



Cryotherapy and Post-Treatment Endodontic Pain

Mina Khayamzadeh ¹, Ava Taghizadeh ^{2*} 

1. Department of Oral and Maxillofacial Medicine, International Campus, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran.

2. Department of Oral Medicine, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran.

ARTICLE INFO

Article Type: Original Article

Received: 1 June 2024

Revised: 10 August 2024

Accepted: 27 September 2024

*Corresponding author:

Ava Taghizadeh

Department of Oral Medicine, School of Dentistry,
Tehran University of Medical Sciences, Tehran,
Iran.

Tel: +98-21-84903747

Fax: +98-21-84903747

Email: taghizadeh.ava.71@gmail.com

ABSTRACT

Introduction: The management and approach of dealing with pain after endodontic treatment is one of the most important fields of endodontics, which has received special attention in recent years. The effect of cryotherapy can be achieved by reducing blood flow and metabolic activity by suppressing neurotransmitters and increasing oxygenation in the damaged tissue. We aimed to conduct a systematic review of randomized clinical trials between 2023 and 2024 regarding the effect of cryotherapy in reducing pain after endodontic treatment.

Materials and Methods: This research is prepared and presented based on PRISMA reporting items. The databases used for this research are PubMed, Scopus and Google Scholar. Gray texts were also done by searching the sources of found articles. The time limitation for the search strategy was set for 2023 and 2024. Inclusion criteria were based on the PICOTS definition. To assess the risk of bias, the ROB2 tool was used.

Results: Based on the search results in databases, 138 articles were found in 2023 and 2024. Finally, 19 studies were included in this review. Finally, five articles had a mild risk of bias, and six studies had a moderate risk of bias. Other studies were also unbiased based on the evaluation. Finally, we included them all in the review study. For each of the studies included in this review, the name of the first author, age of the participants, sample size, population under study, groups under study, outcome, findings and final interpretation were extracted. The tool used to measure pain in 3 articles was the NRS scale; one used VRS, and other studies used VAS. The range of age groups used in all studies was from a minimum 4 of four to a maximum of 60 years. The sample size was in the range of 20 to 152.

Conclusion: It was concluded that cryotherapy can be used as a pain relief method after dental surgery. However, this evidence was accompanied by limitations for the included studies.

Keywords: Cryotherapy; Post treatment; Endodontic; Pain; Systematic review.

Please cite this Article as:

Khayamzadeh M, Taghizadeh A. Cryotherapy and Post-Treatment Endodontic Pain. J Craniomaxillofac Res 2024; 11(4): 240-248. DOI:



Copyright © 2024 Tehran University of Medical Sciences.

This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International license (<https://creativecommons.org/licenses/by-nc/4.0/>). Non-commercial uses of the work are permitted, provided the original work is properly cited.

Introduction

The management and approach to dealing with pain after endodontic treatment is one of the most important fields of endodontics, which has received special attention in recent years [1]. Pain after endodontic treatment exists in the range between 3% and 58% [2]. In another study, after 24 h it was 25% and 40% [3]. This pain occurs after endodontic treatment, which is caused by chemical, mechanical or microbial damage in the peri-radicular tissues. In order to control this pain, there are many treatments prescribed by the doctor in different texts, including intracanal treatments or occlusal reduction, non-steroidal anti-inflammatory drugs, opioid use, calcium hydroxide use, and laser use. Each of the above-mentioned cases has disadvantages that can cause inappropriate effects on the patient. One of the interventions to reduce pain is the cryotherapy technique, which lowers the temperature of the tissue for the target of care [4]. Cryotherapy is a low-cost, easy and non-toxic technique [5-7].

Cryotherapy is an approach based on anti-inflammatory treatment [8]. It is a term that is taken from ancient Greece, which was “cryo” instead of “cold” and “therapy” instead of “cure” [8]. In ancient Egypt, they used low temperatures to treat inflammation and wounds [9]. The effect of cryotherapy can be achieved by reducing blood flow and metabolic activity by suppressing neurotransmitters and increasing oxygenation in the damaged tissue. In addition to endodontics, cryotherapy is used for various treatment fields in orthopedics, maxillofacial surgery, physiotherapy, and so on [8]. Since much attention has been paid to cryotherapy in recent years [10,11], in addition to the research grounds for conducting more standardized randomized clinical trials than in the past, and despite the systematic reviews that exist on earlier studies, therefore a need to conduct a review study on more recent clinical trials. Therefore, in this research, we aimed to conduct a systematic review of randomized clinical trials between 2023 and 2024 regarding the effect of cryotherapy in reducing pain after endodontic treatment.

