- European Endodontic journal
- Photobiomodulation, Photomedicine and Laser surgery

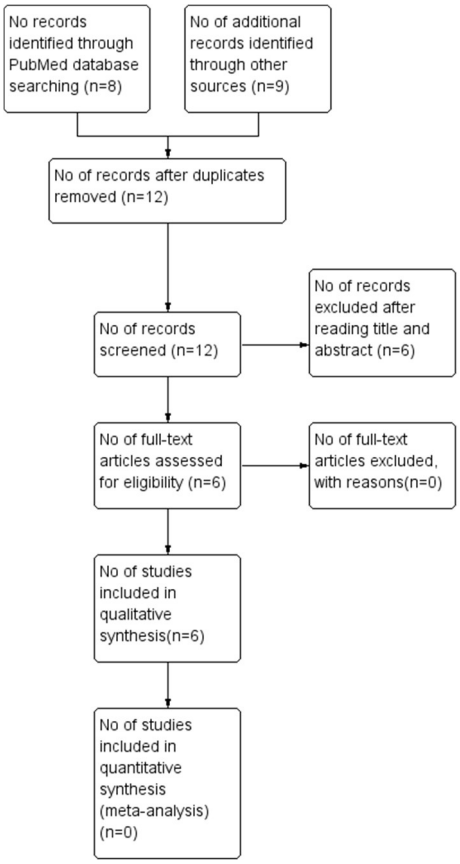
FIGURE 1:SEARCH METHODOLOGY

#27	···	›	Search: **((((((((((((((Root canal treatment)) OR (Endodontic treatment)) OR (root canal disinfection)) OR (sonic irrigation)) OR (ultrasonic irrigation)) OR (endoactivator)) OR (passive ultrasonic irrigation)) OR (lasers)) OR (laser activated irrigation)) OR (Er YSGG lasers)) OR (Nd YAG lasers)) OR (diode lasers)) AND (conventional needle irrigation)) OR (traditional endodontic irrigation)) AND (Postoperative pain)**	8	08:09:44
#26	···	›	Search: **((((((((((((Root canal treatment) OR (Endodontic treatment)) AND (sonic irrigation)) OR (ultrasonic irrigation)) OR (endoactivator)) OR (passive ultrasonic irrigation)) OR (lasers)) OR (laser activated irrigation)) OR (Er YSGG lasers)) OR (Nd YAG lasers)) OR (diode lasers)) AND (conventional needle irrigation)) OR (traditional endodontic irrigation)) AND (postoperative pain)**	5	08:03:13
#25	···	›	Search: **((Root canal treatment) AND (conventional needle irrigation)) AND (postoperative pain)**	5	07:58:00
#24	···	›	Search: **(((((((Root canal treatment) AND (lasers))) OR (Er ysgg)) OR (Nd yag)) OR (Diode lasers)) AND (conventional needle irrigation)) AND (postoperative pain)**	1	07:57:12
#23	···	›	Search: **(((((Rootcanaltreated) AND (Lasers)) OR (Er ysgg)) OR (Nd yag)) OR (Diode lasers)) AND (postoperative pain)**	248	07:53:32
#22	···	›	Search: **((Rootcanaltreatment) AND (lasers)) AND (postoperativepain)**	0	07:31:59
#21	···	›	Search: **((root canal treatment) AND (lasers)) AND (postoperative pain)**	28	07:31:58
#20	···	›	Search: **(Root canal treatment) AND (nd YAG lasers)**	283	07:31:24
#19	···	›	Search: **(Root canal treatment) AND (diode lasers)**	166	07:30:58
#18	···	›	Search: **(Rootcanaltreatment) AND (Er YSGG lasers)**	0	07:30:30

