Journal of Cardiothoracic Surgery

REVIEW

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Effectiveness of breathing relaxation exercises on pain due to chest tube removal: a systematic review-meta-analysis

Ayşe Yacan Kök[1] and Ezgi Eyiler[2*]

Abstract

Background Chest tube placement is essential for draining air or fluid from the pleural cavity, often performed after cardiothoracic surgeries to prevent complications. However, chest tube removal (CTR) can be painful and stressful for patients. Proper pain management is crucial to enhancing patient comfort.

Aim The aim of this systematic review and meta-analysis was to asssess the effectiveness of breathing and relaxation exercises for pain associated with CTR.

Methods Database searches were carried out in Pub med, Web of Science, MEDLINE, Academic Search Ultimate, CINAHL Complete, Cochrane Library, Science Direct to December 2024. The Risk of Bias 2 tool was used to assess the risk of bias. Heterogeneity and publication bias were also assessed.

Findings A total of 8 randomized controlled trials were included. Findings indicated that breathing relaxation exercises had a negative effect on chest tube removal. The mean effect size for the effect of breathing relaxation exercises on CTR was − 1.46 Three of the studies included in the meta-analysis assessed outcomes before CTR procedure. The mean effect size is 0.070 with a 95% confidence interval of -0.208 to 0.348. Also, four of the studies included in the meta-analysis assessed outcomes immediately after the procedure. The mean effect size is -1.403 with a 95% confidence interval of -2.337 to -0.469. The mean effect size in the universe of comparable studies could fall anywhere in this interval. Q-value is 30.826 with 3 degrees of freedom and $p < 0.001$.

Conclusions The results of this meta-analysis indicated that breathing and relaxation exercises can be effective in reducing pain associated with the CTR procedure.

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Introduction

Chest tube placement is the procedure of draining air and fluid from the pleural cavity with a sterile tube. The chest tube is placed in the intercostal spaces between the 6th and 8th ribs It is commonly inserted after cardiothoracic surgeries and interventional radiologic procedures to protect the heart and lungs from clinical settings such as hemothorax, pneumothorax, empyema, and pleural effusion [1]. Although it is indispensable to prevent potential cardiopulmonary complications, chest tube removal (CTR) is a painful and stressful procedure for patients [2]. Pain associated with CTR may lead to neurohormonal and physiological changes. This may lead to hypertension and myocardial infarction due to increased sympathetic activity. However, decreased peripheral blood supply may result in complications such as paralytic ileus and decreased bladder movement [3, 4]. These vital changes and situations reveal the need for pain management. Also, pain management associated with CTR is a major attention for nursing care [5]. However, for managing pain associated with CTR, there are no clinical standards or guidelines [6].

Pharmacological agents such as local anesthetics, opiod analgesics and anti inflammatory medications used commonly for pain management for procedure of CTR. Side effects such as vomiting, nausea, respiratory distress, hypotension may reduce patients' comfort. Non-pharmacological techniques may enhance medications effectiveness in pain management and increasing patients' comfort [7]. Previous studies indicated that non-pharmacological techniques such as cold therapy [8], transcutaneous electrical nerve stimulation [9], acupressor [10], music therapy [11], hearing a beloved person's voice [12], aromatherapy [13], foot reflexology massage [14] virtual reality [15], breathing and relaxation exercises tested to pain associated with CTR. For managing pain associated with CTR cold therapy and relaxation exercises are the prominent non-pharmacological therapies [16, 17]. Ceylan and Rizalar (2022) indicated that cold therapy and relaxation exercises were effective reducing procedure of CTR pain level. In the same study determined that there was no significant difference in pain reduction levels when comparing cold therapy with breathing and relaxation exercises [16]. Chauhan et al., (2021) recommended that breathing exercises was effective, safe and inexpensive nursing intervention may be used pain management with procedure of CTR [18].

Breathing and relaxation exercises is a basic nursing intervention. During CTR procedure pain management and comfort are important for nurses [6]. Breathing exercises support muscle activation that strengthens lung function, allowing to improve oxygenation and blood volume indicators, as well as their essential vital capacity [19]. Relaxation exercise is described absence of physical, physiological and emotional tension [20]. Breathing and relaxation exercises cost effective, affordable and easily applicable for nurses to manage pain assosiated with CTR. In studies evaluating the effects of breathing and relaxation exercises, pain has often been measured as an outcome [1, 16, 19]. Prior systematic reviews with meta-analyses of randomized controlled trials (RCTs) have predominantly focused on the effectiveness of breathing and relaxation exercises for coronary by-pass greft (CABG) patients [21]. These study findings demonstrated that breathing and relaxation exercises effectively when assessed 15 min after CTR. However, randomized controlled trials (RCTs) have been established not only determine at a time, also body mass index, age, gender and using analgesic patients undergoing CTR have not been established. The study asssess the effectiveness of breathing and relaxation exercises for pain relief associated with CTR.

