Systematic Review

The Efficacy and Safety of the Rhomboid Intercostal Block for Postoperative Analgesia in Chest Surgery and Breast Surgery: A Systemic Review and Meta-Analysis

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Background: Prior research has suggested that the rhomboid intercostal block (RIB) may contribute to postoperative analgesia after surgeries of the chest and breast

Objective: To explore the effectiveness and safety of RIB for postoperative analgesia, as well as whether RIB is superior to other types of nerve blocks.

Study Design: A systematic review and meta-analysis.

Setting: Querying electronic databases, including the Cochrane Library, PubMed, Embase, and Web of Science, was part of the process in searching for eligible clinical trials for this meta-analysis and systematic review.

Methods: The Cochrane Collaboration's tool for quality evaluation was utilized in assessing the bias risk in the selected randomized controlled trials (RCTs). meta-analysis was facilitated through the utilization of Review Manager 5.3. The determination of the evidence's quality adhered to the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) approach.

Results: After the inclusion and exclusion criteria were established, the incorporation of 8 RCTs, encompassing 714 patients, took place. During the first 24 hours after the operation, patients in the RIB group exhibited lower pain scores and less opioid consumption than did those in the no-block group. Furthermore, a decrease in the incidence of postoperative vomiting and nausea was noted in the RIB group. Nevertheless, when comparing outcomes, it was revealed that the RIB group and the other nerve block group did not differ significantly.

Limitations: No subgroup analysis to investigate the sources of heterogeneity was performed. The number of studies in this meta-analysis of RIB compared to those that focus on other types of nerve block is relatively small. The optimal concentrations and volumes of local anesthetics were not evaluated.

Conclusions: RIB may be a new option for pain relief after chest and breast surgery.

Key words: Rhomboid intercostal block, pain score, opioid consumption

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Pain that follows different types of chest surgery (such as breast, lung, or thoracic surgery) is a major concern among patients. Postoperative pain is associated with several factors, such as the removal of the pectoralis major fascia (1) and the placement of a thoracic drainage tube (2). Severe postoperative pain can lead to increased consumption of opioids, which has several adverse effects, such as postoperative nausea and vomiting (PONV) (3), respiratory depression (4), urinary retention (5), and pruritus (6). Failure to manage postoperative acute pain can prolong a patient's hospital stay, imposing a substantial burden on patients and society (7). Furthermore, acute postoperative pain that is challenging to control can initiate the onset of chronic postoperative pain, a persistent pain state characterized by neuropathic pain that is unresponsive to opioids (8). The Enhanced Postoperative Recovery (ERAS) strategy is a combination of perioperative multimodal evidence-based strategies intended to decrease various postoperative complications, such as postoperative pain, and allow patients to achieve early recovery (9). In 2016, Elsharkawy et al first proposed a new fascia plane block called the rhomboid intercostal block (RIB). This process involves the injection of local anesthetics between the intercostal and rhomboid major muscles, resulting in a nerve block that provides analgesia to the entire chest (10). Notably, some clinical studies have reported that RIB is an effective method of delivering postoperative analgesia after different types of chest surgeries (11-14). A recent meta-analysis showed that RIB could effectively decrease acute pain after breast surgery and thoracoscopic surgery (15). However, the inclusion of only 4 randomized controlled trials (RCTs) characterized the meta-analysis, which did not compare RIB to other types of blocks. Additionally, several relevant clinical trials have been published recently.

The investigation into the effectiveness and safety of RIB as a technique for delivering postoperative analgesia was conducted through a systematic review and meta-analysis.

Methods

The execution of this systematic review and meta-analysis was in strict compliance with the guidelines set forth by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). This study's registration number in the International Prospective Register of Systematic Reviews is CRD42023438378.

Systematic Literature Search

The databases chosen for this meta-analysis were PubMed, Embase, Web of Science, and the Cochrane Library, which we searched from their inception dates until September 30, 2023, without restrictions on language. The search strategy for PubMed is described in detail in the supplemental data. A systematic search was also conducted for references corresponding to the eligible studies.

Selection Criteria

Inclusion criteria were as follows: (1) patients (P): individuals who underwent general anesthesia for chest surgery or breast surgery; (2) intervention (I): trials reporting the use of the RIB technique; (3) comparison (C): no presence of block or other type of nerve block; (4) outcome (O): studies that evaluated the RIB technique's effectiveness; and (5) study designs (S): RCTs.