Materials and Methods

This research is prepared and presented based on Prisma reporting items. The databases used for this research are PubMed, Scopus and Google Scholar. Included keywords to find the articles were <<cryotherapy, post endodontic, pain, treatment>>. Gray texts were also done by searching the sources of found articles. Articles that were published in English are consid-

ered in this review. The time limitation for the search strategy was set for 2023 and 2024.

Inclusion criteria were based on the PICOTS definition as follows:

P: human in worldwide .

I: Cryotherapy with each type of it.

C: anyone.

O: pain with any scale.

T: 2023 and 2024.

S: clinical trials.

All types of studies, case reports, review studies, animal studies, cohort studies, and case-control studies were excluded from this review. We also removed duplicate articles from different databases. After extracting the data, we entered them into the Excel environment. To assess the risk of bias, the ROB2 tool developed by Downes et al. [12] was used.

Results

Based on the search results in databases, 138 articles were found as of September 15, 2024, for the range of articles published in 2023 and 2024. These articles were evaluated by two of the authors based on the abstract, so that 35 articles were related to the inclusion criteria for this study, and then the full text of the articles was further evaluated by the evaluator team to match the objectives of the study. Its more details are explained in the Prisma flowchart in Figure 1. We did not use meta-analysis in this review because the reported values of pain scores were reported at dissimilar time intervals after treatment and thus did not provide us with single-arm data. Also, in this study, there was no need to communicate with the responsible authors of each study. Because there was enough data in each of the articles for this review. Two reviewers evaluated the entry criteria of the articles in parallel. In one case, there was a difference of opinion, and the desired agreement was reached through a two-way discussion between them. Therefore, there was no need to send articles to a third referee. A risk of bias assessment was done on 19 articles included in the study based on Table 1. In several studies and many cases listed in Table 1, we saw the occurrence of bias. Finally, five articles had a mild risk of bias, and six studies had a moderate risk of bias. Other studies were also unbiased based on the evaluation. Finally, we included them all in the review study.

For each of the studies included in this review, based

on Table 2, the name of the first author, age of the participants, sample size, population under study, groups under study, outcome, findings and final interpretation were extracted. The tool used to measure pain in 3 articles was NRS scale [14,15,18], one [30] used VRS, and

other studies used VAS. The range of age groups used in all studies was from a minimum of four [26] to a maximum of 60 years. The sample size was in the range of 20 to 152.