Method

Material method

Aim

The aim of this systematic review and meta-analysis was to asssess the effectiveness of breathing and relaxation exercises for pain associated with CTR.

Design

This meta-analysis was conducted in accordance with the Cochrane Handbook for Systematic Reviews of Interventions and the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) statement [22].

Eligibility criteria

The PICOS question and inclusion and exclusion criteria were descriped. These parts involve the patient population (P), intervention (I), the comparison group (C), the outcome (O), and the study design (S) (20). The studies were selected according to the inclusion and exclusion criteria of PICOS elements. The inclusion criteria were as follows:

- Population: Participants should be age ≥ 18 and received chest tube care.
- Intervention: Breathing and relaxation exercises to manage pain.
- Comparison: The control group received routine care (regular and planned care).
- Outcomes: Comparison of the pain level of a patient with a chest tube before and immediately after removal of the chest tube.
- Study design: Randomized controlled trials published in English language.

The inclusion criteria of the studies: readily accessible randomized controlled trials focused on effect of breathing and relaxation exercises on pain during CTR were included, participants age over 18 years adults who have chest tube. It includes pain assessment measurements during the CTR process, it includes intervention group results including relaxation and breathing exercises to manage pain, control group received standard routine and planned care, randomized controlled trials were included in the meta-analysis.

The exclusion criteria were as follows: editorials, commentaries, qualitative, observational or non-randomised, reviews and meta-analyses, full text not available, studies that compared breathing and relaxation exercises without a control group and pediatric patients and pain scores not available.

Search methods

Search terms were defined (Appendix 1). Seven electronic databases (Pub med, Web of Science, MEDLINE, Academic Search Ultimate, CINAHL Complete, Cochrane Library, Science Direct) were searched to determined studies published up to December 2024. In addition to the databases, the reference lists of included articles were searched for articles that met the criteria. No limitations were placed on the dates and the languages of the articles. The English keywords used for the searches were as follows: "chest tube", "chest drain", "chest drain removal", "relaxation technique", "breathing exercise", "coughing exercise", "respiratory relexation exercise", "relaxation therapy", "pain", "reduce pain".

Quality assessment

Two researchers (AYK and EE) independently searched critical appraisal and quality assessment of the articles using the Cochrane Risk-of-bias tool for randomized trials version 2.0 [22]. Consensus was achieved through discussion and consultation with the each other and statistical analyst.

Data extraction

Three-stage selection process was used to manage the records of the literature search. Firstly, two authors independently reviewed the retrieved articles by title and abstract (AYK and EE). Second stage, the abstracts of all articles were read separately by two authors (AYK and EE) and assessed the articles together to their eligibility through consultation. Finally, reading the full texts separately by authors, using predetermined inclusion criteria. The preliminarily searched articles were imported into Endnote X8 literature management software to remove duplicates. Article screening was performed by two authors independently.

The following information was extracted from each eligible study: first author, publication year, countries; participants mean BMI, surgery types, mean, age sample size, female proportion, intervention, intervention description, analgesic types, instruments for pain assessing, outcome and time point of outcome measurements. One author extracted the data, which were independently checked by the other two reviewers. Once all data was verified to be consistent, author AYK entered the data into spreadsheets and author EE verified the entries to ensure the data was accurate with no omissions. In all studies included in the meta-analysis, pain during chest tube removal was assessed using the Visual Analog Scale (VAS) and Numerical Rating Scale (NRS). They are considered to be a reliable, valid, and usable measurement tool for repeated measurements. Excel program was used to prepare the data set of the meta-analysis.

Strategy for data synthesis

All studies investigated the effect of breathing and relaxation exercises on pain associated with CTR. The study was conducted using the Comprehensive Meta-Analysis (CMA) software version 3 (Version 3, Biostat, Englewood, New Jersey). Heterogeneity was evaluated using the I2 test and Cochrane's Q test [23]. The findings of the heterogeneity test were analyzed as the results of the included studies were not functionally similar and that the estimated impact size allowed for the extrapolation of generalizations to larger populations. The heterogeneity test revealed significant differences among the studies included in the meta-analysis and the effect size distributions were heterogeneous ($p = 0.05$). The I [2] value, which is the complement of the Q statistic, has a high level of heterogeneity (87.437%) (Cooper et al., 2009; Higgins & Thompson, 2002). The random effects model was applied in the meta-analysis process as the effect sizes of the eight distinct studies that were part of the meta-analysis that looked at how breathing relaxation exercises affected the pain associated with CTR had a heterogeneous distribution ($Q = 55.719$; $df = 7$; $p = 0.000$; $I2 = 87.437$) ($p < 0.01$) (Table 1). Funnel plots were used to assess publication bias. The presence of funnel plot asymmetry was quantitatively assessed using Egger's regression test; a p-value

Table 1 Heterogeneity test results

Model	k	d	CI		Heterogeneity			
			LL	UP	Q-value	df (Q)	*p*	I^2
Fixed effects	8	-1.207	-1.410	-1.005	55.719	7	0.000	87.437
Random effects	8	-1.457	-2.040	-0.873				

of less than 0.05 indicated a significant publishing bias [24]. This approach can be useful in identifying publishing bias, despite its questionable validity. Publication bias is typically indicated by a strong asymmetry in the funnel plot, particularly if one side of the mean effect size line is concentrated. The eight studies that were part of this meta-analysis showed no signs of publication bias (Fig. 1).

