EUROPEAN ENDODONTIC JOURNAL

SYSTEMATIC REVIEW

The Influence of Sodium Hypochlorite and Chlorhexidine on Postoperative Pain in Necrotic Teeth: A Systematic Review

Estefano BORGO SARMENTO, Ludmila da SILVA GUIMARAES, Sandro Junio de OLIVEIRA TAVARES, Katherine AZEVEDO BATISTELA RODRIGUES THULLER, Livia Azeredo ALVES ANTUNES, Leonardo DOS SANTOS ANTUNES, Cinthya Cristina GOMES

ABSTRACT

Objective: The purpose of this systematic review was to provide the answer to the question: Can sodium hypochlorite and chlorhexidine influence postoperative pain after the endodontic treatment in necrotic teeth?

Methods: The PROSPERO registration number is CRD42018096433 and was conducted following the PRISMA statements. The MeSH and free terms were used to search for articles published in the electronic databases (PubMed, Web of Science, Scopus, Cochrane Library, and Virtual Health Library), in the gray literature, and by a manual search. The reviewers selected the studies considering predetermined eligibility criteria, performed data extraction, and evaluated the risk of bias. Only clinical trials comparing the effect of sodium hypochlorite and chlorhexidine on postoperative pain in teeth of adult patients with necrotic pulps were included.

Results: Five studies were qualified for the systematic review. Two studies were considered a low risk of bias. The results showed no statistically significant difference regarding postoperative pain in the groups. Only 1 study reported a statistically significant difference in the sixth postoperative hour, and the pain was associated with the sodium hypochlorite group.

Conclusion: There was no influence of auxiliary chemical substance (NaOCl and CHX) on postoperative pain used in endodontic treatment in the teeth with pulp necrosis. However, one study observed a significant difference in the sixth postoperative hour, associated with the sodium hypochlorite group.

Keywords: Chlorhexidine, dental pulp necrosis, endodontics, postoperative pain, sodium hypochlorite

Please cite this article as: Borgo Sarmento E, Silva Guimaraes L, Oliveira Tavares SJ, Azevedo Batistela Rodrigues Thuller K, Alves Antunes LA, Dos Santos Antunes L, Gomes CC. The Influence of Sodium Hypochlorite and Chlorhexidine on Postoperative Pain in Necrotic Teeth: A Systematic Review. Eur Endod J 2020; 3: 177-85

From the Postgraduate Program (E.B.S., S.J.O.T., K.A.B.R.T.), Faculty of Dentistry, Fluminense Federal University, Nova Friburgo, Rio de Janeiro, Brazil; Postgraduate Program (L.S.G.), Faculty of Dentistry, Fluminense Federal University, Niterói, Rio de Janeiro, Brazil; Department of Specific Formation (L.A.A.A., L.D.S.A., C.C.G. ✉ cinthyagomes@id.uff.br) Faculty of Dentistry, Fluminense Federal University, Nova Friburgo, Rio de Janeiro, Brazil

Received 29 January 2020, Accepted 29 April 2020

Published online: 14 October 2020
DOI 10.14744/eej.2020.94830

HIGHLIGHTS

- Pain sensation after root canal treatment is a common undesired consequence, with the implication in the patient's quality of life;
- To date, no systematic review has been performed comparing the influence of NaOCl and CHX on postoperative pain after the endodontic treatment in teeth with pulp necrosis;
- There was no difference in postoperative pain when using NaOCl or CHX in endodontic treatment in teeth with pulp necrosis.

INTRODUCTION

The presence of microorganisms in the root canal systems is a critical factor for the development of pulp and periapical pathologies (1, 2). Therefore, the treatment of the root canal aims to suppress these microorganisms and their by-products through the mechanical action of instruments and endodontic irrigators (3-5).

Different chemical substances have been used to remove pulp tissues and microorganisms (6). Sodium hypochlorite (NaOCl) is the most common and has been widely used in endodontics for more than 70 years because of its ability to act as a solvent for organic matter and its efficient antimicrobial action, however, at high concentrations, it is likely to irritate periradicular tissues (7, 8). Complications caused by the extrusion of sodium hypochlorite during endodontic treatment can result in pain, mainly in necrotic teeth (9). This accident has been the subject of several reports describe in the literature (10-12) as well as a systematic review (13). Therefore, new alternatives to irrigation of root canals have emerged to minimize these effects (14).

Chlorhexidine (CHX) has been indicated as an alternative irrigation agent in the preparation of the root canal system, due to its broad-spectrum antimicrobial capacity, dentin tubule disinfec-

tion, dentin adsorption, high substantivity, and low toxicity compared to NaOCl (15, 16). The inability to dissolve organic tissues (17) of the CHX provides controversial in the use of this irrigant, and due to this limitation, some authors do not indicate it as the main irrigation solution in endodontic treatment, despite its utility as a final irrigation solution (18).

Pain sensation after root canal treatment is a common undesired consequence with the implication in the patient quality of life (19). Twenty-five percent to forty percent reported different degrees of pain resulting from the initiation of endodontic treatment in necrotic and vital pulps (20). Possible factors for postoperative pain are related to mechanical extrusion of debris, traumatic occlusion, preoperative pain, and extrusion of irrigating solutions (21). The best way to remove tissue remnants in areas where the instrument does not reach is by using substances. However, if extruded to the apical region, pain, swelling, and tissue damage can occur (22).

To date, no systematic review has been performed comparing the influence of these 2 irrigating substances on postoperative pain after the endodontic treatment in teeth with pulp necrosis. Therefore, the objective of this systematic review was to answer the question based on the PICOS strategy: Can sodium hypochlorite and chlorhexidine influence postoperative pain after the endodontic treatment in necrotic teeth?