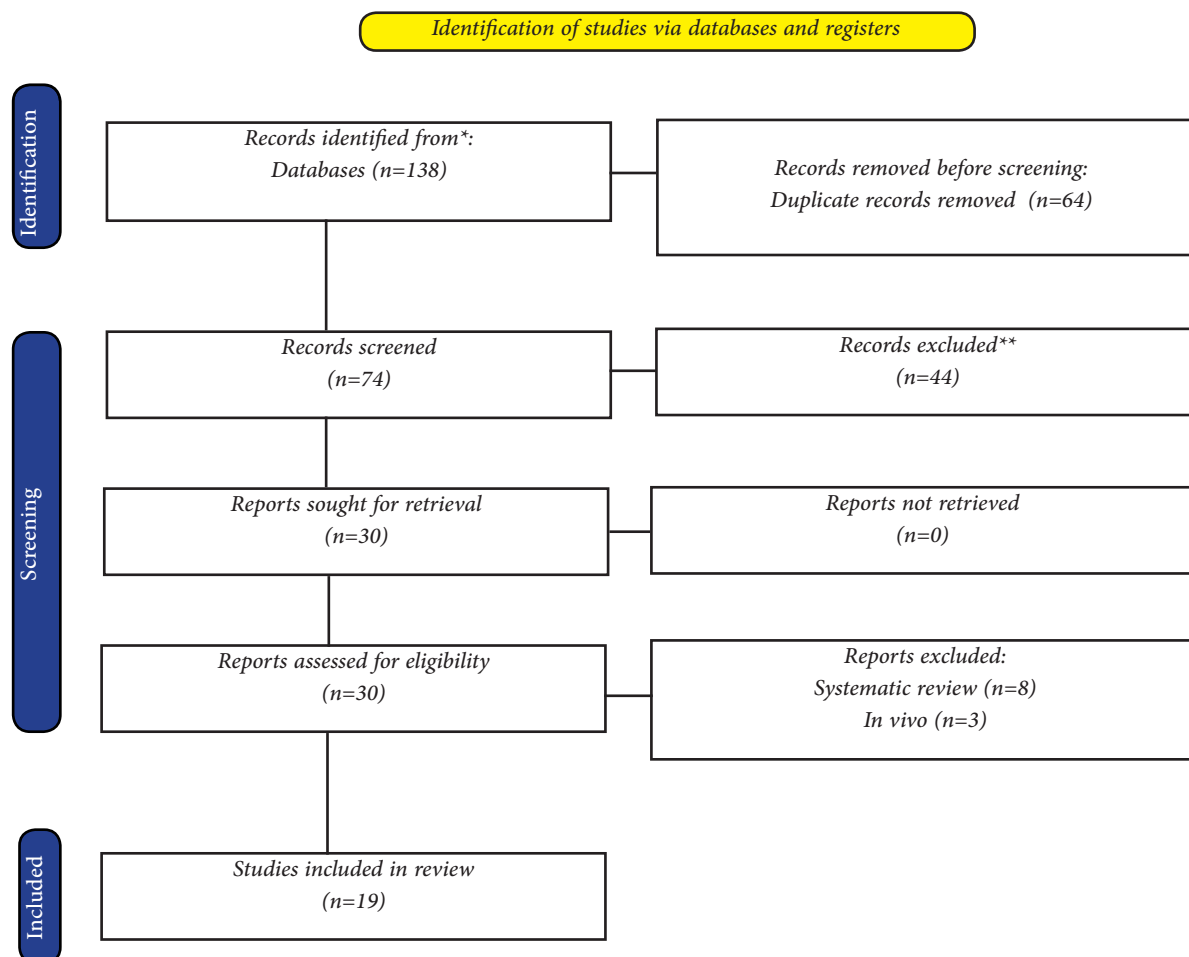


Figure 1. Prisma flowchart for literature related to this systematic review.

Table 1. Risk of bias for the included studies.

Study (reference number)	Abdelbaky (13)	Ajeesh (14)	Akhtil (15)	Bashir (16)	El-henny (17)	Elsherbeny (18)	Ezzat (19)	Hamza (20)	Ho-seini (21)	Ibrahim (22)	Nuño-vero (23)	Jasani (24)	Keskin (25)	Ku-mari (26)	Lal-fakaw-mi (27)	Patel (28)	Pupne-ja (29)	Shah (30)	Solomon (31)
Clear aims/objectives	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Study design appropriate for the stated aim(s)	N	Y	Y	Y	Y	N	N	N	Y	N	Y	Y	Y	N	Y	Y	Y	N	Y
Sample size justification	Y	U	Y	Y	U	Y	U	Y	U	Y	Y	Y	U	Y	Y	Y	U	Y	Y
Target/reference population clearly defined?	U	Y	Y	Y	U	Y	Y	U	Y	Y	U	Y	Y	U	Y	Y	Y	Y	U
Sample representative of target/reference population	N	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	N	Y	Y	N

Study (reference number)	Abdelbaky (13)	Ajeesh (14)	Akhil (15)	Bashir (16)	El-hemmy (17)	Elsherbiny (18)	Ezzat (19)	Hamza (20)	Ho-seini (21)	Ibrahim (22)	Nuño-ve-ro (23)	Jasani (24)	Keskin (25)	Ku-mari (26)	Lal-jakaw-mi (27)	Patel (28)	Pupne-ja (29)	Shah (30)	Solo-mon (31)
Selection process likely to represent target/reference population	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Variables appropriate to study aims	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Variables measured correctly and trialled/piloted/published previously	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Clear method to determine statistical significance	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Methods sufficiently described to enable repeat	Y	N	Y	Y	Y	N	Y	Y	N	Y	Y	Y	N	Y	Y	N	Y	Y	N
Basic data adequately described	Y	Y	N	Y	Y	N	Y	Y	N	Y	Y	Y	N	Y	N	Y	Y	N	Y
Results internally consistent	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Results for the analyses described in the methods presented	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Authors' discussions and conclusions justified by the results	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Limitations of the study discussed	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Funding sources or conflicts of interest	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Ethical approval/consent of participants	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Table 2. Characteristics of the included studies in the review.