Exclusion criteria for this research encompassed: (1) animal studies; (2) studies that involved a continuous RIB technique, (3) noninferiority studies; (4) studies that did not contain available outcomes; and (5) incomplete studies, including conference abstracts without full texts and ongoing studies.

The Process of Extracting Data and Outcomes

The initial step involved 2 authors independently utilizing EndNote to remove duplicity. Subsequently, we assessed whether the controlled trials met the specified criteria, examining their titles and abstracts for this purpose. The final step involved a careful evaluation of the complete text of the screened studies to assess their fulfillment of all the inclusion criteria. Independently, the 2 authors conducted a retrieval and cross-checking of the following information from the included studies' data: general anesthesia details, sample size, age, surgery type, publication year, names of authors, and postoperative pain management.

This study's main outcome was defined as the pain scores recorded during the first 24 hours after the operation. In the case of studies that evaluated pain scores using a time range, such as 1–2 hours after the operation, rather than a specific time point, we analyzed the results as pain scores measured 2 hours postoperatively. For studies that evaluated pain scores in different states (at rest and coughing), we included only pain scores measured during coughing in the meta-analysis. Included as secondary outcomes were patients' opioid consumption during the first 24 postoperative hours and the incidence of complications,

such as postoperative nausea and vomiting (PONV) and block-related complications.

Evaluation of the Quality and Risk

The studies included were evaluated for bias risk utilizing the Cochrane Collaboration's risk-of-bias assessment tool. The table indicating the risk of bias contains reporting bias (selective reporting), attrition bias (incomplete outcome data), detection bias (blinding of outcome assessment), performance bias (blinding of patients and personnel), selection bias (random sequence generation and allocation concealment), and other biases. The evaluation of each trial categorized it as high risk, with some concerns, or low risk. The Grading of Recommendations Assessment, Development, and Evaluation (GRADE) approach was employed to evaluate the degree of confidence. The evaluation categorized the level of certainty as high, moderate, low, or very low, in accordance with the criteria.

Statistical Analysis

For this meta-analysis, Review Manager 5.3 (Cochrane) was employed as the statistical software. For dichotomous outcomes, 95% confidence intervals (CIs) and the combined risk ratio (RR) were calculated. For continuous data with the same units, the evaluation of 95% CIs and mean differences (MD) was conducted, with standardized mean difference (SMD) used for different units. For studies that defined continuous data as median (interquartile ranges) or median (minimum–maximum), we transformed the values to corresponding mean and standard deviation to adhere to the previously discussed methods. Statistical significance was attributed to *P*-values under 0.05. Pain scores, reported through numeric rating, verbal, or visual scales for quantitative assessment, were standardized to a 0–10 analog scale. Heterogeneity in the trials was evaluated using the I^2 statistic, with $I^2 > 50\%$ indicating high heterogeneity. High clinical heterogeneity was attributed primarily to methodological and clinical issues. For studies exhibiting low I^2 values, the analysis employed a random-effects model.

Results

Search Results

From the electronic databases, an initial retrieval yielded a total of 411 related studies. Based on the exclusion criteria, we ruled out 135 duplicated publications and 262 studies after reading their abstracts and titles. The full texts of the remaining 14 studies were evaluated to assess their eligibility for inclusion in the study. We then excluded 3 trials for the following reasons: one was not an RCT (n = 1) (11), another did not involve general anesthesia (n = 1) (16), a third was a noninferiority study (n = 1) (12), and none showed available outcomes (n = 3) (13,17,18). Lastly, we included 8 studies in the meta-analysis based on the inclusion criteria (14,19-25). The process of literature screening is depicted in Fig. 1.

Study Characteristics

The publication years of the studies we included spanned from 2020 to 2023, with sample sizes ranging between 40 and 213. In 7 trials, the patients were adults, and the remaining study focused on children. Five trials were 3-arm clinical studies, while the remaining 3 were 2-arm clinical studies. Five studies used bupivacaine, while 3 studies used ropivacaine. Three trials were based on breast surgeries, whereas the others were based on thoracic surgeries. Detailed information about these studies is presented in Table 1.