Results

Study characteristics

A total of 128 records were identified by searching in seven electronic databases. After eliminated duplications of studies using the Endnote programme, the titles and abstracts of the remaining 47 study were read and 64 studies were excluded. 17 studies were analysed for eligibility and their full texts were read. A total of 8 studies that met the inclusion criteria were included in the meta-analysis (Fig. 2). The characteristics of the study are described in Table 2 (Table 2). The 8 studies selected were published between 2006 and 2022. Two of the studies were conducted in Iran, two in Turkey, and the other studies were carried out in Jordan, Egypt and the USA. A total of 470 patients were included in the selected trials, 234 in the intervention group and 236 in the control group. In one study, we found that the acetaminophen group drug was administered regularly in per 6 h. Other study paracetamol group drug less than 1 h. Other studies did not provide information about routine hospital practice. The sample size of the studies varied from 19 to 40.

All studies involved pain as an outcome. As can be seen Table 1, pain was evaluated using Visual Analog Scale (VAS) in seven study and Numerical Rating Scale (NRS) [20] in a study. On the NRS, patients rated their pain from 0 ("No pain") to 10 ("Unbearable pain"). On the VAS, patients marked their pain level on a 10-cm horizontal line, with the left end representing "No pain" and the right end representing "Worst pain imaginable." The surgery types of participants were CABG, valve surgery, Pneumothorax, Chest Trauma, Pleural Effusion, Mass in the Lung. Analgesic used in one study which was acetoaminophen before CTR [25]. All studies assessed pain before CTR. There was variability among studies regarding the assessment of pain following the CTR procedure. Five studies conducted their initial time point for pain measurement were immediately after the procedure. One study reported the first pain measurement at 1–2 min post-procedure, while another study assessed at 5 min after CTR. Additionally, the other included study reported pain assessment at 10 min post-procedure.

Risk of bias the included studies

All studies had been decleration in their randomisation, but selection process were not expressed in the studies. When the blinding status of the studies included in the research was examined, four studies were reported as single blind. All studies had a low risk of bias. Five studies determined some concern in terms of missing outcome data and reporting of outcomes. Three studies received financial support (Fig. 3).