SEYBOLD Report
ISSN: 1533 - 9211
DOI: 10.5281/zenodo.7095016

#17	···	›	Search: **(root canal treatment) AND (er ysgg laser)**	195	07:30:30
#16	···	›	Search: **(Root canal treatment) AND (lasers)**	1,038	07:29:04
#15	···	›	Search: **(Root canal treatment) AND (laser activated irrigation)**	160	07:27:48
#14	···	›	Search: **((((Root canal treatment) AND (ultrasonic irrigation)) OR (passive ultrasonic irrigation)) AND (conventional needle irrigation)) AND (postoperative pain)**	1	07:26:53
#13	···	›	Search: **((((Root canal treatment) AND (Ultrasonic irrigation)) OR (passive ultrasonic irrigation))) AND (Post operative pain)**	6	07:24:29
#12	···	›	Search: **((Root canal treatment) AND (ultra sonic irrigation)) OR (passive ultrasonic irrigation)**	322	07:22:51
#11	···	›	Search: **(((Root canal treatment) AND (sonic irrigation)) AND (conventional needle irrigation)) AND (postoperative pain)**	1	07:21:45
#10	···	›	Search: **((Root canal treatment) AND (sonic irrigation)) AND (postoperative pain)**	3	07:19:31
#9	···	›	Search: **(Root canal treatment) AND (Sonic irrigation)**	143	07:19:07
#8	···	! ›	Search: **Traditional irrigation in endodontics**	84	07:18:38
#7	···	›	Search: **Conventional needle irrigation**	149	07:18:18
#6	···	›	Search: **Laser activated irrigation**	363	07:17:49
#5	···	›	Search: **Ultrasonic irrigation**	1,238	07:17:09
#4	···	›	Search: **Sonic irrigation**	258	07:16:56
#3	···	! ›	Search: **Irrigation in endodontics**	4,710	07:16:34
#2	···	›	Search: **Endodontically treated teeth**	4,153	07:15:55
#1	···	›	Search: **Root canal treatment**	24,365	07:15:39

FIGURE 2:SEARCH FLOW CHART



SEYBOLD Report
ISSN: 1533 - 9211
DOI: 10.5281/zenodo.7095016

Selection of Studies

The selected studies were analyzed based on the inclusion/exclusion criteria and imported to a reference managing software. After removal of duplicates, the title and abstract of the remaining records were screened independently for eligibility.

TABLE 1:LIST OF EXCLUDED ARTICLES

S NO	AUTHOR	YEAR	REASON FOR EXCLUSION
1	He JM	2004	Incomplete data .
2	Gondim	2010	Comparison was done between positive and negative pressure systems which were not in inclusion criteria .
3	Topcuoglu	2018	Included Manual agitation technique which was not in inclusion criteria .
4	Coelho	2019	Photo dynamic therapy was evaluated which was not in inclusion criteria .
5	Topcuoglu	2020	The study population was primary molar teeth which don't fit in the inclusion criteria.
6	Grisby	2020	Both irrigation delivery and activation was done by the same system (Gentle wave).

Outcomes Measured

The assessment of postoperative pain was measured using VAS-Visual analog scale , NRS - Numeric Rating Scale

Data Extraction

Data of the included studies was extracted independently by 2 reviewers using a customized data extraction form. Data extracted consisted of the following:

- Article identification information – Authors, and Publication year, Type of Study
- Study Characteristics – Sample size, population,intervention used
- Outcome of Interest – Postoperative Pain.

Quality Assessment and Level of Evidence

The assessment of the methodology was conducted using Cochrane Collaboration‘s Risk of Bias Assessment Tool -Review Manager (5.4.1). Domains that were assessed was as follows

- Random sequence generation
- Allocation Concealment

SEYBOLD Report
ISSN: 1533 - 9211
DOI: 10.5281/zenodo.7095016

- Blinding of participants and personnel
- Blinding of the outcome assessment
- Incomplete outcome data
- Selective reporting
- Other sources of bias

Results

Study Selection

The search identified a total of 17 publications. After removing the duplicates, 12 publications were assessed for full text assessment. 6 publications were excluded for reasons mentioned in Table 1. Finally, 6 studies were included in the systematic review (Figure 2).

Data extraction

All included studies were invivo studies ,with population majorly comprising of non vital teeth,intervention groups being some mode of activated irrigation which includes Endoactivator ,diode laser,PIPS,Er:YAG 2940 nm laser,EDDY tips,conventional needles and side vented needles (Table 2).

The commonly used irrigants in included studies are NAOCL(2.5-5%),17%EDTA.The instrumentation used in all the included studies were different and the time period of assessment of pain also differed from 6 hrs to7 days (Table 3).

Quality Assessment and Level of Evidence

Cochrane‘s ROB tool was used to assess the quality of the available literature. 5 studies showed a low risk of bias for randomization while 1 study showed unclear risk. In terms of allocation concealment, 4 studies showed a low risk of bias, 1 study showed an unclear risk of bias, while 1 study showed a high risk of bias. In terms of blinding of participants, 4 studies showed an unclear risk of bias while 2 studies showed a high risk. In terms of blinding of outcome assessment,all 6 studies showed an unclear risk of biasIn terms of attrition bias, 3 studies showed a low risk of bias,3 studies showed an unclear risk, while 2 studies showed a high risk. In terms of selective reporting, all the studies had an unclear risk of bias. Overall, the highest risk of bias was seen in the blinding of the participants , while the least risk was seen in randomization(Table 5 Figure 3 and 4). 5 studies had a level of evidence of 1b while 1 study had a level of evidence of 2b (Table 4).