MATERIALS AND METHODS

Literature search strategy

This study was registered under the PROSPERO (https://www.crd.york.ac.uk/prospero/) registration number CRD42018096433 and was conducted following the PRISMA statements (23). The literature was searched to identify published articles analyzing the influence of irrigation substances on postoperative pain. A broad search was conducted in the electronic databases: PubMed, Web of Science, Scopus, Cochrane Library, and Virtual Health Library (VHL) for articles published through November 13, 2018. The grey literature was also consulted (http://www.opengrey.eu) The MeSH terms "Pain", "Hyperemia", "Edema", "Hyperesthesia", "Fistula", "Root canal preparation", "Root canal therapy", "Root canal irrigants", Sodium hypochlorite", "Chlorhexidine", Chlorhexidine gluconate" and free terms were used. The searches were complemented by screening the references of selected studies to find any study that did not appear in the database search.

Eligibility criteria

Inclusion criteria

The inclusion criteria were based on the formulation of the clinical question and elaborated according to Population, Intervention, Comparison, Outcome, and Study (PICOS):

Population: Teeth of adult patients with necrotic pulp undergoing root canal treatment;

Interventions: Irrigation with NaOCl;

Comparisons: Irrigation with CHX;

Outcome: Effect of the irrigating substance on postoperative pain;

Study: Clinical trials, controlled clinical trials, or randomized controlled trials.

Exclusion criteria

The following studies were excluded:

i. In vitro or animal studies, review articles, case reports, opinion articles, observational studies

ii. Studies that evaluated only the antimicrobial effect of the irrigating substance

iii. Studies on primary teeth

iv. Studies that analyzed only teeth with vital pulp

Study selection

All references were tabulated in the MENDELEY program and the publications found were independently assessed by 2 reviewers (E.B.S. and L.S.G.) who excluded articles that did not meet the inclusion criteria. Articles appearing in more than 1 database were considered only once, and the duplicate references were deleted. To reduce the possibility of discarding important studies, articles in which the title and abstract were not clear, were read in full. Subsequently, the reviewers selected the studies based on the eligibility criteria through full evaluation and reading of the selected studies. If there was disagreement between authors, it was resolved after discussion with a third critic (L.S.A.), who has experience in systematic review methodology. The authors were contacted when further clarification was required on the methodology or results of the study.

Data extraction

All methodological data from the included studies were subdivided and organized as follows:

Characteristics of the studies that met the inclusion criteria

i. Author/year;

ii. Country;

iii. Type of study;

iv. Sample (size, the sample size of necrotic teeth, gender; tooth type; systemic disease; preoperative pain; preoperative medication);

v. Endodontic treatment (pulp diagnosis, instrumentation, foraminal enlargement, surgical diameter, the concentration of the substance, the number of sessions, intracanal medication, sealing technique, type of cement, and crown sealing).

Tools for analysis of postoperative symptoms

i. Author/year;

ii. Instruments used for symptom of assessment (evaluation tools; period; categorization; analyzed symptoms; postoperative medications);

iii. Results.

Quality assessment

Based on the Cochrane Handbook for Systematic Reviews of Interventions for Risk Assessment of Bias (24), the selected ar-

ticles were systematically reviewed to assess the quality of the methodology. Each domain was classified as having a high (+), low (-), or uncertain (?) risk of bias and the following parameters were recorded: random sequence generation; concealment of allocation; blindness of participants and personnel; blindness of outcome assessment; incomplete outcome data; selective reporting; inclusion and exclusion criteria; and sample calculation. For methodological quality evaluation, the studies were read in full, and the evaluators considered each domain to have a "high risk" of bias when the information provided by the article did not address the specific domain or when the information was not evident, the domain was given a rating of "uncertain". Studies that provided the necessary information were considered as having a "low risk" of bias (Fig. 2). Therefore, the study was classified as "high risk" if three or more domains were answered with "high risk". Any disagreement between authors was resolved after consensus with a third critic. The reviewers of this study sought to request data not reported in the studies through contact with the authors.

RESULTS

Included studies

Electronic and manual searches identified 775 studies in the databases (PubMed: 179; Web of Science: 8; Scopus: 441; Virtual Health Library: 52; Cochrane Library: 95), and the results