First Author	Age	Sample size	Study population	Study groups	Outcome	Interpretation
Abdelbaky (13)	25-50	68	dental/endodontic emergency clinics	Control 1: saline (NS) control 2: chlorhexidine at room temperature, intervention: cryotherapy with NS (cryotherapy /NS), and intervention: (cryotherapy / chlorhexidine)	pain incidence and level after 12, 24, 48, 72 hours and at 7 days	cryotherapy led to decrease of pain
Ajeesh (14)	18-55	108	patients with symptomatic apical periodontitis	A: sodium hypochlorite (control) B: (Intracanal) cold (2°C–4°C) saline C: (Intraoral) room temperature saline	postoperative pain using the NRS scale at 6 h	Both intracanal and intraoral cryotherapy are effective
Akhil (15)	-	60	mature permanent mandibular molar teeth	In group I (conventional pulpotomy), In group II (cryotherapy),	Preoperative and 24, 48 and 72 h pain with Numerical Rating Scale.	Cryotherapy diminish pain and without adverse effect

First Author	Age	Sample size	Study population	Study groups	Outcome	Interpretation
Bashir (16)	18 to 60	98	patients with symptomatic irreversible pulpitis in mandibular molars and pre-endodontic pain	Group A (normal saline) and Group B (cryotherapy)	Visual Analogue Scale (VAS) to assess pain	Cryotherapy has not difference diminish in pain score than normal saline
Elheeny (17)	10-17	152	Healthy 10- to 17-year-old children	two equal groups; cryotherapy plus IANB (inferior alveolar nerve block) and the control group (conventional IANB).	Visual analogue scale (VAS)	The cryotherapy is proper but additional anesthesia was still necessary
Elsherbeny (18)	23-40	78		Group A: room temperature saline Group B: room temperature saline with ultrasonic activation using (Ultra-X). Group C: cold saline	NRS at 6, 12, 24, 48,72 hours and 1 week	Cold saline is effective to decrease the pain
Ezzat (19)		78	mandibular molar teeth with symptomatic irreversible pulpitis	intracanal cryotherapy group and intraoral cryotherapy group	The patients' postoperative pain was recorded at 6- 12- 24- 48- and 72 hours postoperatively	intraoral cryotherapy may be proper as intracanal cryotherapy in postoperative pain reduction.
Hamza (20)	Control: 29.70 ± 6.29 Intervention: 25.15 ± 5.43	20	patients with symptomatic apical periodontitis (SAP).	Cryotherapy Group or the Control Group without applying any cold subject	Visual Analogue Scale (VAS)	intraoral cryotherapy is effective for treatment of pain
Hoseini (21)		60	symptomatic irreversible pulpitis in a mandibular molar tooth	Group 1: Control (without cryotherapy) Group 2: intracanal cryotherapy (2.5 °C normal saline), group 3: intraoral cryotherapy with the ice pack and Group 4: extraoral cryotherapy.	Patients' post-endodontic pain was recorded on the first and third days.	Cryotherapy is a mild treatment for diminish of pain after root canal treatment. Time reduces pain more than cryotherapy itself
Ibrahim (22)	Control: 29.70±6.29 Intervention: 25.15±5.43	20	patients with symptomatic apical periodontitis	one for cryotherapy and the other for control	VAS	Intraoral cryotherapy is effective in treatment of pain
Nuñoверо (23)	46.71 (16.85)	120	patients with asymptomatic apical periodontitis	4 groups: Control, Cryotherapy, Foraminal Enlargement, Cryotherapy and Foraminal Enlargement	VAS	Cryotherapy is not effective on the pain
Jasani (24)		60	teeth with symptomatic irreversible pulpitis treated in a single visit	cold saline, normal saline	VAS	cold saline decreased post-operative pain.