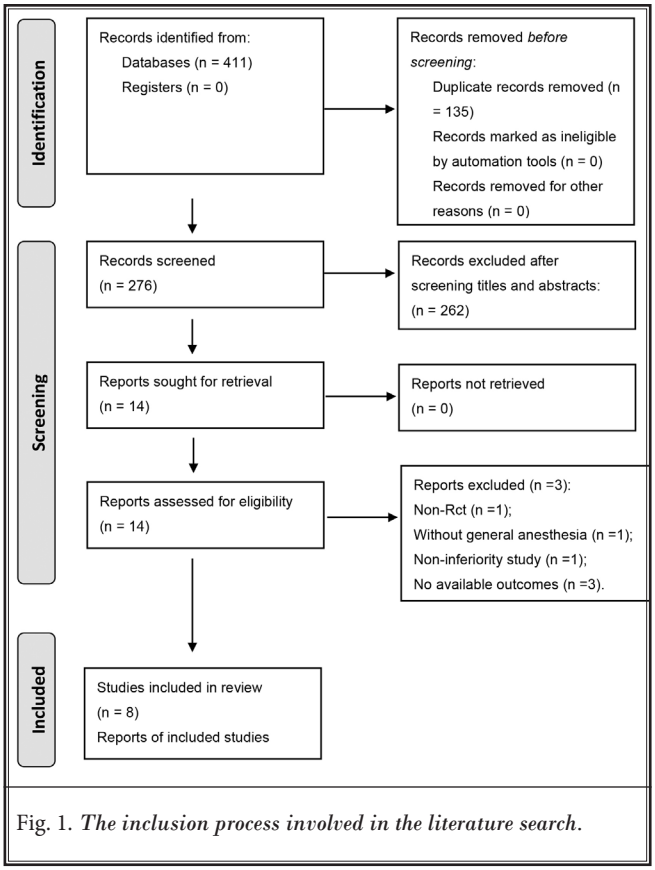

Fig. 1. *The inclusion process involved in the literature search.*

Table 1. *The detailed information of included studies.*

Study	Type of Surgery	Age	ASA Classification	Sample Size	General Anesthesia Induction	General Anesthesia Maintenance	RIB Group	Control /Other Nerve Block Group	Postoperative Analgesia
Altıparmak 2020 (19)	Breast cancer surgery	18-70	I–II	R group: 28 C group: 28	Propofol 2-3 mg k/g, fentanyl 1.5 μg k/g and rocuronium bromide 0.6 mg k/g	Desflurane	30 mL 0.25% bupivacaine	No intervention	Intravenous PCA
Ciftci 2021 (20)	Breast cancer surgery	18-65	I–II	R group: 30 C group: 30 P group: 30	Propofol 2-2.5 mg/kg, fentanyl 1-1.5 μg/kg and rocuronium bromide 0.6 mg/kg	Sevoflurane, remifentanil	30 mL 0.25% bupivacaine	C: No intervention P: 30 mL 0.25% bupivacaine	Ibuprofen, tramadol
Deng 2021 (21)	Thoracoscopic surgery	18-80	I–II	R group: 30 C group: 30 RS group: 30	Midazolam 0.05 mg/kg, sufentanil 0.5 μg/kg, propofol 1–2 mg/kg, and cisatracurium 0.15 mg/kg.	Sevoflurane, remifentanil, and propofol	20 mL 0.375% ropivacaine	C: No intervention RS: 40 mL 0.375% ropivacaine	Intravenous PCA
Elhouty 2023 (14)	Thoracoscopic surgery	15-40	I–II	R group: 71 C group: 71 S group: 71	Propofol 2.5 mg/kg, atracurium 0.5 mg/kg, and fentanyl 1 μg/kg	Isoflurane	20 mL 0.25% bupivacaine	C: No intervention S: 20 mL 0.25% bupivacaine	Ketorolac, acetaminophen, fentanyl
Jiang 2021 (22)	Modified radical mastectomy	18-80	I–II	R group: 30 E group: 30 S group: 30	Midazolam 0.05 mg/kg, sufentanil 0.5 μg/kg, propofol 2 mg/kg, and cisatracurium 0.15 mg/kg.	Sevoflurane, remifentanil, and propofol	20 mL 0.5% ropivacaine	E: 20 ml 0.5% ropivacaine S: 20 mL 0.5% ropivacaine	Tramadol
Kumar 2020 (23)	Thoracoscopic surgery	7-12	I–II	R group: 20 C group: 20	Propofol 3 mg/kg, fentanyl 1 μg/kg. atracurium 0.5 mg/kg	Sevoflurane	10 mL 0.2% ropivacaine	C: No intervention	Intravenous PCA
Şimek 2022 (24)	Thoracotomy	18-75	I–III	R group: 25 C group: 25 E group: 25	Propofol 1-2 mg/kg, Fentanyl 1-1.5 μg/ kg, and rocuronium 0.6 mg/kg	Sevoflurane and remifentanil	20 mL 0.25% bupivacaine	C: No intervention. E: 20 mL 0.25% bupivacaine	Paracetamol, tramadol
Toulan 2022 (25)	Thoracoscopic surgery	18-65	I–II	R group: 30 C group: 30	Propofol 2–3 mg/kg, rocuronium 0.6–0.8 mg/kg, and midazolam 0.05 mg/kg.	Sevoflurane.	20 mL 0.25% bupivacaine	C: local wound infiltration with 0.25% bupivacaine	Intravenous PCA