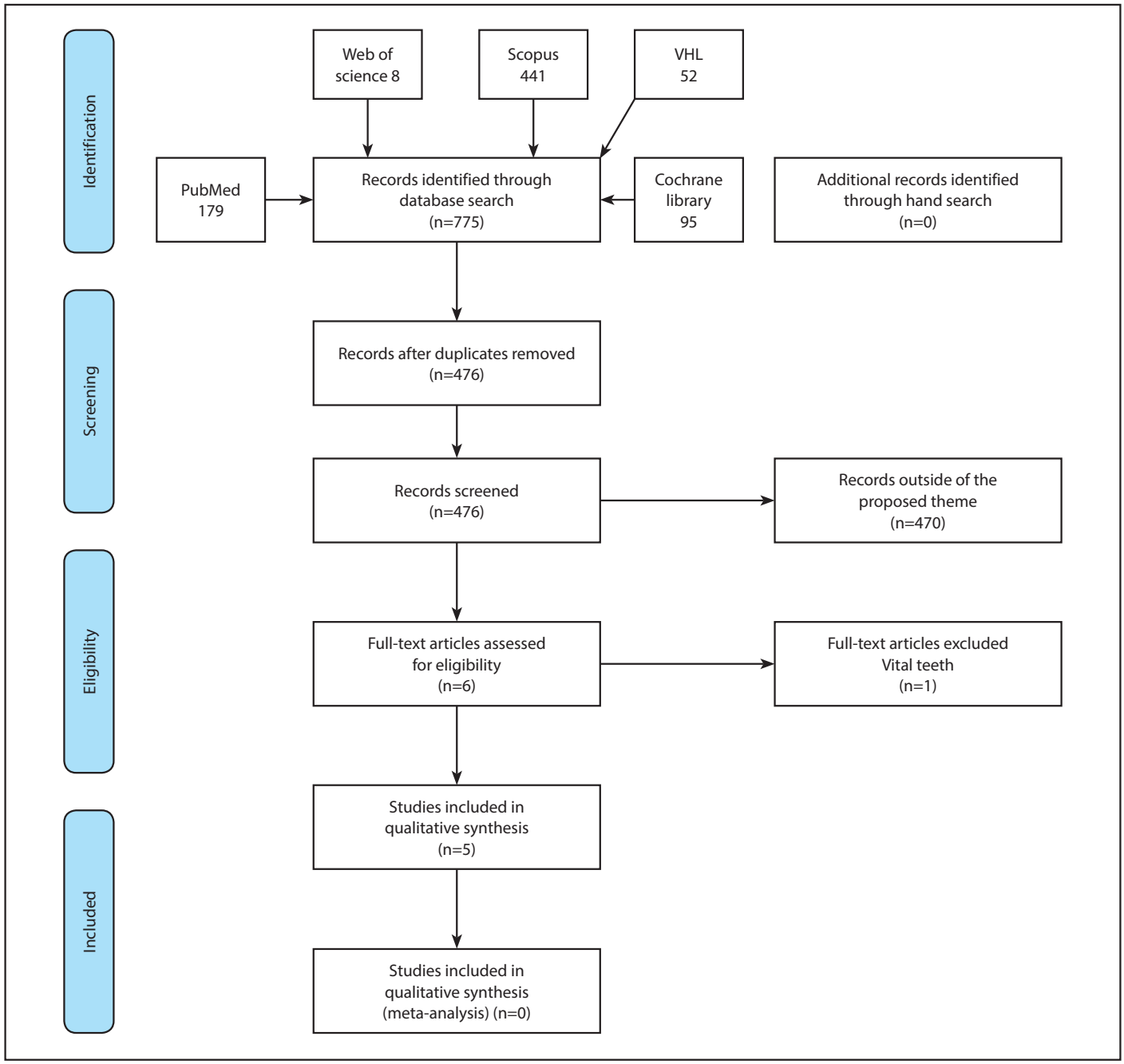

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: Prisma 2009 Flow Diagram. (From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal. pmed1000097. For more information, visit www.prisma-statement.org)

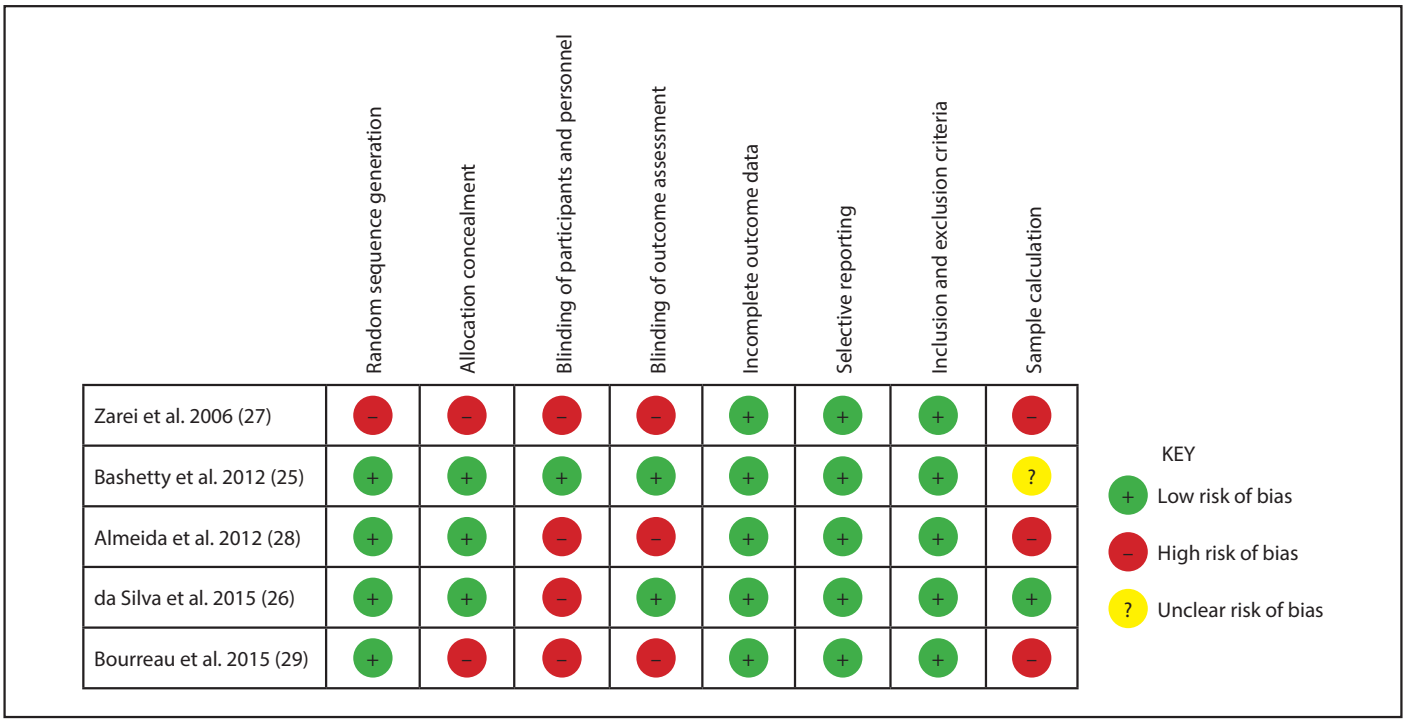

Figure 2. Quality assessment of the selected studies (The Cochrane Collaboration tool for assessing risk of bias)