Risk of bias of included articles

The assessment for the main methodological quality items are shown in the table.(Table 5 and Table 6). The study was assessed to have a ‘High risk of bias’ if it did not record a ‘yes’ in three or more of the four main categories, ‘Moderate risk of bias’ if it did not record yes in two out of the four categories and ‘Low risk of bias’ if randomization, allocation concealment, assessor blinding and completeness to follow up were considered adequate.Out of 6 studies included in

SEYBOLD Report
ISSN: 1533 - 9211
DOI: 10.5281/zenodo.7095016

this study 4 showed low risk of bias ,1 showed moderate risk and 1 showed high risk of risk.

TABLE 2:GENERAL CHARACTERISTICS TABLE OF INCLUDED STUDIES

SNO	Author /Year	Study Design	Sample size	Population	Intervention	Method of Evaluation	Outcome
1	Ramamoorthi,2015	Invivo	N=72	Posterior teeth,with symptomatic irreversible pulpitis	Group 1-Endodontic irrigating needle Group 2-EndoActivator	VAS	The EndoActivator group resulted in significantly less postop-erative pain than the conventional needle protocol.
2	Middha ,2017	Invivo	N=70	mandibular molars with non-vital pulps and apical periodontitis	Group 1-ultrasonic irrigation Group 2-syringe irrigation	VAS	A significant difference was observed between CUI and syringe irrigation on the first postoperative day .
3	Morsy ,2018	invivo	N=56	Upper anterior teeth with chronic periapical lesions	Group 1-DL(DIODE LASER) group: root canals were irradiated with 200	NRS	Statistically significant lower pain levels in the DL group compared with the

DOI: 10.5281/zenodo.7095016

					µm fiber optic Group 2- control group (Endo): the DL fiber was placed in root canal with no activation		Endo group at all time interval
4	Dagher ,2019	In Vivo	N=56	premolars or molars with asymptomatic irreversible pulpitis, symptomatic irreversible pulpitis, or symptomatic pulpal necrosis, with or without apical periodontitis	Group 1- CNI Group 2- PIPS protocol, using an Er:YAG 2940 nm laser	VAS	There was no significant difference in pain between the laser-irradiated group and the control group
5	Gundogar,2020	Inviv o	N= 160	mandibular premolar teeth with irreversible pulpitis	Group 1- side-port endodontic needles (NI) without any agitation; in groups 2 and 3, sonic	VAS	Pain in the NI group was found higher than that of the EDDY group at 24 h,after which there

SEYBOLD Report
ISSN: 1533 - 9211
DOI: 10.5281/zenodo.7095016

					activation was performed using EDDY and EndoActivator (EA), respectively; and in group 4, passive ultrasonic irrigation (PUI)		is no significant difference among the groups.
6	Mandras ,2020	Invivo	N=54	first or second maxillary or mandibular molar with pulp necrosis with or without apical periodontitis	Group A (n = 27) traditional irrigation Group B (n = 27), with PIPS irrigation	VAS	PIPS shows significant reduction in pain on day 1than traditional irrigation with the trend values seemed to be lower in PIPS group

VAS-Visual analog scale ,NRS - Numeric Rating Scale

TABLE 3:TABLE OF VARIABLES OF OUTCOMES

SNO	Author /Year	Irrigant	Instrumentation	No of operator	Time of assessment
1	Ramamoorthi, 2015	3% NaOCl&17%EDTA	Mtwo upto #25	single operator	8, 24 and 48 h
2	Middha ,2017	5.25% NAOCL & 17% EDTA	three sizes larger than the first apical binding file at the WL	single operator	Everyday for 7 days

SEYBOLD Report
ISSN: 1533 - 9211
DOI: 10.5281/zenodo.7095016

			with 0.02 taper stainless steel hand files		
3	Morsy ,2018	2.5% sodium hypochlorite &17%EDTA	Protaper universal upto #F4	One operator and one assessor	6, 12, 24, 48 hours and 7 days
4	Dagher ,2019	17%EDTAand 5.25% NaOCl	Reciproc R25	single operator	24, 48, and 72 h and 7 days
5	Gundogar,2020	3% NaOCl&17%EDTA	Protaper Next #30	single operator	8, 24, 48 h and 7 days
6	Mandras ,2020	5% NaOCl and 10% EDTA	NiTi flex #25	single operator	Every 24 hrs for 7 days

TABLE 4:Levels of Evidence

Author	**Year**	**Study design**	**Level of evidence**
Ramamoorthi	2015	Randomized Clinical Trial	Level 1b
Middha	2017	Randomized Clinical Trial	Level 1b
Morsy	2018	Randomized Clinical Trial	Level 1b
Dagher	2019	Randomized Clinical Trial	Level 2b
Gundogar	2020	Randomized Clinical Trial	Level 1b
Mandras	2020	Randomized Clinical Trial	Level 1b