Abbreviations: ASA, American Society of Anesthesiologists; RIB, rhomboid intercostal block; PCA, patient-controlled analgesia; C, control; R, rhomboid intercostal block; RS, rhomboid intercostal block with sub-serratus plane block; P, pectoral nerve block; S, serratus plane block, E, erector spinae plane block.

Risk of Bias

Figure 2 provides a summary of the risk of bias. The randomization method was reported in all trials; however, one trial did not report the allocation concealment (24). One trial did not include double blinding (20). All trials reported that the outcome assessors were blinded. As for "incomplete outcome data," an "unclear risk" was identified in 2 trials (19,21), while "selective reporting" was noted in one trial (21).

Outcomes in RIB Group vs. No-Block Group

Postoperative Pain Scores

In total, 6 trials (14,19,20,23-25) clearly reported pain scores during the first 24 hours after the operation. The forest plot showed that the RIB technique was associated with a significantly greater decrease in postoperative pain than was the no-block group (2 hours, MD = –1.36, 95% CI [–1.73, –0.98]; $P < 0.01$, $I^2 = 82\%$; 4 hours, MD = –1.51, 95% CI [–1.86, –1.16]; $P < 0.01$, $I^2 = 78\%$; 6 hours, MD = –1.75, 95% CI [–3.08, –0.42]; $P < 0.05$, $I^2 = 99\%$; 8 hours, MD = –1.46, 95% CI [–1.76, –1.15]; $P < 0.01$, $I^2 = 0\%$; 12 hours, MD = –0.51, 95% CI [–0.96, –0.05]; $P < 0.05$, $I^2 = 86\%$; 24 hours, MD = –0.91, 95% CI [–1.44, –0.39]; $P < 0.05$, $I^2 = 95\%$, Fig. 3).

Postoperative Opioid Consumption

Postoperative opioid consumption was evaluated in 7 trials (14,19-21,23-25). The result of the forest plot revealed that the RIB group showed a more significant reduction in opioid consumption than did the no-block group (SMD = –2.65, 95% CI [–3.46, –1.83]; $P < 0.01$, $I^2 = 90\%$, Fig. 4).

Adverse Effects

The incidence of PONV was evaluated in 5 trials. The result of the forest plot showed an association between a significant decrease in the occurrence of PONV and the RIB technique (RR = 0.30, 95% CI [0.18, 0.47], $P < 0.01$, $I^2 = 0$ %, Fig. 5). No block-related complication was reported.

Outcomes of RIB Group vs. Groups That Used Other Nerve Blocks

Postoperative Pain Scores

Five trials compared the postoperative analgesic effects of RIB with those associated with other types of nerve blocks, but only 3 (14,20,24) (which studied the pectoral nerve block, serratus plane block, and erector spinae plane block, respectively) clearly recorded pain scores within 24 hours after surgery. Therefore, we included those 3 trials in our meta-analysis. No significant difference was demonstrated between the RIB group and the other nerve block group in the forest plot (2 hours, MD = 0.00, 95% CI [–0.23, –0.23]; $P > 0.05$, $I^2 = 0$%; 4 hours, MD = 0.07, 95% CI [–0.20, 0.34]; $P > 0.05$, $I^2 = 0$%; 6 hours, MD= –0.82, 95% CI [–2.34, 0.71]; $P > 0.05$, $I^2 = 94$%; 12 hours, MD = –0.68, 95% CI [–2.19, 0.82]; $P > 0.05$, $I^2 = 92$%; 24 hours, MD = –0.38, 95% CI [–0.90, 0.14]; $P > 0.05$, $I^2 = 83$%, Fig. 6).