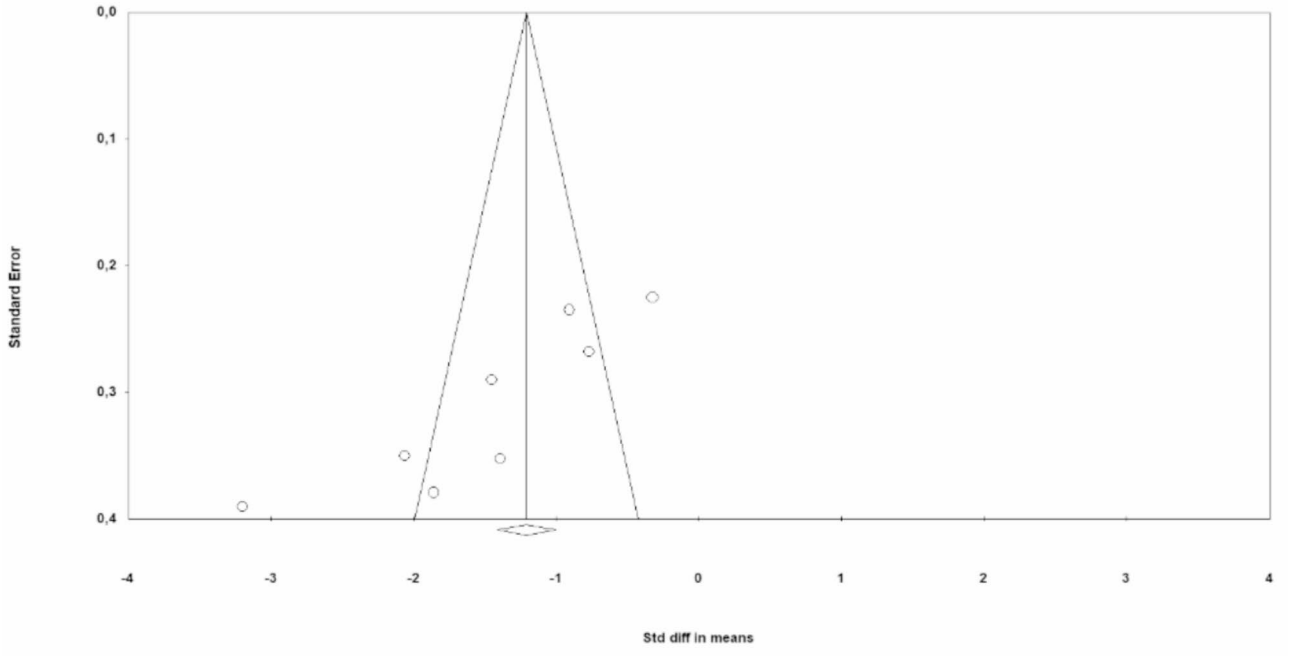


Fig. 1 *Effect size funnel on publication bias*

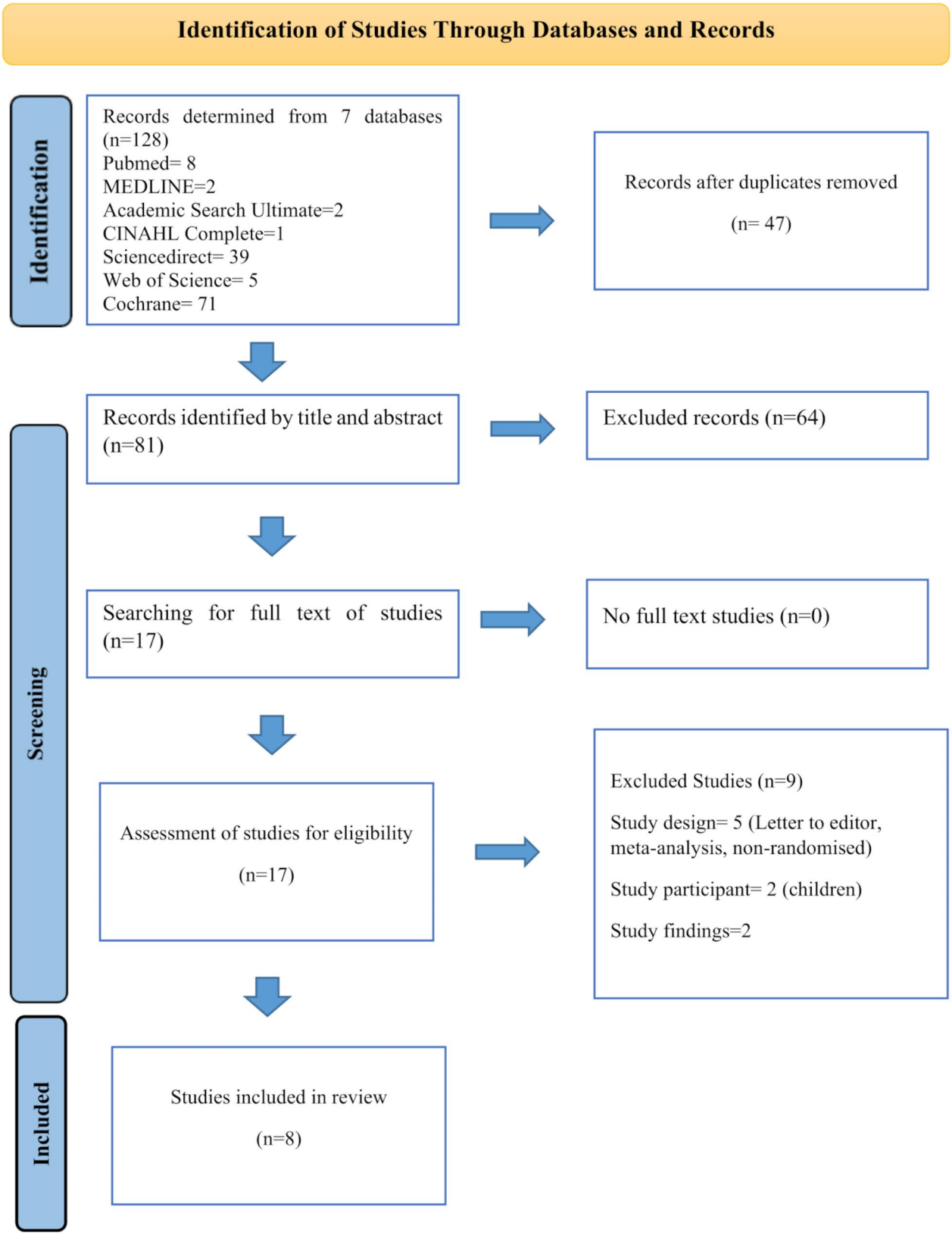


Fig. 2 PRISMA flow diagram

Table 2 Characteristics of studies

Author, year	Countries	BMI restrictions for participant eligibility (kg/m2)	Surgery	Mean Age (years)	Sample Size (people)	Female proportion (%)	Intervention	Intervention description	Analgesic	Instruments for pain	Outcome	Time points of outcome measurements
Jarrah et al., 2022	Jordan	Nil	CABG	61.1 63.6	25 25	32.0% 44.0%	Control Relaxation exercises	No intervention Breathing exercise for 15 min	Not receive analgesic 4 h before CTR Not receive analgesic 4 h before CTR	VAS	Breathing exercises are effective way to reduce the pain of CTR.	T1: before CTR T2: 5-min post CTR T3: 15-min post CTR
E. Ceylan, 2023	Turkey	Nil	CABG, valve surgery	40–49: 4 50–59: 10 60–69: 14 ≥ 70: 2 40–49: 1 50–59: 7 60–69: 15 ≥ 70: 7	30 30	36.7% 40%	Control Relaxation exercises	No intervention Breathing exercise 10 min before the procedure	No clearly Mentioned No clearly mentioned	VAS	Breathing exercises are effective way to reduce the pain of CTR.	T1: before CTR T2: immediately after withdrawal CT T3: 15-min post CTR
Sajedi Monfared et al., 2021	Iran	BMI < 35	Cardiovascular surgery	57.70 51.26	30 30	43.3% 33.3%	Control Relaxation exercises	No intervention Respiratory relaxation for 15 min before CTR	Not receive analgesic 4 h before CTR Not receive analgesic 4 h before CTR	NRS	Breathing exercises are effective way to reduce the pain of CTR.	T1: 10 min and immediately before CTR, T2: immediately CTR T3: 15 min after CTR
Friesner et al., 2006	USA	Nil	CABG	63.0 69.0	21 19	23.8% 26.3%	Control Relaxation exercises	No intervention Respiratory relaxation for 5 mins before CTR	Receive analgesic less than 1 h before CTR Receive analgesic less than 1 h before CTR	VAS	Slow, deep breathing relaxation exercise is effective in reducing pain.	T1: before CTR, T2: immediately after CTR, T3: 15 min after CTR.