First Author	Age	Sample size	Study population	Study groups	Outcome	Interpretation
Keskin (25)	18-35	44	Mandibular pre-molar teeth	control: water 20-22°C, cryo-therapy water 2.5°C.	VAS	Intracanal cryotherapy was effective on pain
Kumari (26)	4-7	120	teeth requiring pulpectomy in primary teeth	3 groups: intracanal cryo-therapy using 2.5°C cold saline, curcumin, or normal saline	VAS	Cryotherapy may be effective for decrease the pain.
Lalfakawmi (27)		66	Individuals diagnosed with symptomatic irreversible pulpitis and symptomatic apical periodontitis in mandibular molars	Control (at 25°C), cold NaOCl (2°C) and warm NaOCl (60°C)	Heft Parker Visual Analogue Pain Scale (HP-VAS)	cold NaOCl was effective on pain
Patel (28)	>18	80	single-rooted teeth exhibiting irreversible pulpitis and/or apical periodontitis	Group 1 normal saline at room temperature. Group 2 normal saline refrigerated between 2-5°C.	VAS	cryotherapy is effective in the treatment of the pain
Pupneja (29)	≥18	60	Patients with symptomatic irreversible pulpitis	Group I – saline at room temperature (37°C) (control group), Group II – cold saline (at 4°C), and Group III – cold saline (at 2.5°C).	VAS	Cryotherapy led to reducing the pain.
Shah (30)	30-60	120	having symptomatic irreversible pulpitis with symptomatic apical periodontitis	Group A – normal saline (n = 60) and Group B – cryo-therapy 2.5°C (n = 60)	modified Verbal Rating Scale	cold saline causes a significant reduction in treatment of pain.
Solomon (31)	18-40	50	Patients with single visit root canal treatment	physiological saline (Group 1), cold saline (Group 2), and 2ml Dexamethasone (Group 3).	VAS	the effect of significant pain reduction in cryotherapy and dexamethasone method compared to physiological saline has been observed.

Discussion

This review was showed that the pain after endodontic is reduced by cryotherapy. Cryotherapy is a proper treatment that dentist can use it for their patients. Based on the study of Abdelbaky et al., [13] the occurrence of pain was reported at 12, 24, 48 and 72 hours and 7 days after the treatment. Cryotherapy has been shown to reduce pain both when used with chlorhexidine and normal saline, although when combined with normal saline, it has shown a more effective trend in reducing pain. Ajeesh et al.'s study [14], which was conducted on 108 patients aged 18 to 55 years, con-

cluded that cryotherapy, whether intraoral or intracanal, can play an effective role in reducing pain based on the NRS index among periodontic patients. This evaluation was recorded at 6 and 24 hours after the treatment. In Akhil et al.'s study [15], pain intensity was evaluated after cryotherapy treatment. The results indicated a significant reduction in pain 24 and 48 hours after treatment in the cryotherapy group compared to the group that received conventional pulpotomy. They also showed that it did not cause any side effects. The study of Bashir et al. [16], in which the two groups receiving cryotherapy and normal saline were evaluated

in terms of pain intensity with the VAS scale, indicated the role of both interventions in reducing pain, and no statistically significant difference was shown between the two groups. In Elheeny et al.'s study [17], which was conducted on 10-15-year-olds, the pain intensity in the cryotherapy group was significantly reduced compared to the control group. Of course, cryotherapy was able to increase the analgesic effect of anesthesia and its efficiency.

In the study of Elsher Barry et al [18], which was conducted on people aged 23 to 40 years, three groups were studied: the group receiving normal saline, the group receiving normal saline and ultrasound, and the third group receiving cold saline. Pain intensity was evaluated using the NRS index. Based on this, the ultrasonic washing method was reported to have a lower incidence and intensity of pain on the first day after treatment, but after the first day, cryotherapy showed a more significant reduction in the incidence and intensity of pain compared to other groups. In the study of Ezzat et al. [19], which compared the pain reduction effect of intra-canal and intra-oral cryotherapy, intra-oral cryotherapy had a greater effect than intra-canal cryotherapy. Although both methods can be used as pain relief methods. In the study of Hamza et al. [20], they concluded that intraoral cryotherapy is a method of pain control and reduction of inflammatory effects and can have significant cost-effectiveness and at the same time simplicity.