TABLE 5:RISK OF BIAS-MAJOR CRITERIA

S.No	Author	Year	Randomisation	Allocation concealment	Assessment blinding	Dropouts described	Risk of Bias
1	Ramamoorthi	2015	Yes	Yes	No	Yes	Low
2	Middha	201	Yes	Yes	No	No	Moderat

SEYBOLD Report
ISSN: 1533 - 9211
DOI: 10.5281/zenodo.7095016

		7					e
3	Morsy	2018	Yes	Yes	Yes	No	Low
4	Dagher	2019	Yes	No	No	No	High
5	Gundogar	2020	Yes	Yes	No	Yes	Low
6	Mandras	2020	Yes	Yes	No	Yes	Low

TABLE 6:RISK OF BIAS-MINOR CRITERIA

S.No	Author	Year	Sample justified	Baseline comparison	I/E criteria	Method error
1	Ramamoorthi	2015	Yes	Yes	Yes	No
2	Middha	2017	Yes	Yes	Yes	No
3	Morsy	2018	Yes	Yes	Yes	No
4	Dagher	2019	Yes	No	Yes	No
5	Gundogar	2020	Yes	Yes	Yes	No
6	Mandras	2020	Yes	Yes	Yes	No

SEYBOLD Report
ISSN: 1533 - 9211
DOI: 10.5281/zenodo.7095016

FIGURE 3:RISK OF BIAS SUMMARY

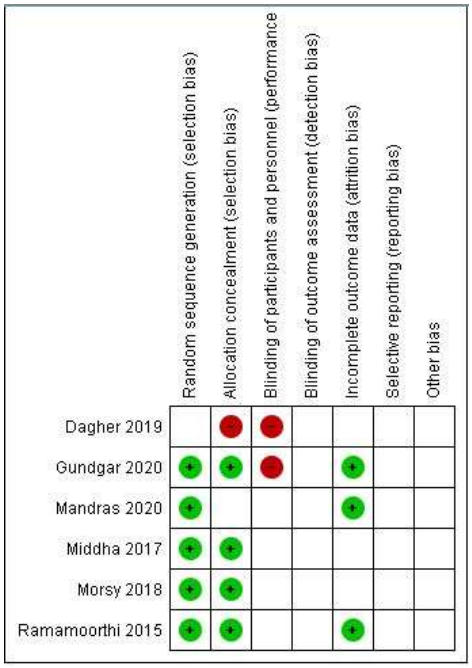
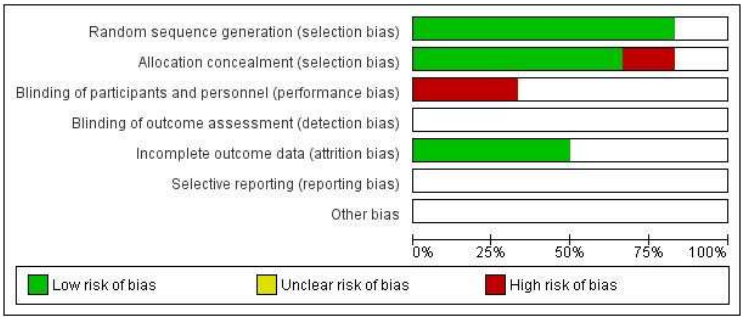


FIGURE 4:RISK OF BIAS GRAPH



DISCUSSION

The purpose of this review was to evaluate the effectiveness of sonic irrigation,ultrasonic irrigation,laser activated irrigation and conventional needle irrigation in the management of postoperative pain during endodontic treatment. Six invivo studies fulfilled the criteria for being included in this review.(Dagher et al., 2019)(Gündoğar et al., 2020; Mandras et al., 2020; Middha et al., 2017; Morsy et al., 2018; Ramamoorthi et al., 2015)

Mostly systematic reviews will require meta-analysis, which involves the statistical pooling of data from individual studies when the studies are similar. A meta-analysis can yield a more precise overall estimate of the treatment effect. However, meta-analysis may not be appropriate in many situations. Owing to the heterogeneity among the studies such as difference in sample sizes and follow-up periods, we could not perform a meta-analysis to summarize the data of included studies. Hence, only descriptive evaluation of data has been provided.