were organized in a flow diagram (Fig. 1). All duplicate records were removed. A total of 470 articles were excluded at the title and abstract level because they did not meet the inclusion criteria, only 6 articles that satisfy the inclusion criteria were selected and read in their entirety, but one article for not containing analysis on necrotic teeth with periapical lesion was excluded. In the end, 5 studies were included in the final analysis. All references to the articles selected were searched manually, and no additional items were found.

Quality assessment

The overall quality of the studies and the data provided by the included studies demonstrated that the risk of bias was considered "low risk" in two studies (25, 26), and the other three studies were considered to have a "high risk" of bias (27-29) (Fig. 2).

Data analysis showed that 4 studies had a low risk of bias in the random sequence generation (25, 26, 28, 29). Two studies did not report concealment of allocation (27, 29), and only one study reported blinding of participants and personnel (25). There was a low risk of bias in all studies regarding the reporting of incomplete outcome data; selective reporting; and inclusion and exclusion criteria, however, only one of them described how the sample calculation was performed (26), 3 beings (27-29) evaluated with a high risk of bias and only one rated as unclear (25).

Clinical parameters

Data extraction from the selected studies is described in Table 1 and Table 2. All studies were clinical trials, with a minimum of 40 and a maximum of 301 samples belonging to patients of both genders with the absence of systemic diseases.

Three selected articles that studied uniradicular teeth with no preoperative pain without systemic medication at least 2 weeks before the study (25-27). However, the other 2 studies (28, 29) included uniradicular and multiradicular teeth with or without preoperative pain, despite lacking data on the use of systemic drugs.

As for instrumentation of the root canals, each study used a different technique; however, most of them used the crown-down direction with rotary files (25, 27, 28, 29), and the only one used reciprocating files (26). The concentration of the auxiliary chemical in 4 of the studies (25, 26, 28, 29) was 5.25% sodium hypochlorite and 2% chlorhexidine, although 1 of them used 2.5% sodium hypochlorite and 0.2% chlorhexidine (27). Two of the selected studies performed foraminal enlargement and established a working length equal to the actual patency length (26) to 1 mm beyond the canal length (29), to instrument the area of the apical foramen.

Endodontic treatment was completed either in a single session (26-29) or in 2 sessions (25) without the use of intracanal medication in any study. The canals were sealed in 3 studies, using the technique of the thermoplastic gutta-percha (26, 28, 29) and in one study by the lateral condensation technique (27). Also, the types of cement used were: AH 26 (27), Pulp Canal Sealer (28, 29), and AH plus (26). In this way, they obtained coronary sealing with Cavit (25, 27), Composite resin Z-250 (28), and Coltosol and composite resin or glass ionomer cement (29).

All the studies evaluated symptoms of postoperative pain after root canal treatment. The period of symptom evaluation was at least 6 hours and no more than 7 days after the procedure. The articles used the Visual Analog Scale tool (25, 27) and a self-explanatory questionnaire (28). da Silva (26) and Bourreau (29) did not report the type of questionnaire used (missing data).

TABLE 1. Characteristics of the studies that met inclusion criteria

				Samples						Endodontic treatment										
Author/year	Country	Types of study	Size	Sample size of necrotic teeth NaOCl	CHX	Gender	Tooth type	Sistemic disease	Preoperative pain	Preoperative medication	Pulp Diagnosis	Instrumentation	Foraminal enlargement	Surgical diameter	Concentration of substance NaOCl	CHX	Number of sessions	Intracanal medication	Sealing technique	Type of cement	Crown sealing
Zarei et al./ 2006 (27)	Iran	In vivo study	50	25	25	MD	Single canal	Absent	With no sign or symptom	Analgesic or antibiotic two weeks before the study	Necrotic teeth	Rotatory (Easy-race)	No	MD	2.5%	0.2%	Single	No medication	Lateral condensation technique	AH 26 sealer	Cavit temporary restoration
Bashetty et al./ 2012 (25)	India	Randomized clinical trial	40	20	20	MD	Mandibular first Premolars	MD	No preoperative pain	No medication preoperative	Irreversible pulpitis, necrosed pulp and nonvital teeth exhibiting acute apical periodontitis	Rotatory (Profile series)	No	Size 30	5.25%	2%	Two visits	No medication	MD	MD	Cavit temporary restoration
Almeida et al./ 2012 (28)	Brazil	Prospective, randomized clinical trial	126	63	63	80 women and 46 men	Single and multiple canals	Absent	No preoperative pain	Antibiotics, anti-inflammatories or analgesics for at least 1 week before the study treatment	Chronic apical periodontitis and necrotic pulp	Rotatory (ProTaper Universal) Hand files	No	F3 (size 30) Size 25, 30 or 35 Flexofile, depending on the anatomy of the canal.	5.25%	2% CHX+ normal saline	Single	No medication	Vertical condensation technique (System B) and Obtura II system	Pulp Canal Sealer EWT	Z-250 resin composite
da Silva et al./ 2015 (26)	Brazil	Prospective, randomized clinical trial	62	31	31	23 men and 39 woman	Single Canal	Absent	No preoperative pain	None of the patients was taking any medication that could alter his/her perception of pain	Asymptomatic necrotic teeth and evidence of apical periodontitis	Reciprocating (Reciproc 40)	Yes	R40 (Size 40/0.06 taper)	5.25%	2% CHX +0.9% saline solution	Single	No medication	Vertical compaction with the continuous -wave technique	AH Plus sealer	MD
Bourreau et al. 2015 (29)	Brazil	Prospective, randomized clinical study	301	100		MD	Single and multiple canals	MD	Yes/no preoperative pain		Vital tooth; Non vital tooth; Retreatment	Rotatory (Mtwo)	Yes	Mtwo 25/.06	5.25%	2%	Single	No medication	De Deus obturation technique; thermoplasticization and vertical compaction	Pulp Canal Sealer EWT	Coltosol and composite resin or glass fiber post cementation, as required