Ozcan and Karagozoglu, 2020	Turkey	BMI ≤ 30	Pneumothorax, Chest Trauma, Pleural Effusion, Mass in the Lung	< 30: 5 31–60: 24 ≥ 61: 11 < 30: 8 31–60: 21 ≥ 61: 11	40 40	27.5% 22.5%	Control Relaxation exercises	No intervention Respiratory and progressive muscle relaxation exercise just before CTR	Not receive analgesic before CTR Not receive analgesic before CTR	VAS	Cold therapy and local anesthesia were more effective than relaxation exercise during CTR	T1: before CTR, T2: 1–2 min after CTR, T3: 15 min after CTR.

Table 2 (continued)

Author, year	Countries	BMI restrictions for participant eligibility (kg/m2)	Surgery	Mean Age (years)	Sample Size (people)	Female proportion (%)	Intervention	Intervention description	Analgesic	Instruments for pain	Outcome	Time points of outcome measurements
Chauhan, 2021	India	Nil	CABG, Closed heart -surgery	18–30 years: 5(25.0) 31–43 years: 4(20.0) 44–56 years: 7(35.0) 57–69 years 4(20.0) 18–30 years: 4(20.0) 31–43 years: 6(30.0) 44–56 years: 3(15.0) 57–69 years: 7(35.0)	20 20	40.0% 45%	Control Breathing exercise	No intervention Breathing exercise 10 min before the procedure	No clearly Mentioned No clearly Mentioned	VAS	Breathing exercises effective way to reduce pain of CTR	T1: During CTR T2: After 10 min CTR
Gorji et al., 2014	Iran	26.16 25.51	CABG Surgery Patients	58.48 57.75	40 40	42.5% 42.5%	Control Breathing exercises	No intervention breathing exercises for 15 min before procedure	Acetaminophen pills each 6 h	VAS	Breathing exercises effective way to reduce pain of CTR	T1: before CTR, T2: immediately after CTR, T3: 15 min after CTR.
Mokadem et al., 2017	Egypt		CABG Surgery Patients	41.25 37.55	30 30	40.0% 36.67%	Control Breathing exercises	No intervention Deep Breathing Exercise for 5 min before procedure	Not receive analgesic before CTR Not receive analgesic before CTR	VAS	Breathing exercises effective way to reduce pain of CTR	T1: before CTR, T2: immediately after CTR, T3: 15 min after CTR. T4: 30 min after CTR

CABG = coronary artery bypass graft; CTR: chest tube removal NRS = Numerical Rating Scale; VAS = Visual Analog Scale; T = time point;