In Hoseini et al.'s study [21], four groups have been evaluated. In the first group, cryotherapy was not used, in the second group, two and a half degrees of normal saline cryotherapy was performed inside the canal, and in the third group, intraoral cryotherapy with an ice pack was performed, and in the fourth group, extra-oral cryotherapy was performed. Pain intensity was the lowest on the first and third days after the treatment, except for the ice pack group. However, on the third day after the treatment, the intensity of the pain decreased significantly. In the study by Ibrahim et al. [22], pain intensity in intraoral cryotherapy was insignificantly reduced compared to the control group. In the study of Nuñovero et al. [23], 4 groups were evaluated: the control group, the cryotherapy group, the Foraminal enlargement and the Foraminal enlargement and cryotherapy group. They concluded that cryotherapy did not affect post-treatment pain reduction either with or without foraminal enlargement. In the study of Jasani et al. [24], which compared the pain intensity in the cold saline and normal saline groups, the results indicated that cryotherapy was more effective than the

control group during 6 hours after the treatment. In the study of Keskin et al. [25], intra-canal cryotherapy was more effective than using room temperature water of 20 to 22 degrees in reducing pain, which was not significant in 24 hours after the operation, but there was a significant difference in three days after the treatment. In the study of Kumari et al. [26], where three groups were compared, intracanal cryotherapy was used, curcumin was used in one group, and normal saline was used in another group.

The results indicated the significant effectiveness of cryotherapy in reducing pain compared to other groups. In the study of Lalfakawmi [27], where the pain index was evaluated using Fat Parker VS, the control group was compared with normal saline at room temperature, normal saline at 2 degrees and normal saline at 60 degrees. The group receiving cold saline had far less pain than the other two groups in 6 hours after the treatment. Patel et al., [28] conducted a study in two groups and compared the pain reduction effect of normal saline and saline at 2 to 5 degrees. The results indicate that the pain in the cryotherapy group decreased differently than the other group in 48 hours after the treatment. In the study of Pupneja [29], which studied the effectiveness of root pain in three groups, cryotherapy is considered a suitable non-pharmacological treatment method to reduce pain. In the study of Shah et al [30], which again compared cryotherapy and normal saline at room temperature, it was concluded that there was a significant decrease in pain in the cryotherapy group compared to the normal saline group, and this decrease was also statistically significant.

In the study of Solomon et al. [31], the effect of significant pain reduction in cryotherapy and dexamethasone method compared to physiological saline has been observed. In addition, in the comparison of cryotherapy with dexamethasone, no difference was observed at 6 hours after treatment, but at 12 hours and 24 hours, a significant difference was observed between them, so the mean pain score in the dexamethasone group was lower than the cryotherapy group. This study has some limitations. The number of samples in some studies is not enough and they can be increased for future studies. The number of studies on children is very small, so it is recommended to increase the field of conducting such research for this age group in order to provide sufficient evidence to conduct more appropriate reviews. Time intervals statistical analyses and more homogeneous reported mean values if done in all studies related to field pain can greatly help to conduct a meta-analysis of findings, which will again pro-

vide better evidence of the treatment effect for other researchers.

Conclusion

It was concluded that cryotherapy can be used as a pain relief method after dental surgery. Cryotherapy is a cheap method without side effects that can be used in all age groups compared to many traditional procedures. However, this evidence was accompanied by limitations for each of the included studies.

Conflict of Interest

There is no conflict of interest to declare.