Postoperative Opioid Consumption

Similarly, 3 trials (14,20,24) evaluated patients' opioid consumption at 24 hours after surgery. The results of the forest plot showed no significant difference between the RIB group and the other nerve block group (SMD = –0.52, 95% CI [–1.57, 0.52]; $P > 0.05$, $I^2 = 93$%, Fig. 7).

Adverse Effects

Another 3 trials (20-22) reported on the incidence of PONV. No significant difference between the RIB group and the other nerve block group was observed in the results of the forest plot (RR = 0.75, 95% CI [0.40, 1.40], $P > 0.05$, $I^2 =$ %, Fig. 8). Furthermore, no block-related complication was reported.

GRADE Results

Evidence quality ranged from moderate to high, as reported in the findings. The GRADE results are summarized in Table 2.

Discussion

Our investigation into the safety and effectiveness of RIB for postoperative analgesia revealed that RIB reduced postoperative pain, opioid consumption, and PONV incidence. However, outcomes between the RIB group and other nerve block groups were not significantly different.

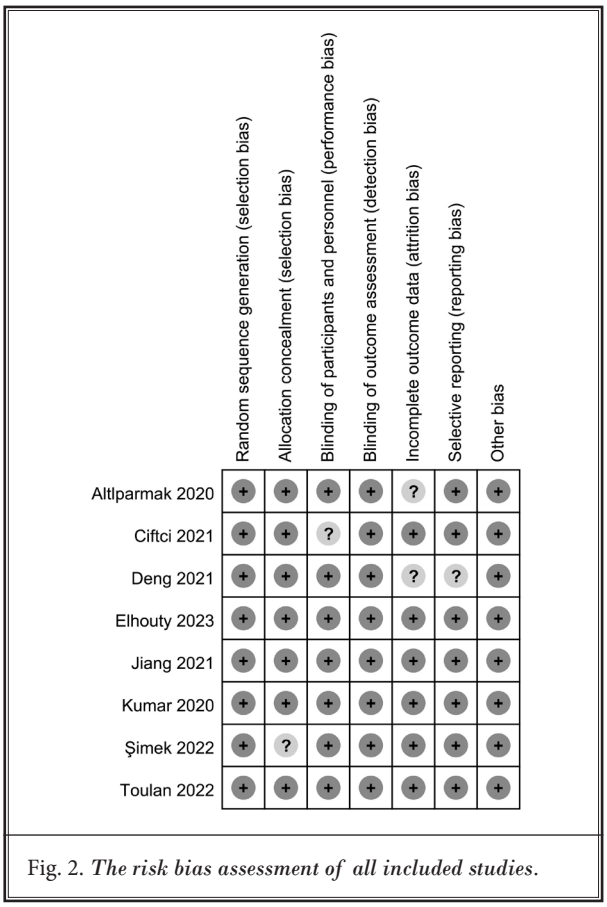

Fig. 2. *The risk bias assessment of all included studies.*

The most common types of chest surgery are thoracic and breast surgery, which are often accompanied by varying degrees of postoperative pain (26,27). Furthermore, poorly controlled moderate-to-severe postoperative pain is closely related to persistent postsurgical pain (28). Though the epidural block was the gold standard method for postoperative pain relief in traditional chest surgery, that type of block had limitations, such as patient position, high requirements for coagulation, and puncture position (29,30). Consequently, prescribing opioid drugs became the obvious choice for pain management; however, this strategy increased the incidence of opioid-related complications and the risk of drug abuse (31).