MD: Missing data, NaOCL: Sodium hypochlorite, CHX: Chlorhexidine

In addition to pain, only 2 studies evaluated the presence of swelling (25, 27). Regarding the use of medication, cases in which any type of pain or discomfort after treatment was reported, the operator was informed, and the patients were instructed to use analgesics (25, 26, 28) and anti-inflammatory drugs (29).

Thus, 4 studies resulted in no statistically significant difference regarding the use of the chemical auxiliary substance (NaOCl and CHX) in the evaluation of postoperative pain (26-29), however, 1 of these studies (25) showed a statistically significant difference (P=0.006) at the sixth postoperative hour, and the pain was associated with the NaOCl group (Table 2).

DISCUSSION

Microorganisms are the main cause of pulpal and periapical pathologies, which mainly occur in infected root canals (30). During treatment of the root canal system, especially on necrotic teeth, disinfection through instrumentation and irrigation with auxiliary chemical substances are fundamental steps before the filling of a root canal to control and reduce microorganisms (28, 31).

Cases of pain or discomfort after endodontic treatment are attributed to a tissue response caused by one or more factors, including over-instrumentation and extrusion of irrigation solutions (32, 33).

The painful experience after endodontic treatment is the greatest fear of the patients. This fact allows the appearance of several studies to correlate understanding the influence of endodontic treatment on the prevalence of pain (34). Irrigation is an important step during the treatment of root canals, however, it can lead to the extrusion of these substances into the periapical region making it possible to cause pain between the consultations (9). Soon, the use of a biocompatible and nontoxic substance is required to diminish or avoid postoperative discomfort (26).

NaOCl has been described as the most common irrigant of choice in endodontic treatments (35). Although CHX does not dissolve necrotic tissues, this substance is used in association with NaOCl as a final irrigation solution (36). However, it can be used as a main irrigant as shown by several authors in this systematic review (25-29).

The irrigation of root canals with auxiliary chemical substances such as NaOCl and CHX is fundamental, however, the potential toxicity combined with negligent injection enables extrusion to the periapical tissues, increasing postoperative discomfort. Several reports of pain and complications caused by chemical irrigants such as NaOCl have been described (37, 38).

TABLE 2. Analysis tools of post-operative symptoms

Instruments used for symptom of assessment						
Author/year	Evaluation tools	Period	Categorization	Analyzed symptoms	Postoperative medications	Results
Zarei et al./ 2006 (27)	Visual Analogue Scale (VAS)	6, 12, 18, 24 and 48h	Pain: no pain, mild, moderate and severe. Swelling: no swelling, mild, moderate and severe.	Pain and swelling	MD	No significant difference was found for the incidence of pain in two groups. No significant difference was detected in the incidence of swelling in jaws 24h after treatment, while more swelling was observed in maxilla after 48h.
Bashetty et al./ 2012 (25)	Modified visual analogue scale (VAS)	At a procedure, at 6 and 24 hours, and on 4th and 7th days after the cleaning and shaping.	None, mild, moderate and severe.	Pain, discomfort and swelling	Patients who had severe pain or discomfort, swelling and other side effects after their instrumentation appointment could contact endodontic resident to receive advice or medication(s).	Statistically significant difference was observed (P=0.006) at 6th hour postoperatively, and more pain was associated with NaOCl group.
Almeida et al./ 2012 (28)	Questionnaire for assessment of pain (on a self-explanatory scale) and determination of frequency of use of analgesics after the root canal procedure	24, 48, 72hs and 7 days after treatment	Pain: 0=absent, 1=mild (not requiring analgesia), 2=moderate (relieved by analgesia) and 3=severe (not relieved by analgesia).	Pain	Analgesic	No significant differences between the 2 groups in terms of postoperative pain (P>0.05). The worst period was 24 hours after the treatment, when 2 (3%) of the 63 patients in each group experienced moderate pain.
da Silva et al./ 2015 (26)	Simple verbal categorization form after treatment according to Silva et al 2013.	24, 48 and 72h after treatment	Pain: no pain (1), the patient feels well; slight pain (2), if the patient is distracted, he/she does not feel the pain and no analgesic is required; moderate pain (3), the patient feels moderate pain even while concentrating on some other activity and analgesic is required; and severe pain (4), the patient is no longer able to perform any type of activity, needs to lie down and seek dentist help (analgesics had little or no effect in relieving the pain).	Pain and number of used analgesic tablets	Analgesic (400 mg Ibuprofen)	No statistically significant differences were seen between the groups at any observation period. No significant difference among the groups was observed in the mean number of used analgesic tablets.
Bourreau, et al./ 2015 (29)	MD	24h	Pain: sensitivity, mild pain, moderate pain or severe pain; and used doses of medication	Pain and discomfort	100 mg of Nimesulide every 12 hours for 3 days	The auxiliary chemical substances used had no statistically significant influence on the outcome of postoperative pain, irrespective of pulp status of the teeth. And only 6.3% (19/301) had some level of pain and used one or two doses of medication.