Ramamoorthi et al(Ramamoorthi et al., 2015) compared the postoperative level of pain after activation of irrigants using EndoActivator with conventional needle irrigation during root

SEYBOLD Report
ISSN: 1533 - 9211
DOI: 10.5281/zenodo.7095016

canal therapy.In this study , 72 symptomatic irreversible pulpitis patients were assigned to two groups(Endodontic Needle EN & Endoactivator EA) based on block randomisation after routine root canal preparation.In group EN, procedures were performed with endodontic irrigating needle (n = 36) while group EA received activation using EndoActivator (n = 36) in the final irrigation protocol. All the participants were called through the phone at 8, 24 and 48 h to analyze pain score using visual analogue scale. Those patients who developed pain were prescribed ibuprofen 200 mg. Pain score and frequency of tablet intake were recorded and statistically analyzed. It was observed that group EA resulted in significantly less postoperative pain and analgesics intake than group EN. This study recommended the activation of irrigants using EndoActivator as an effective method for reducing postoperative pain.(Ramamoorthi et al., 2015)

Middha et al (Middha et al., 2017)compared the effect of continuous ultrasonic irrigation on post- operative pain in mandibular molars with non-vital pulps.Seventy mandibular molars with non-vital pulps and apical periodontitis were treated endodontically using two different irrigation techniques. The patients were randomly allocated to one of two groups, continuous ultrasonic irrigation (CUI) (n=35) and syringe irrigation (SI) (n=35). The CUI group received irrigant activation using a Proultra Piezoflow ultrasonic needle as the final irrigation protocol, while in the SI group, the final irrigation was performed using a 27 gauge needle. All the patients were prescribed ibuprofen 400mg to be taken every 8 hours, if required. Post- operative pain using a visual analog scale and analgesic intake were recorded every day for 7 days. Data were analyzed using Chi–Square, Mann–Whitney and multiple linear regression tests.The study showed the post-operative pain was lower in the CUI as compared to SI group, but the difference was significant on the first day only (P = 0.032). The overall 24 hour pain prevalence was 41.4%. CUI had a lower incidence of pain (31.4%) as compared to the SI group (51.4%), but the difference was not significant (P > .05). No significant difference was observed in analgesic consumption between the groups (P > .05). Regression analysis revealed a significant association of mean postoperative pain at 24 hours with the irrigant protocol (P = 0.017) and pre-operative pain (P = 0.000).This study concluded stating that there was a significant difference between continuous ultrasonic irrigation and syringe irrigation on the first postoperative day following chemo-mechanical preparation but the benefit observed was not clinically relevant.(Middha et al., 2017)

The study by Morsy et al (Morsy et al., 2018)aimed to investigate the ability of the diode laser (DL) to decrease postoperative pain and achieve root canal sterility.Fifty six patients with anterior teeth with chronic periapical lesions in upper anterior teeth were randomly divided into two groups (n = 28). All patients were treated with two visits of conventional root canal treatment with ProTaper Universal. The DL group: root canals were irradiated with 200 μm fiber optic at both visits; the control group (Endo): the DL fiber was placed in the root canal with no activation. Bacterial samples were collected from all the cases at each step of the treatment. Pain levels were evaluated using a numerical rating scale preoperatively, and after

DOI: 10.5281/zenodo.7095016

6, 12, 24, 48 hours and 7 days. Bacterial count was used to detect both aerobic and anaerobic bacterial load.The qualitative pain scores revealed statistically significant lower pain levels in the DL group compared with the Endo group at all time intervals (P<0.001), except preoperatively where there was no significant difference. There was a statistically significant lower bacterial count for both aerobic and anaerobic bacteria in the DL group compared with the Endo group in both S3 samples (after laser application) and S4 samples (bacterial colonization) (P<0.001).This study recommended the use of 980 nm diode laser as a successful adjunct to conventional endodontic treatment of necrotic cases with chronic periapical lesions in terms of postoperative pain and root canal disinfection.(Morsy et al., 2018)

In the study by Dagher et al(Dagher et al., 2019), Fifty-six healthy premolars or molars with asymptomatic irreversible pulpitis, symptomatic irreversible pulpitis, or symptomatic pulpal necrosis, with or without apical periodontitis, were mechanically prepared for endodontic treatment and divided into two groups. Patients were randomly allocated to treatment groups. In the positive control group G1, the final irrigation with 2 cc of 5.25% sodium hypochlorite (NaOCl) was achieved using a 27G needle and in the experimental group G2, the root canals were irrigated with 17% ethylenediamine tetric acid (EDTA) and 5.25% NaOCl following the PIPS protocol, using an Er:YAG 2940nm laser. Postoperatively, the patients were advised to take a minor analgesic (ibuprofen 400 mg) in the event of pain perception. Post- operative pain levels were assessed after 24, 48, and 72 h and 7 days through the use of a Visual Analogue Scale questionnaire, completed by each patient. Data were analyzed using Kolmogorov–Smirnov, Fisher Exact, Chi square, Mann–Whitney test, and Friedman's test. It was observed that there was no significant difference between the laser-irradiated group and the control group .Laser activation of irrigating solutions did not increase postoperative pain.This study showed that PIPS was as effective as conventional irrigation in relation to postoperative pain, recommending this technique as supplementary root canal disinfection.(Dagher et al., 2019)