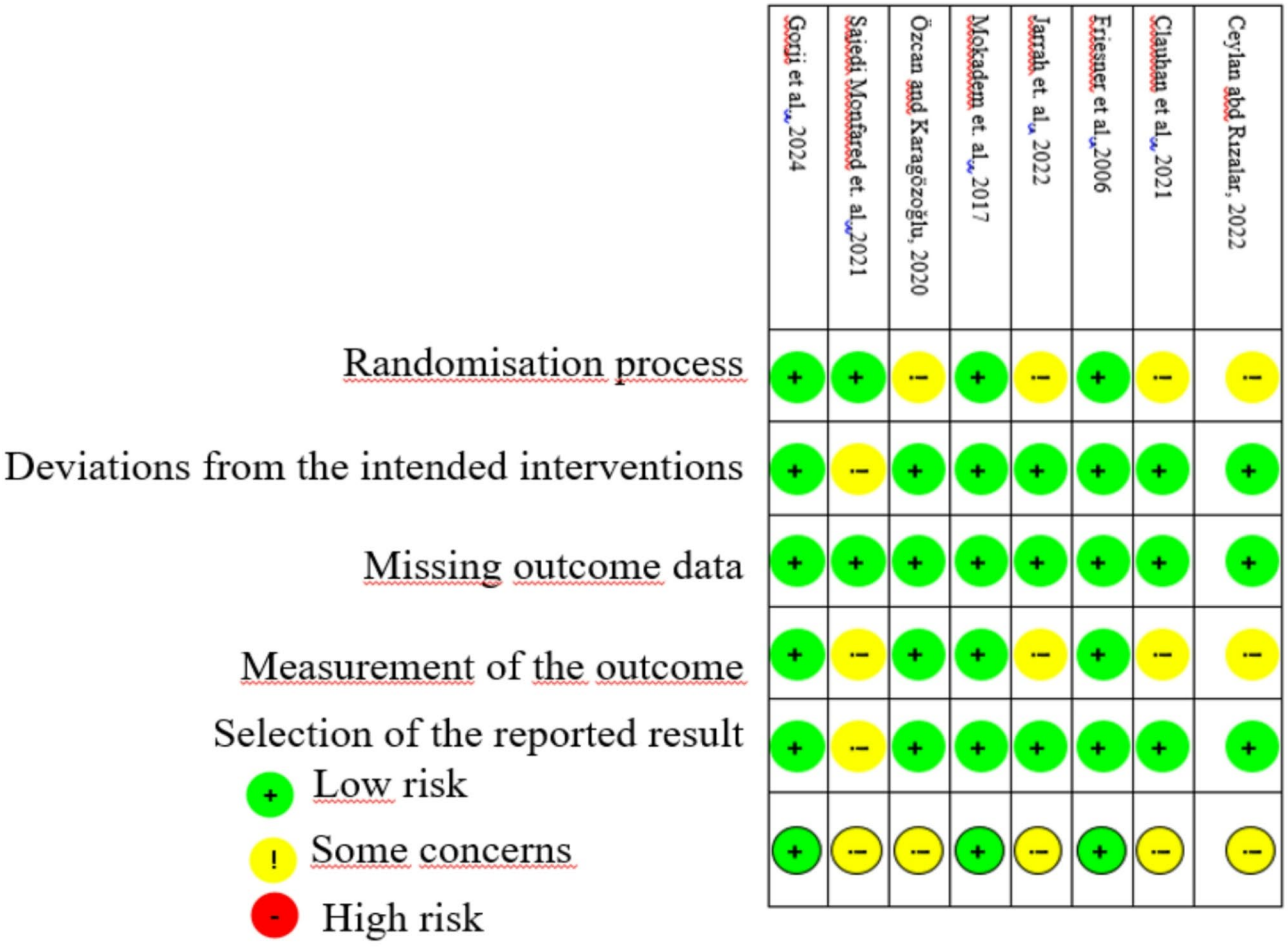


Fig. 3 Risk of bias assessment of included studies

Participant characters

In all studies adult chardiothoracic surgery patients were included. Five studies reported the mean ages of participants in both the intervention and control groups [1, 2, 17, 20, 25]. In contrast, three studies provided age distributions within defined ranges, accompanied by measures taken to minimize potential bias [16, 18, 26]. The proportion of female participants in both the intervention and control groups was lower compared to men. In the intervention group, the percentage of female ranged from 22.5 to 45%. Similarly, in the control group, the proportion of female ranged from 23.8 to 42.5%. Gender-related statistics were reported in seven of the studies included in the meta-analysis. However, only three studies provided statistical comparisons based on gender. Also, generalization is not possible. While a difference based on gender was observed in the experimental groups of the included studies, no such difference was found in the control group. The mean effect size is 1.381, with a 95% confidence interval ranging from 0.502 to 2.261 (Appendix 2). Only three included studies were reported BMI. One study provided categorical data BMI proportions for each groups (Control: 26.16 Intervention: 25.59).