MD: Missing data

Therefore, this systematic review sought all available literature comparing two chemical substances (NaOCl and CHX) used in endodontic treatment concerning postoperative pain, in teeth with pulp necrosis, to improve the clinical practices through the scientific evidence available of low risk of bias.

In this systematic review, 5 articles were included, of which, after assessment and categorization of study quality regarding the risk of bias, 2 were considered to have a low risk of bias (25, 26), and the others had a high risk of bias (27-29). Although 4 studies (25, 26, 28, 29) performed adequate randomization, only 1 study (25) performed blinding of participants and personnel. These practices avoid the tendency of bias ensuring greater reliability to the study.

Postoperative pain is significant clinical discomfort, and the irrigation step should be performed with caution and without pressure, to avoid such discomfort from the treatment. Teeth with necrotic pulps are possible reservoirs of infection, and when subjected to root canal treatments during the preparation of the root canal system, the use of irrigating instruments and substances results in the extrusion of debris and/or the chemical itself with a greater chance of pain and inflammation of the periradicular tissues (39). Salzgerber showed through the use of a radiopaque solution that the irrigation in root canals with necrotic pulps tends to pass beyond the instrumented area when compared to the vital pulps, and if extruded in the periapical tissues, can fill random spaces (40). Different concentrations and irrigation protocols of NaOCl (2.5%-5.25%) and CHX (0.2%-2%) were used to evaluate pain and postoperative symptoms in the five selected articles. In any case, NaOCl or CHX should be used with caution to avoid discomfort during treatment. To standardize the use of irrigating substances and reduce bias, only 2 of the selected studies (25, 26) measured the injection length of the chemical substance through the rubber stop in up to 3 mm short of the working length to reduce the risk of extravasation.

Four articles selected (26-29) did not demonstrate a statistically significant difference in pain level between the two substances; in contrast to the study by Bashetty (25) that verified a significant difference only at the 6th hour postoperatively and more pain was associated with NaOCl group. According to this author (25), this result can indicate that the probable cause of pain is due to the greater number of cases in the necrotic pulp group. Furthermore, the presence of microorganisms and their endotoxins in the root canal with necrotic pulp may trigger pain (41, 42).

The influence of the use of manual, rotary, and reciprocating instruments on postoperative pain after the root canals treatment has been studied. Several results (43-45), including a systematic review (46), show that rotating and reciprocating systems contribute less postoperative pain compared with manual files and other systems. However, operator experience is a factor that also influences postoperative pain after root canal treatment (47).

Although the selected studies used rotary (25, 27-29) and reciprocating (26) systems for root canal instrumentation, this variable presents no risk of bias for this study because of the different chemical substances used (NaOCl or CHX) were compared with the same operative technique.

Four studies (26-29) finished their endodontic treatment in a single session, and they did not observe a statistically significant difference in postoperative pain between the 2 groups of irrigating substances (NaOCl and CHX). However, only 1 of these studies performed the treatment in 2 sessions and observed significantly greater pain associated with the NaOCl group at the sixth postoperative hour (25).

Although it is common, postoperative pain is an unpleasant and unwanted sensation after endodontic treatment; however, it is important to point out that the evaluation of pain is subjective, and the threshold of each person is unique (20). Therefore, to obtain a good result in the evaluation of pain, an adequate scale or questionnaire is indispensable, so that the questions are assimilated by the patients and well interpreted by the researchers.

da Silva (26) and Almeida (28) evaluated pain by questionnaire, and 2 studies evaluated pain by VAS (27, 25), which, despite the ability to assess the intensity of pain and changes that occur during treatment, cannot determine the cause (48). Nevertheless, the pain condition is variable and can be modulated by physical, psychological and generated conditions beyond the experimental procedure (25). The use of a pain scale plays an important role in this analysis. The VAS when properly planned and applied can be considered a viable scale instrument to estimate pain intensity (49).

This systematic review can be considered as low risk of bias, due to the extensive research in the literature and careful methodological qualification. However, it is necessary to consider some limitations that can alter the quality of the analyzed results. First, non-standardization of the periods of evaluation of the pain scales was observed. Second, the absence of data and differences in the distribution of samples by sex, suggest a potential risk of bias, since women tend to have lower thresholds and tolerance to pain than men (48). Third, the criterion for inclusion, randomization, blinding, and quantity of samples that were not displayed influenced the observed effects and evidenced a risk of bias. The variation of the pain evaluation times and missing data for provided by the articles clarifying the number of patients with postoperative pain in necrotic teeth for each group (NaOCl or CHX) analyzed, prevented the accomplishment of a meta-analysis.

In addition, postoperative pain can be the result of different factors such as pulpal and periradicular status, inadequate instrumentation, extrusion of debris, occlusal trauma, preoperative pain, periodontal pathosis, and extrusion of irrigation solutions (21). And, the visual analog scale is considered a subjective method that evaluates only pain, and this condition may be related also to other factors, however as the articles are standardized with similar groups, this reduces the risk of bias.

Therefore, caution is needed in interpreting these data and we recommend further research with randomized clinical trials,

with appropriate sample size and objective data, since they are necessary to reduce the risk of bias and allow the assessment and interpretation of postoperative pain related to use of endodontic irrigators.

CONCLUSION

In conclusion, understanding that irrigation is an important step during endodontic treatment, the results of this systematic review showed no influence of auxiliary chemical substances (NaOCl and CHX) on postoperative pain used in the endodontic treatment of teeth with pulp necrosis. However, one study was observed a significant difference in postoperative pain associated with the NaOCl group at the sixth postoperative hour.