The study by Gundgar (Gündoğar et al., 2020)aimed to assess the effectiveness of irrigation activation techniques on postoperative pain in mandibular premolar teeth with irreversible pulpitis after single-visit endodontic treatment. A total of 160 patients with symp- tomatic irreversible pulpitis were included in this prospective randomized clinical study. Four different activation methods were used in mandibular premolar teeth. In group 1, teeth were irrigated with side-port endodontic needles (NI) without any agitation; in groups 2 and 3, sonic activation was performed using EDDY and EndoActivator (EA), respectively; and in group 4, passive ultrasonic irrigation (PUI) was used. Patients' analgesic intake—as well as pain intensity during and after treatment—were recorded at 8, 24, 48 h and 7 days. The data relating to age, sex and analgesic intake was evaluated using the Chi-square test and the preoperative pain and PP intensity at different time intervals was evaluated with the Kruskal– Wallis test at a 5% significance level. Highest PP was recorded at 8 h, pain intensity decreased in all groups by the time. Pain in the NI group was found higher than that of the EDDY group at 24 h ($P < 0.05$). EA and PUI had caused mild pain and had similar pain scores at 24 h. ($P > 0.05$). No statistically

DOI: 10.5281/zenodo.7095016

difference was found among the groups with regard to analgesic intake (P > 0.05). Although there were slight differences in PP levels between the groups at 24 h, pain levels decreased in all groups after 24 h. Activation of the irrigation solution did not make any difference in terms of PP after 24 h.(Gündoğar et al., 2020)

A study by Mandras et al(Mandras et al., 2020) evaluated the ability of a PIPS (photon-induced photoacoustic streaming) Er:YAG laser to reduce the root canal system bacterial count in vivo in comparison to the traditional irrigation technique. The post-operative patients' quality of life (QoL) after endodontic therapy was evaluated through a questionnaire. Fifty-four patients affected by pulp necrosis with or without apical periodontitis biofilm disease were selected for endodontic treatment and randomly assigned to Group A (n = 27) with traditional irrigation and Group B (n = 27), with PIPS irrigation applied according to the protocol. Shaping was performed with ProGlider and ProTaper Next, and irrigation was performed with 5% NaOCl and 10% EDTA. Intracanal samples for culture tests were collected before and after irrigation. The microbiological analysis was evaluated by the Kolmogorov–Smirnov normality and Mann–Whitney tests ($p < 0.05$). A self-assessment questionnaire was used to evaluate the QoL during the 7 days after treatment; differences were analyzed with Student's t-test. Irrigation with the PIPS device was significantly effective in reducing bacterial counts, which were higher for facultative than obligate anaerobic strains, particularly for Gram-negative bacteria, without statistical significance ($p > 0.05$). The QoL indicators appeared to be more favorable on postoperative Day 1 for the patients enrolled in the PIPS group. Among the other analyzed variables, the PIPS method showed less discomfort than the traditional irrigation protocol.There were no significant differences among the QoL indicators, except for the maximum pain ,eating difficulty and difficulty performing daily functions in the first few days post-treatment. This study suggested that PIPS may represent an aid to root canal disinfection not affecting the patients' QoL, particularly for the first day after treatment.(Mandras et al., 2020)

None of the studies could delineate the exact reason or mechanism for pain reduction.The reason for pain being influenced by multifactorial it is very difficult to delineate one particular factor.All the six studies have well defined their population with structured inclusion and exclusion criteria . Preoperative pain is considered as one of the predictable outcomes for postoperative pain which was taken into consideration in all the included studies except the study by Dagher et al(Dagher et al., 2019). The final apical diameter of the root canal has its influence on the postoperative pain ,which was taken care of in all the included studies by standardizing the endodontic protocol between the comparison groups.

Previous systematic review by Decurcio et al (Decurcio et al., 2019)and Susila et al (Decurcio et al., 2019; Susila & Minu, 2019)has also shown that machine assisted /activated irrigation has better control over the postoperative pain and they have also given recommendations for further research on the irrigant activation techniques for improving the clinical efficacy.Our institution is passionate about high quality evidence based research and has excelled in various fields (R.

DOI: 10.5281/zenodo.7095016

K. Jain et al., 2014; Johnson et al., 2019; Keerthana & Thenmozhi, 2016; Lakshmi et al., 2015; Neelakantan et al., 2011). We hope this study adds to this rich legacy.

This systematic review could highlight the variability in study designs among the included studies which assessed the association of postoperative pain and irrigation techniques. It recommends the standardisation for factors such as preoperative factors (patient age,sex,type of tooth,pulp/periodontal diagnosis,preoperative pain),intraoperative factors (irrigant type,volume &concentration,activation technique,instrumentation protocol)and postoperative factors (analgesics prescription ,technique used to evaluate pain ,follow up).