Breathing and relaxation exercises intervention

The findings from the studies included in the meta-analysis revealed variations in the intervention groups. Two studies compared a breathing and relaxation exercises group to a control group [1, 2]. Three studies included a cold application group as a third group. In two studies, a fourth group combined breathing and relaxation exercises with cold application. One study featured four groups: breathing and relaxation exercises, cold therapy, local anesthetic, and a control group. In all studies breathing and relaxation group was considered intervention and also routine caring group accepted as a control group. The breathing and relaxation exercises were generally defined as involving slow inhalation through the nose and slow exhalation through pursed lips. Participants typically initiated the technique 5 minutes prior to the intervention, continuing for after CTR process 5 to 15 minutes. There was notable variability in descriptions of the intervention. Six studies referred to the

Table 3 Effects of interventions on changes in pain intensity scores from chest tube removal

Study Name	Point estimate	Standart error	LL	UL	Z-Value	*p*-Value	Experiment Group (*n*)	Control Group (*n*)
Ceylan & Rızalar, 2022	−3,20	0,39	−3,96	−2,44	−8,21	0,00	30	30
Chaun et al., 2021	−1,39	0,35	−2,08	−0,70	−3,95	0,00	20	20
Gorji et al., 2024	−0,32	0,23	−0,77	0,12	−1,44	0,15	40	40
Jarrah et al., 2022	−2,06	0,35	−2,75	−1,37	−5,89	0,00	25	25
Mokadem et al., 2017	−1,45	0,29	−2,02	−0,88	−5,00	0,00	30	30
Özcan & Karagözoğlu, 2020	−0,91	0,23	−1,37	−0,45	−3,87	0,00	40	40
Sajedi Monfared et al., 2021	−0,77	0,27	−1,29	−0,24	−2,87	0,00	30	30
Stacy et al. 2006	−1,86	0,38	−2,60	−1,12	−4,91	0,00	19	21
	−1,46	**0,30**	**−2,04**	**−0,87**	**−4,89**	**0,00**	**234**	**236**

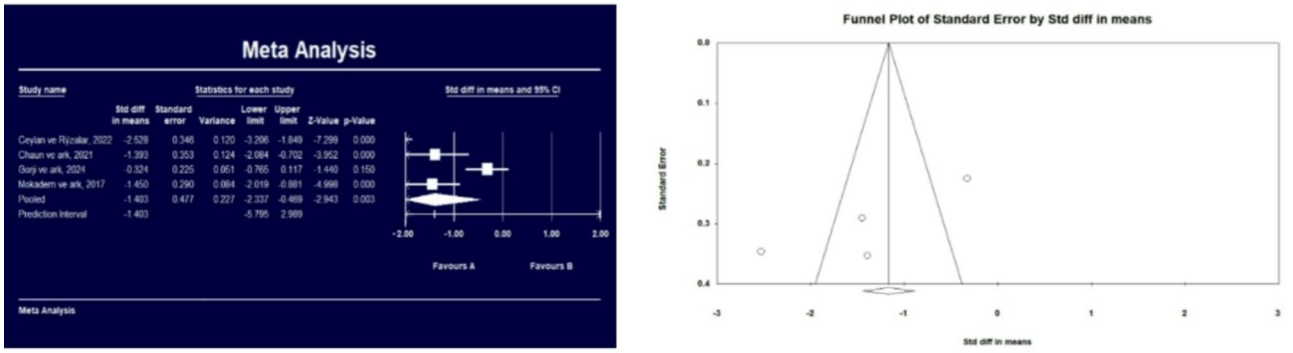


Fig. 4 Effects of interventions on changes in pain intensity scores from baseline to just removal

intervention as "breathing" or "deep breathing," while one study used the term "respiratory exercises" and another referred to the technique as "progressive muscle relaxation exercises".

In all studies included in the meta-analysis, during the breathing and relaxation exercises, instructions were given to breathe deeply, calmly and slowly with eyes closed or focused on a fixed object, and to breathe slowly and slightly through the pursed lips while inhaling through the nose. In five studies, CTR was carried out after performing this exercise for 5 min [1, 2, 17, 25, 26]. CTR was perfermod after 10 min of exercise in other studies. The two studies were instructed to put participants their hands abdomen with semi fowler position [1, 16]. Pain levels were evaluated before CTR procedure in all studies. In all studies, before CTR removal procedure pain level was no significant statistical difference in all groups. Pain level was assessed immediately after CTR procedure in five study. Ozcan and Karagozoglu (2020) was reported assessment of pain level after CTR two min and Chauhan (2021) was measured second time after 10 min of the procedure. In seven studies, 15 min after CTR procedure pain assessment were determined and only one study fourth pain assessment after the procedure of 30 min [17].