Disclosures

Conflict of interest: No potential conflict of interest relevant to this article was reported.

Ethics Committee Approval: Not applicable.

Peer-review: Externally peer-reviewed.

Financial Disclosure: Self-funded.

Authorship contributions: Concept – E.B.S., L.S.G., S.J.O.T., K.A.B.R.T., L.A.A.A., L.S.A., C.C.G.; Design – E.B.S., L.S.G., L.A.A.A., L.S.A., C.C.G.; Supervision – L.A.A.A., L.S.A., C.C.G.; Funding - None; Materials - None; Data collection &/or processing – E.B.S., L.S.G.; Analysis and/or interpretation – E.B.S., L.S.G.; Literature search – E.B.S., L.S.G.; Writing – E.B.S., L.S.G. L.A.A.A., L.S.A., C.C.G.; Critical Review – E.B.S., L.S.G., S.J.O.T., K.A.B.R.T., L.A.A.A., L.S.A., C.C.G.

REFERENCES

1. Kakehashi S, Stanley HR, Fitzgerald RJ. The effects of surgical exposures of dental pulps in germ-free and conventional laboratory rats. Oral Surg Oral Med Oral Pathol 1965; 20:340–9.
2. Sundqvist G. Associations between microbial species in dental root canal infections. Oral Microbiol Immunol 1992; 7(5):257–62.
3. Ercan E, Ozekinci T, Atakul F, Gül K. Antibacterial activity of 2% chlorhexidine gluconate and 5.25% sodium hypochlorite in infected root canal: in vivo study. J Endod 2004; 30(2):84–7.
4. Harrison JW. Irrigation of the root canal system. Dent Clin North Am 1984; 28(4):797–808.
5. Jeansonne MJ, White RR. A comparison of 2.0% chlorhexidine gluconate and 5.25% sodium hypochlorite as antimicrobial endodontic irrigants. J Endod 1994; 20(6):276–8.
6. Johnson BR, Remeikis NA. Effective shelf-life of prepared sodium hypochlorite solution. J Endod 1993; 19(1):40–3.
7. Senia ES, Marshall FJ, Rosen S. The solvent action of sodium hypochlorite on pulp tissue of extracted teeth. Oral Surg Oral Med Oral Pathol 1971; 31(1):96–103.
8. Zehnder M. Root canal irrigants. J Endod 2006; 32(5):389–98.
9. Saba K, Maxood A, Abdullah S, Riaz A, Uddin S. Comparison of frequency of pain in root canal treatment using sodium hypochlorite and chlorhexidine as root canal irrigants. J Pak Med Assoc 2018; 68(9):1334–8.
10. Tsk L, Of W, Syh T. A case report of sodium hypochlorite accident. Hong Kong J Emerg Med 2010; 17(2):173–6.
11. Hatton J, Walsh S, Wilson A. Management of the sodium hypochlorite accident: a rare but significant complication of root canal treatment. BMJ Case Rep 2015; 2015:bcr2014207480.
12. Faras F, Abo-Alhassan F, Sadeq A, Burezq H. Complication of improper management of sodium hypochlorite accident during root canal treatment. J Int Soc Prev Community Dent 2016; 6(5):493–6.
13. Guivarc'h M, Ordioni U, Ahmed HM, Cohen S, Catherine JH, Bukiet F. Sodium hypochlorite accident: A Systematic Review. J Endod 2017; 43(1):16–24.
14. Ferraz CC, Gomes BP, Zaia AA, Teixeira FB, Souza-Filho FJ. In vitro assessment of the antimicrobial action and the mechanical ability of chlorhexidine gel as an endodontic irrigant. J Endod 2001; 27(7):452–5.
15. Komorowski R, Grad H, Wu XY, Friedman S. Antimicrobial substantivity of chlorhexidine-treated bovine root dentin. J Endod 2000; 26(6):315–7.
16. Gomes BP, Vianna ME, Zaia AA, Almeida JF, Souza-Filho FJ, Ferraz CC. Chlorhexidine in endodontics. Braz Dent J 2013; 24(2):89–102.
17. Okino LA, Siqueira EL, Santos M, Bombana AC, Figueiredo JA. Dissolution of pulp tissue by aqueous solution of chlorhexidine digluconate and chlorhexidine digluconate gel. Int Endod J 2004; 37(1):38–41.
18. Rahimi S, Janani M, Lotfi M, Shahi S, Aghbali A, Vahid Pakdel M, et al. A review of antibacterial agents in endodontic treatment. Iran Endod J 2014; 9(3):161–8.
19. Dioguardi M, Gioia GD, Illuzzi G, Laneve E, Cocco A, Troiano G. Endodontic irrigants: Different methods to improve efficacy and related problems. Eur J Dent 2018; 12(3):459–66.
20. Silva EJ, Menaged K, Ajuz N, Monteiro MR, Coutinho-Filho Tde S. Postoperative pain after foraminal enlargement in anterior teeth with necrosis and apical periodontitis: a prospective and randomized clinical trial. J Endod 2013; 39(2):173–6.
21. Hou XM, Su Z, Hou BX. Post endodontic pain following single-visit root canal preparation with rotary vs reciprocating instruments: a meta-analysis of randomized clinical trials. BMC Oral Health 2017; 17(1):86.
22. Alkahtani A, Al Khudhairi TD, Anil S. A comparative study of the debridement efficacy and apical extrusion of dynamic and passive root canal irrigation systems. BMC Oral Health 2014; 14:12.
23. Moher D, Liberati A, Tetzlaff J, Altman DG; PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med 2009; 6(7):e1000097.
24. Higgins JP, Altman DG, Gøtzsche PC, Jüni P, Moher D, Oxman AD, et al; Cochrane Bias Methods Group; Cochrane Statistical Methods Group. The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. Version 2. BMJ 2011; 343:d5928.
25. Bashetty K, Hegde J. Comparison of 2% chlorhexidine and 5.25% sodium hypochlorite irrigating solutions on postoperative pain: a randomized clinical trial. Indian J Dent Res 2010; 21(4):523–7.
26. da Silva EJ, Monteiro MR, Belladonna FG, Almeida JF, De-Deus G, Neves Ade A. Postoperative pain after foraminal instrumentation with a reciprocating system and different irrigating solutions. Braz Dent J 2015; 26(3):216–21.
27. Zarei M, Bidar M. Comparison of two intracanal irrigants' effect on flare-up in necrotic teeth. Iran Endod J 2006; 1(4):129–32.
28. Almeida G, Marques E, De Martin AS, da Silveira Bueno CE, Nowakowski A, Cunha RS. Influence of irrigating solution on postoperative pain following single-visit endodontic treatment: randomized clinical trial. J Can Dent Assoc 2012; 78:c84.
29. Bourreau MLS, Soares AJ, Souza-Filho FJ. Evaluation of postoperative pain after endodontic treatment with foraminal enlargement and obturation using two auxiliary chemical protocols. Rev Odontol UNESP 2015; 44(3):157–62.
30. Grossman LI, Meiman BW. Solution of pulp tissue by chemical agents. J Am Dent Assoc 1941; 28(2):223–5.
31. Sjögren U, Figdor D, Persson S, Sundqvist G. Influence of infection at the time of root filling on the outcome of endodontic treatment of teeth with apical periodontitis. Int Endod J 1997; 30(5):297–306.
32. Siqueira JJ, Barnett F. Interappointment pain: mechanisms, diagnosis, and treatment. Endod Topics 2004; 7(1):93–109.
33. Figini L, Lodi G, Gorni F, Gagliani M. Single versus multiple visits for endodontic treatment of permanent teeth: a Cochrane systematic review. J Endod 2008; 34(9):1041–7.
34. Pak JG, White SN. Pain prevalence and severity before, during, and after root canal treatment: a systematic review. J Endod 2011; 37(4):429–38.
35. Mohammadi Z. Sodium hypochlorite in endodontics: an update review. Int Dent J 2008; 58(6):329–41.
36. Surender LR, Shikha A, Swathi A, Manaswini C, Habeeb A, Prabha SS. Alexidine: a Safer and an Effective Root Canal Irrigant than Chlorhexidine. J Clin Diagn Res 2017; 11(7):ZC18–21.
37. Hülsmann M, Hahn W. Complications during root canal irrigation--literature review and case reports. Int Endod J 2000; 33(3):186–93.
38. Gonçalves LS, Rodrigues RC, Andrade Junior CV, Soares RG, Vettore MV. The effect of sodium hypochlorite and chlorhexidine as irrigant solutions for root canal disinfection: A systematic review of clinical trials. J Endod 2016; 42(4):527–32.
39. Akbar I. Efficacy of prophylactic use of antibiotics to avoid flare up During root canal treatment of nonvital teeth: A randomized clinical trial. J Clin Diagn Res 2015; 9(3):ZC08–11.