References

- [1] Hespanhol FG, Guimarães LS, Antunes LAA, Antunes LS. Effect of intracanal cryotherapy on postoperative pain after endodontic treatment: systematic review with meta-analysis. *rde*. 2022; 47(3):e30-0.
- [2] Sathorn C, Parashos P, Messer H. The prevalence of postoperative pain and flare-up in single- and multiple-visit endodontic treatment: a systematic review. *Int Endod J*. 2008; 41(2):91-9.
- [3] Sabino-Silva R, Cardoso IV, Vitali FC, Alves AMH, Souza BDM, Bortoluzzi EA, et al. Prevalence of postoperative pain after endodontic treatment using low and high concentrations of sodium hypochlorite: a systematic review and meta-analysis. *Clinical Oral Investigations*. 2023; 27(8):4157-71.
- [4] Almohaimede A, Al-Madi E. Is Intracanal Cryotherapy Effective in Reducing Postoperative Endodontic Pain? An Updated Systematic Review and Meta-Analysis of Randomized Clinical Trials. *International Journal of Environmental Research and Public Health*. 2021; 18(22):11750.
- [5] Al-Nahlawi T, Hatab TA, Alrazak MA, Al-Abdullah A. Effect of Intracanal Cryotherapy and Negative Irrigation Technique on Postendodontic Pain. *J Contemp Dent Pract*. 2016; 17(12):990-6.
- [6] Gundogdu EC, Arslan H. Effects of Various Cryotherapy Applications on Postoperative Pain in Molar Teeth with Symptomatic Apical Periodontitis: A Preliminary Randomized Prospective Clinical Trial. *J Endod*. 2018; 44(3):349-54.
- [7] Alharthi AA, Aljoudi MH, Almaliki MN, Almalki MA, Sunbul MA. Effect of intra-canal cryotherapy on post-endodontic pain in single-visit RCT: A randomized controlled trial. *Saudi Dent J*. 2019; 31(3):330-5.
- [8] Al Bast A, Abiad RS. CRYOTHERAPY IN THE FIELD OF ENDODONTICS: A LITERATURE REVIEW. *BAU Journal-Science and Technology*. 2024; 5(2):7.
- [9] Fayyad DM, Abdelsalam N, Hashem N. Cryotherapy: A New Paradigm of Treatment in Endodontics. *J Endod*. 2020; 46(7):936-42.
- [10] Miranda JP, Silva WT, Silva HJ, Mascarenhas RO, Oliveira VC. Effectiveness of cryotherapy on pain intensity, swelling, range of motion, function and recurrence in acute ankle sprain: A systematic review of randomized controlled trials. *Phys Ther Sport*. 2021; 49:243-9.
- [11] Chaudhary D, Sun Y, Gao X. Comparison of Cryotherapy and Topical Salicylic Acid in Common Warts: A Systematic Review and Meta-Analysis. *Dermatologic Therapy*. 2023; 2023(1):4283918.
- [12] Downes MJ, Brennan ML, Williams HC, Dean RS. Development of a critical appraisal tool to assess the quality of cross-sectional studies (AXIS). *BMJ Open*. 2016; 6(12):e011458.
- [13] Abdelbaky MM. Effectiveness of Two Intracanal Irrigation Solutions Delivered Through Cryotherapy on Post-Endodontic Pain Relieve. A Randomized Clinical Trial. *Egyptian Dental Journal*. 2024; 70(3):2965-74.
- [14] Ajeesh K, Jayasree S, James EP, Pooja K, Jauhara F. Comparative evaluation of the effectiveness of intracanal and intraoral cryotherapy on postendodontic pain in patients with symptomatic apical periodontitis: A randomized clinical trial. *Journal of Conservative Dentistry and Endodontics*. 2023; 26(5):555-9.
- [15] Akhil V, Kumar V, Aravind A, Sharma R, Sharma S, Chawla A, et al. Novel cryotherapy technique for pulpotomy in mature permanent teeth with symptomatic irreversible pulpitis-a randomized controlled trial. *Clinical Oral Investigations*. 2024; 28(5):1-14.
- [16] Bashir AF, Jatala UW, ud din Ahmad M, Khan MT, Khan SR, Butt AA. Determining Efficacy of Intracanal Cryotherapy on Post Endodontic Pain in Irreversible Pulpitis: Cryotherapy on Post Endodontic Pain. *Pakistan Journal of Health Sciences*. 2024:68-72.