Effects of interventions on changes in pain intensity scores from baseline to just removal

Table 3 summarizes the results regarding the effect of breathing relaxation exercises on chest tube removal. These findings indicated that breathing relaxation exercises had a negative effect on chest tube removal. The mean effect size for the effect of breathing relaxation exercises on CTR was −1.46 (Table 3). While the effect was of this magnitude between before and after in all studies, effect sizes were also reported separately when subanalyses were performed in studies before and after chest tube removal. Three of the studies included in the meta-analysis assessed outcomes before CTR procedure. The mean effect size is 0.070 with a 95% confidence interval of -0.208 to 0.348 (Fig. 4). The random effects model was used because the procedures used in the included studies were different and the included studies showed significant heterogeneity. Also, four of the studies included in the meta-analysis assessed outcomes immediately after the procedure. The mean effect size is -1.403 with a 95% confidence interval of -2.337 to -0.469. The mean effect size in the universe of comparable studies could fall anywhere in this interval. Q-value is 30.826 with 3 degrees of freedom and $p < 0.001$. Using a criterion alpha of 0.100 we can reject the null hypothesis that the true effect size is the same in all these studies. This analysis includes four studies. As a general rule, estimates of heterogeneity based on less than ten studies are not likely to be reliable [27].

Discussion

Eight studies conducting a systematic review and meta-analysis to investigate the effects of breathing and relaxation exercises on pain assosiated with CTR. Breathing and relaxation exercises was determined to be effective non-pharmocological technique in reducing participants' pain during and after procedure of CTR. In literature, many non-pharmacological methods and techniques were examined reducing pain associated with CTR [8–15]. It is recognized as the most cost-effective technique, requiring minimal personnel training to optimize patient comfort during extremely painful and stressful procedures. Pain control is an important issue for nursing care. The CTR procedure is performed not only in operating rooms but also in intensive care units, emergency departments, outpatient clinics, and other healthcare settings. Nurses should be aware of reducing pain and discomfort in CTR process. Only two studies found that breathing and relaxation exercises were less effective in reducing pain during CTR [20, 26]. Sajedi-Monfared et al. (2021) reported no statistically significant difference in pain level immediately after ($p = 0.052$) and 15 min after ($p = 0.329$) CTR between the control and experimental groups [20]. In this study, it was reported that participants were unable to complete the exercises with full concentration due to the intensive care environment. These findings may be particularly generalizable to intensive care patients aged 50 and older. Sajedi-Monfared et al. (2021) indicated that silence was not provided because the study was conducted in an intensive care unit. As a result, no reduction in pain level or anxiety levels was observed in the study [20]. In the study by Özcan and Karagözoğlu (2020), cold application, local anesthesia, relaxation exercises were applied during CTR. They found that cold application and local anesthesia were more effective than relaxation exercises [26].

Based on our literature review, No meta-analysis studies on the effectiveness of breathing and relaxation exercises for reducing pain associated with CTR before and immediately after the procedure have been conducted. Past meta-analysis studies on the application of breathing exercises for surgical wounds have focused mostly on its assessment after 15 min of procedure [21]. Moreover the absence of a significant difference in pain intensity between the experimental and control groups in terms of heterogeneity enhances the strength of this meta-analysis. Also, experimental studies on using of breathing and relaxation exercises for the CTR procedure will contribute significantly to the evidence base. Furthermore, the studies included in this study investigated also differed previous meta- analyses.

Limitations

This study has several limitations. Firstly, searching strategies were limited to two languages, Turkish and English, and included only eight studies. These studies were small sample sizes, which may affect the precision of results of metaanalysis. Secondly, the studies evaluated did not adhere to a single standardized type of breathing and relaxation exercises. Thirdly, the majority of the studies lacked robust methods for concealment and blinding. Fourthly, the eligibility criteria included participants over 18 years of age; therefore, the generalizability of the results may not extend to pediatric patients with chest tubes. Additionally, while variables such as BMI, gender, income level, and educational status were reported in the studies, comparative analyses were not conducted, limiting the ability to derive generalizable measurement findings. Finally, the studies only included measurements taken before, during, and after the procedure of CTR, with no standardization regarding the instruction of exercises prior to the intervention. Despite many studies indicating the effectiveness of breathing exercises, some have reported no significant effects. These inconsistencies, coupled with the methodological limitations highlighted above, emphasize the need for further well-designed research to provide clearer and more reliable conclusions.

Conclusion

The results of this meta-analysis indicated that breathing and relaxation exercises can be effective in reducing pain associated with the CTR procedure. These exercises, taught as part of fundamental nursing skills, can be integrated as a standard component of the CTR procedure. This approach offers a safe, cost-effective, and nurse-managed method for pain management without the risk of side effects. To further validate these findings and enhance their applicability, future research should consider multicenter studies, explore combinations of interventions, and evaluate different clinical settings, such as comparisons between intensive care units and general wards, to gain more comprehensive and generalizable insights.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13019-025-03444-4.

Supplementary Material 1

Supplementary Material 2

Supplementary Material 3

Acknowledgements
Not applicable.

Author contributions
All authors have contributed to, read and approved the manuscript: EE, AYKConception and design, analysis and interpretation of data: EE, AYKDrafting the article or revising it critically for important intellectual content: EE, AYKFinal approval of the version to be published: EE, AYK.

Funding
None.

Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
Not applicable.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Received: 31 August 2024 / Accepted: 6 April 2025
Published online: 02 July 2025

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