Recently, the interfascial plane block has emerged as an essential strategy for acute postoperative pain management, due to its advantages of simplicity, effectiveness, safety, and cost-effectiveness, which are in

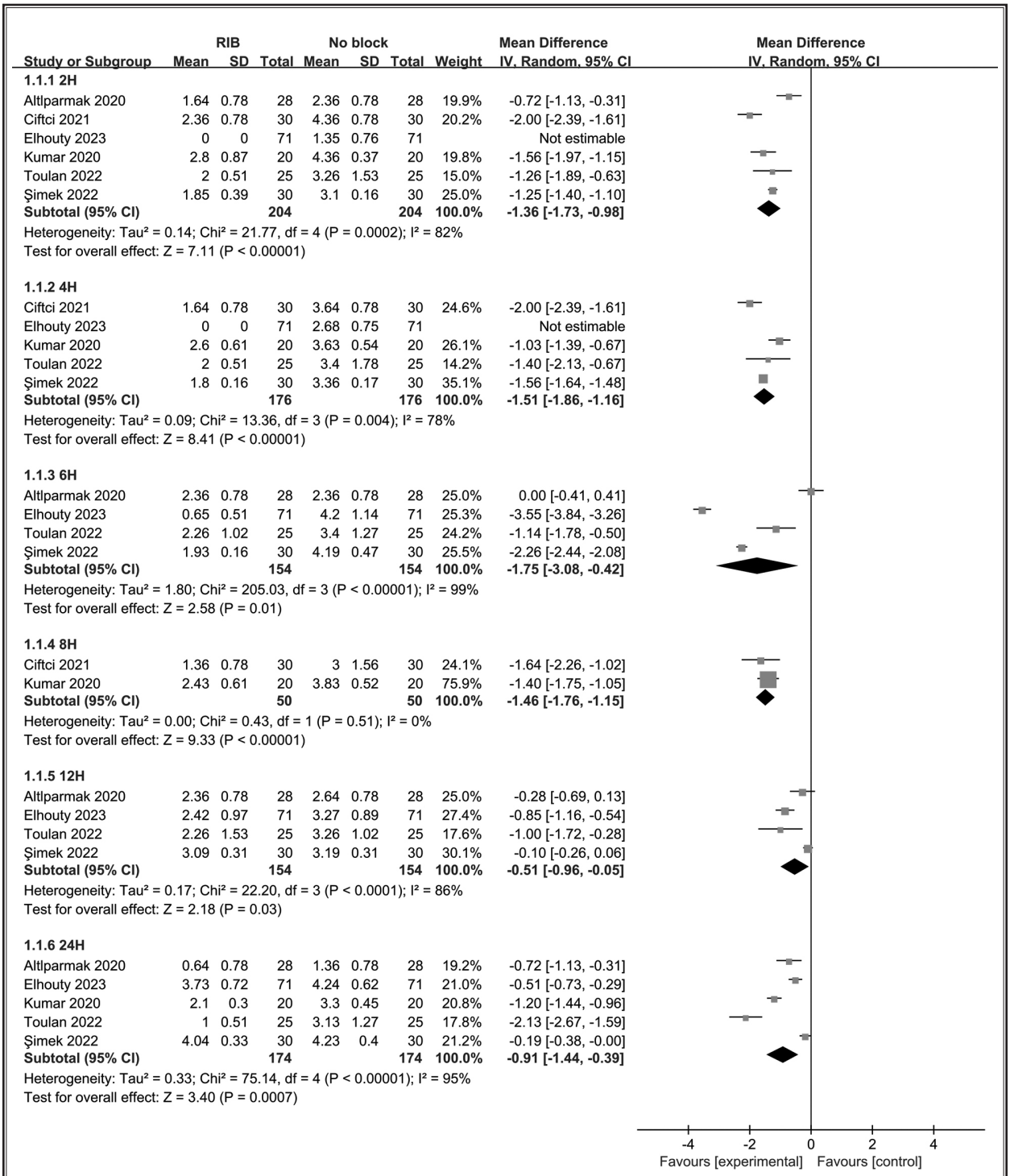

Fig. 3. *Forest plot of hour postoperative pain scores between RIB and no-block groups (RIB, rhomboid intercostal block; H, hour).*