CONCLUSION

With the available evidence from the included studies, the quality of the clinical trials was moderate. Most of the included studies did follow a common methodology to assess the incidence of postoperative pain. More number of clinical trials adhering to accurate randomisation, allocation concealment and blinding have to be carried out to arrive at a definitive conclusion for reduction of postoperative pain after the use of different irrigation techniques.

CONFLICT OF INTEREST : Nil

FINANCIAL SUPPORT : Nil

REFERENCES

- Azeem, R. A., & Sureshbabu, N. M. (2018). Clinical performance of direct versus indirect composite restorations in posterior teeth: A systematic review. *Journal of Conservative Dentistry: JCD*, *21*(1), 2.
- Caron, G., Nham, K., Bronnec, F., & Machtou, P. (2010). Effectiveness of different final irrigant activation protocols on smear layer removal in curved canals. *Journal of Endodontia*, *36*(8), 1361–1366.
- Carver, K., Nusstein, J., Reader, A., & Beck, M. (2007). In vivo antibacterial efficacy of ultrasound after hand and rotary instrumentation in human mandibular molars. *Journal of Endodontia*, *33*(9), 1038–1043.
- Çiçek, E., Koçak, M. M., Koçak, S., Sağlam, B. C., & Türker, S. A. (2017). Postoperative pain intensity after using different instrumentation techniques: a randomized clinical study. *Journal of Applied Oral Science: Revista FOB*, *25*(1), 20–26.
- Dagher, J., El Feghali, R., Parker, S., Benedicenti, S., & Zogheib, C. (2019). Postoperative Quality of Life Following Conventional Endodontic Intracanal Irrigation Compared with Laser-Activated Irrigation: A Randomized Clinical Study. *Photobiomodulation, Photomedicine, and Laser Surgery*, *37*(4), 248–253.

DOI: 10.5281/zenodo.7095016

- Decurcio, D. A., Rossi-Fedele, G., Estrela, C., Pulikkotil, S. J., & Nagendrababu, V. (2019). Machine-assisted Agitation Reduces Postoperative Pain during Root Canal Treatment: A Systematic Review and Meta-analysis from Randomized Clinical Trials. *Journal of Endodontia*, *45*(4), 387–393.e2.
- Felicita, A. S. (2017). Quantification of intrusive/retraction force and moment generated during en-masse retraction of maxillary anterior teeth using mini-implants: A conceptual approach. *Dental Press Journal of Orthodontics*, *22*(5), 47–55.
- Felicita, A. S., Chandrasekar, S., & Shanthasundari, K. K. (2012). Determination of craniofacial relation among the subethnic Indian population: a modified approach - (Sagittal relation). *Indian Journal of Dental Research: Official Publication of Indian Society for Dental Research*, *23*(3), 305–312.
- Gondim, E., Jr, Setzer, F. C., Dos Carmo, C. B., & Kim, S. (2010). Postoperative pain after the application of two different irrigation devices in a prospective randomized clinical trial. *Journal of Endodontia*, *36*(8), 1295–1301.
- Gu, L.-S., Kim, J. R., Ling, J., Choi, K. K., Pashley, D. H., & Tay, F. R. (2009). Review of contemporary irrigant agitation techniques and devices. *Journal of Endodontia*, *35*(6), 791–804.
- Gündoğar, M., Sezgin, G. P., Kaplan, S. S., Özyürek, H., Uslu, G., & Özyürek, T. (2020). Postoperative pain after different irrigation activation techniques: a randomized, clinical trial. *Odontology / the Society of the Nippon Dental University*. https://doi.org/10.1007/s10266-020-00553-5
- Jain, A. R. (2017). Prevalence of Partial Edentulousness and treatment needs in Rural Population of South India. *World Journal of Dentistry*, *8*(3), 213–217.
- Jain, R. K., Kumar, S. P., & Manjula, W. S. (2014). Comparison of intrusion effects on maxillary incisors among mini implant anchorage, j-hook headgear and utility arch. *Journal of Clinical and Diagnostic Research: JCDR*, *8*(7), ZC21–ZC24.
- Johnson, J., Lakshmanan, G., Biruntha, M., Vidhyavathi, R. M., Kalimuthu, K., & Sekar, D. (2019). Computational identification of MiRNA-7110 from pulmonary arterial hypertension (PAH) ESTs: a new microRNA that links diabetes and PAH. *Hypertension Research: Official Journal of the Japanese Society of Hypertension*, *43*(4), 360–362.
- Keerthana, B., & Thenmozhi, M. S. (2016). Occurrence of foramen of huschke and its clinical significance. *Journal of Advanced Pharmaceutical Technology & Research*, *9*(11), 1835.
- Krishnan, V., & Lakshmi, T. (2013). Bioglass: A novel biocompatible innovation. *Journal of Advanced Pharmaceutical Technology & Research*, *4*(2), 78–83.
- Kumar, M. S., Vamsi, G., Sripriya, R., & Sehgal, P. K. (2006). Expression of matrix metalloproteinases (MMP-8 and -9) in chronic periodontitis patients with and without diabetes mellitus. *Journal of Periodontology*, *77*(11), 1803–1808.
- Lakshmi, T., Krishnan, V., Rajendran, R., & Madhusudhanan, N. (2015). Azadirachta indica: A herbal panacea in dentistry - An update. *Pharmacognosy Reviews*, *9*(17), 41–