40. Salzgeber RM, Brilliant JD. An in vivo evaluation of the penetration of an irrigating solution in root canals. J Endod 1977; 3(10):394–8.
41. Seltzer S, Farber PA. Microbiologic factors in endodontology. Oral Surg Oral Med Oral Pathol 1994; 78(5):634–45.
42. Cardoso FG, Chung A, Martinho FC, Camargo CH, Carvalho CA, Gomes BP, et al. Investigation of bacterial contents from persistent endodontic infection and evaluation of their inflammatory potential. Braz Dent J 2016; 27(4):412–8.
43. Arias A, de la Macorra JC, Azabal M, Hidalgo JJ, Peters OA. Prospective case controlled clinical study of post-endodontic pain after rotary root canal preparation performed by a single operator. J Dent 2015; 43(3):389–95.
44. Kashefinejad M, Harandi A, Eram S, Bijani A. Comparison of single visit post endodontic pain using Mtwo rotary and Hand K-File instruments: A randomized clinical trial. J Dent (Tehran) 2016; 13(1):10–7.
45. Mollashahi NF, Saberi EA, Havaei SR, Sabeti M. Comparison of postoperative pain after root canal preparation with two reciprocating and rotary single-file systems: A randomized clinical trial. Iran Endod J 2017; 12(1):15–9.
46. Sun C, Sun J, Tan M, Hu B, Gao X, Song J. Pain after root canal treatment with different instruments: A systematic review and meta-analysis. Oral Dis 2018; 24(6):908–19.
47. García-Font M, Duran-Sindreu F, Calvo C, Basilio J, Abella F, Ali A, et al. Comparison of postoperative pain after root canal treatment using reciprocating instruments based on operator's experience: A prospective clinical study. J Clin Exp Dent 2017; 9(7):e869–74.
48. Borges Silva EA, Guimarães LS, Küchler EC, Antunes LAA, Antunes LS. Evaluation of effect of foraminal enlargement of necrotic teeth on postoperative symptoms: A systematic review and meta-analysis. J Endod 2017; 43(12):1969–77.
49. Price DD, McGrath PA, Rafii A, Buckingham B. The validation of visual analogue scales as ratio scale measures for chronic and experimental pain. Pain 1983; 17(1):45–56.