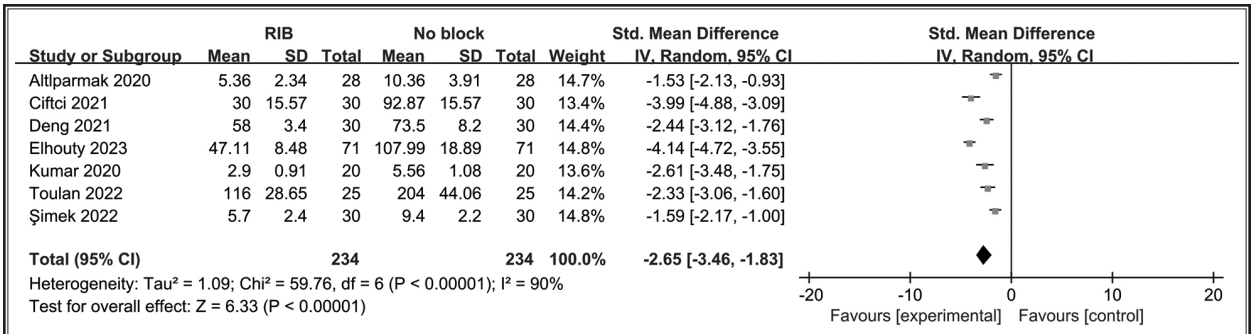

Fig. 4. *Forest plot comparing postoperative opioid consumption in the RIB group to that in the no-block group (RIB, rhomboid intercostal block).*

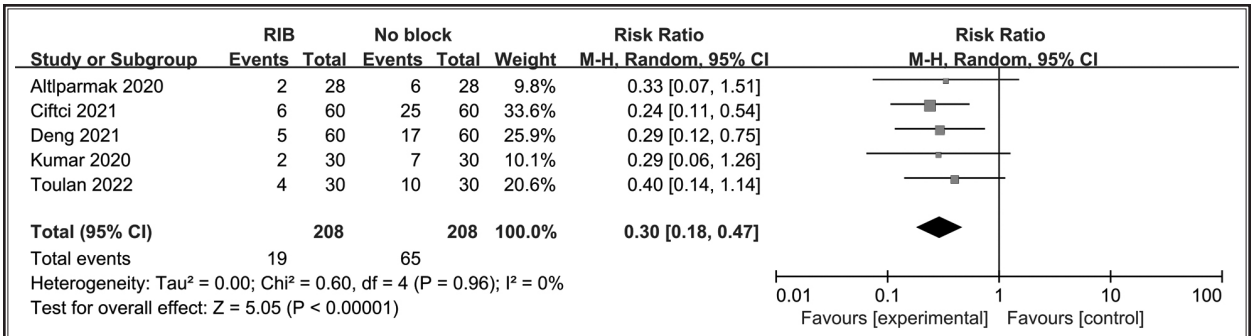

Fig. 5. *Forest plot comparing the incidence of PONV in the RIB group to that in the no-block group (PONV, postoperative nausea and vomiting; RIB, rhomboid intercostal block).*

accordance with ERAS principles (26,32-34). The RIB is a relatively new fascial plane block that exerts analgesic effects between T2 and T9. The lateral branch of the intercostal nerve from T3 to T9 was stained after an RIB was found in a dead body (35), which indicated that the RIB could be inserted in the chest wall in multiple clinical settings. Several clinical studies have investigated the RIB's analgesic effect and safety in chest surgery. A previous meta-analysis showed that the RIB effectively controlled acute pain after breast surgery (15); however, the study included only 4 RCTs, which encompassed 216 patients. Therefore, we conducted the present meta-analysis after performing a systematic literature search.

The present meta-analysis showed that compared to the patients in the no-block group, those in the RIB group experienced significant reductions in pain scores and opioid consumption during the first 24 hours after surgery, indicating that the RIB exerted effective analgesic effects on the chest wall. These results are consistent with the results reported in previous studies. Additionally, we found that the incidence of PONV was lower in the RIB group than in the group that received no nerve block. However, compared to other types of block group, no difference in PONV incidence was observed between the two groups, mainly attributed to reduced postoperative opioids consumption. No block-related complications (such as hematoma, pneumothorax, etc.) were observed in the trials included.