DOI: 10.5281/zenodo.7095016

44.

- Mandras, N., Pasqualini, D., Roana, J., Tullio, V., Banche, G., Gianello, E., Bonino, F., Cuffini, A. M., Berutti, E., & Alovisi, M. (2020). Influence of Photon-Induced Photoacoustic Streaming (PIPS) on Root Canal Disinfection and Post-Operative Pain: A Randomized Clinical Trial. In *Journal of Clinical Medicine* (Vol. 9, Issue 12, p. 3915). https://doi.org/10.3390/jcm9123915
- Middha, M., Sangwan, P., Tewari, S., & Duhan, J. (2017). Effect of continuous ultrasonic irrigation on postoperative pain in mandibular molars with nonvital pulps: a randomized clinical trial. *International Endodontic Journal*, *50*(6), 522–530.
- Morsy, D. A., Negm, M., Diab, A., & Ahmed, G. (2018). Postoperative pain and antibacterial effect of 980 nm diode laser versus conventional endodontic treatment in necrotic teeth with chronic periapical lesions: A randomized control trial. *F1000Research*, *7*, 1795.
- Mp, S. K. (2017). THE EMERGING ROLE OF BOTULINUM TOXIN IN THE TREATMENT OF OROFACIAL DISORDERS: LITERATURE UPDATE. *Asian Journal of Pharmaceutical and Clinical Research*, 21–29.
- Neelakantan, P., Subbarao, C., Subbarao, C. V., De-Deus, G., & Zehnder, M. (2011). The impact of root dentine conditioning on sealing ability and push-out bond strength of an epoxy resin root canal sealer. *International Endodontic Journal*, *44*(6), 491–498.
- Patturaja, K. P. (2016). Awareness of Basic Dental Procedure among General Population. *Research Journal of Pharmacy and Technology; Raipur*, *9*(9), 1349–1351.
- Ramamoorthi, S., Nivedhitha, M. S., & Divyanand, M. J. (2015). Comparative evaluation of postoperative pain after using endodontic needle and EndoActivator during root canal irrigation: A randomised controlled trial. *Australian Endodontic Journal: The Journal of the Australian Society of Endodontology Inc*, *41*(2), 78–87.
- Rao, T. D., & Kumar, M. P. S. (2018). Analgesic efficacy of paracetamol vs ketorolac after dental extractions. *Journal of Advanced Pharmaceutical Technology & Research*, *11*(8), 3375.
- Rosenberg, P. A. (2014). *Endodontic Pain: Diagnosis, Causes, Prevention and Treatment*. Springer.
- Sathorn, C., Parashos, P., & Messer, H. (2008). The prevalence of postoperative pain and flare-up in single- and multiple-visit endodontic treatment: a systematic review. *International Endodontic Journal*, *41*(2), 91–99.
- Sekar, D., Lakshmanan, G., Mani, P., & Biruntha, M. (2019). Methylation-dependent circulating microRNA 510 in preeclampsia patients. *Hypertension Research: Official Journal of the Japanese Society of Hypertension*, *42*(10), 1647–1648.
- Seltzer, S., & Krasner, P. (1988). *Endodontology: Biologic Considerations in Endodontic Procedures*.
- Sivamurthy, G., & Sundari, S. (2016). Stress distribution patterns at mini-implant site during retraction and intrusion—a three-dimensional finite element study. *Progress in Orthodontics*, *17*(1), 1–11.

DOI: 10.5281/zenodo.7095016

- Susila, A., & Minu, J. (2019). Activated Irrigation vs. Conventional non-activated Irrigation in Endodontics - A Systematic Review. *European Endodontic Journal*, *4*(3), 96–110.
- Varela, P., Souza, E., de Deus, G., Duran-Sindreu, F., & Mercadé, M. (2019). Effectiveness of complementary irrigation routines in debriding pulp tissue from root canals instrumented with a single reciprocating file. *International Endodontic Journal*, *52*(4), 475–483.