- [17] Elheeny AAH, Sermani DI, Saliab EA, Turkey M. Cryotherapy and pain intensity during endodontic treatment of mandibular first permanent molars with symptomatic irreversible pulpitis: A randomized controlled trial. *Clinical Oral Investigations*. 2023; 27(8):4585-93.
- [18] Elsherbeny MMH, Naguib EAHNE. Effect of Using Intracanal Cryotherapy Versus Ultrasonic Activated Irrigation on Post-Operative Pain in Single Visit Endodontic Treatment of Teeth with Symptomatic Irreversible Pulpitis "Randomized Clinical Trial". *Future*. 2024; 10(1):1-7.
- [19] Ezzat TM, Ezzat K, Morsy DA. Comparative Evaluation of the Efficacy of Intraoral Cryotherapy Versus Intracanal Cryotherapy on Postoperative Pain in Lower Molar Teeth with Irreversible Pulpitis and Symptomatic Apical Periodontitis: A Randomized Clinical Trial. *Advanced Dental Journal*. 2023; 5(3):581-7.
- [20] Hamza EM, Abd El Aziz TM, Obeid MF. The influence of intraoral cryotherapy on postoperative pain and substance P in symptomatic apical periodontitis: randomized clinical study. *Scientific Reports*. 2024; 14(1):13890.
- [21] Hoseini MS, Ranjbarian P, Mortaheb A, Yousefi E. Evaluating the effect of different cryotherapy methods on postoperative pain in one-visit root canal treatment of mandibular molars with symptomatic irreversible pulpitis. *Contemporary Orofacial Sciences*. 2023; 1(2).
- [22] Ibrahim EM, Abdel Aziz TM, Obeid MF. The effect of cryotherapy on substance P expression. *Ain Shams Dental Journal*. 2024; 33(1):164-70.
- [23] Iparraguirre Nuñovero MF, Hungaro Duarte MA, Kaled Segato AV, da Silva Neto UX, Portela Ditzel Westphalen V, Carneiro E. The effect of intracanal cryotherapy with and without foraminal enlargement on pain prevention after endodontic treatment: a randomized clinical trial. *Scientific Reports*. 2024; 14(1):19905.
- [24] Jasani P, Attur K, Patel N, Jani K, Chhaya P. Effect of Intracanal Cryotherapy Application on Post-Operative Pain After Single Visit Endodontic Treatment in Molars with Symptomatic Irreversible Pulpitis. *Journal of Coastal Life Medicine*. 2023; 11:183-6.
- [25] Keskin C, Aksoy A, Kalyoncuoğlu E, Keleş A, İlik AA, Kömeç O, et al. Effect of intracanal cryotherapy on the inflammatory cytokine, proteolytic enzyme levels and post-operative pain in teeth with asymptomatic apical periodontitis: A randomized clinical trial. *International Endodontic Journal*. 2023; 56(8):932-42.
- [26] Kumari N, Kaur H, Choudhary R, Yeluri R. Comparative evaluation of intracanal cryotherapy and curcumin as a final irrigant in reducing post endodontic pain in primary teeth. *J Indian Soc Pedod Prev Dent*. 2022; 40(3):297-301.
- [27] Lalfakawmi S, Gupta A, Duraisamy AK, Abraham D, Mane AP. Impact of Cryotreated and Warm Sodium Hypochlorite on Post-Operative Pain in Teeth with Symptomatic Irreversible Pulpitis: A Randomized Controlled Trial. *Journal of Endodontics*. 2024.
- [28] Patel H, Kapoor S, Arora A, Shah P, Rana H. The role of cryotherapy in the reduction of postoperative pain in patients with irreversible pulpitis and/or apical periodontitis: A randomized controlled clinical study. *Turkish Endodontic Journal (TEJ)*. 2024; 9(1):39-46.
- [29] Pupneja V, Jindal N, Aggarwal R, Sachdeva ADK. Cryotherapy as a non pharmacological alternative for the management of postoperative endodontic pain after one visit root canal treatment using three irrigating regimens at different temperatures. *SRM Journal of Research in Dental Sciences*. 2024; 15(2):51-6.
- [30] Shah VR, Shah NC, Kishan KV, Kothari MA, Patel JJ, Patel SN. Evaluation of postoperative pain with cryotherapy in teeth with symptomatic irreversible pulpitis with symptomatic apical periodontitis after single-visit endodontics: A randomized clinical study. *Endodontology*. 2023; 35(2):118-23.
- [31] Solomon R-V, Paneeru S-P, Swetha C, Yatham R. Comparative evaluation of effect of intracanal cryotherapy and corticosteroid solution on post endodontic pain in single visit root canal treatment. *Journal of Clinical and Experimental Dentistry*. 2024; 16(3):e250.