This study showed that RIB, in comparison to other types of nerve blocks, cannot reduce opioid consumption and postoperative pain score. According to the findings of the latest RCT, the quality of recovery after video-assisted thoracoscopic surgery with RIB was non-inferior to recovery that ensued after surgery involving the thoracic paravertebral block (36). Tahsin Şimek et al (37) reported that the erector spinae plane block and RIB exhibited similar capabilities in pain management after open thoracotomy. Considering that the sample size of the 3 studies that included other nerve block groups in our meta-analysis was small and each one observed different types of blocks, further subgroup analysis was not possible. Therefore, the interpretation of the results needs to be highly cautious. More high-

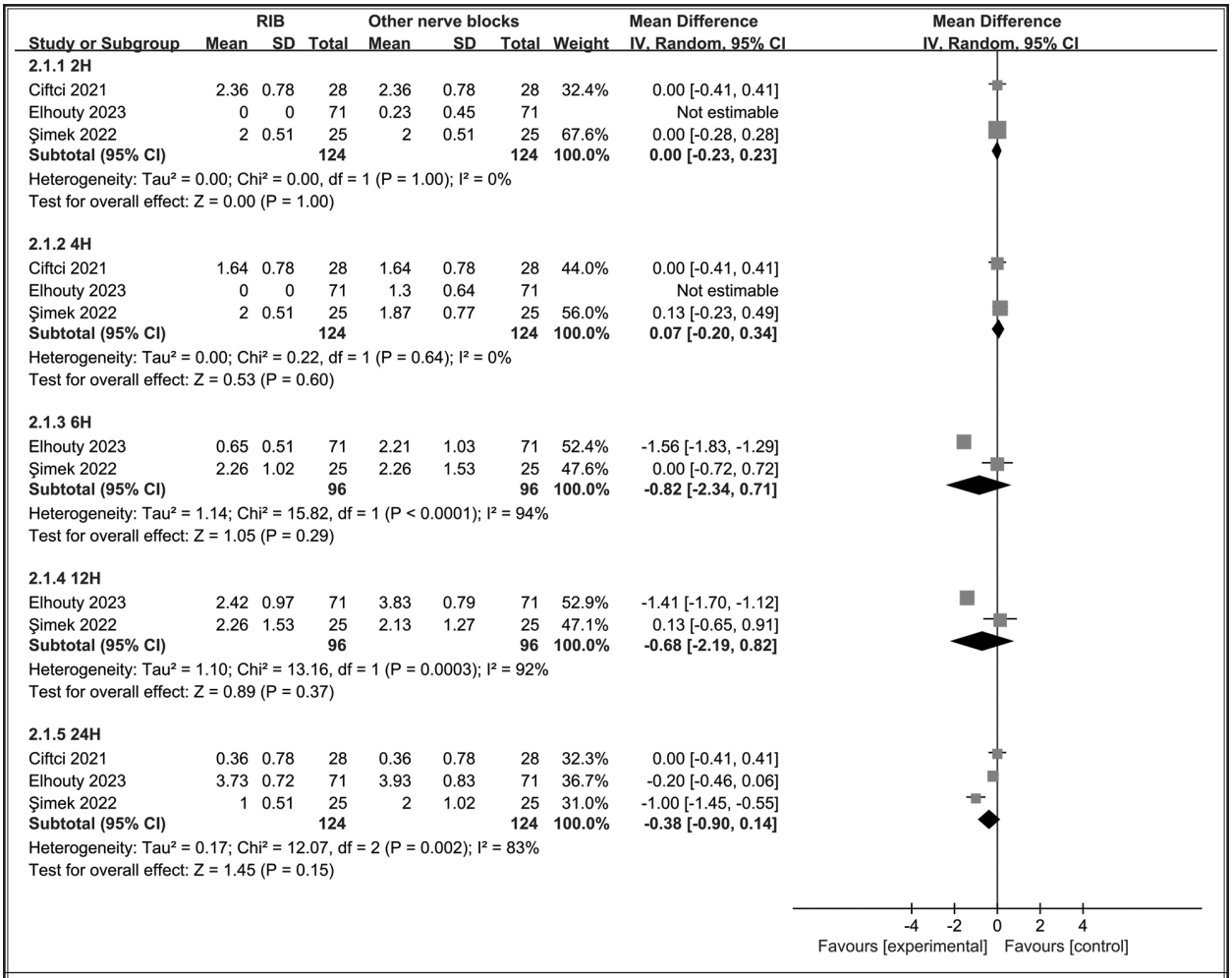

Fig. 6. *Forest plot comparing pain scores one hour after surgery between the RIB group and other nerve block groups (RIB, rhomboid intercostal block).*

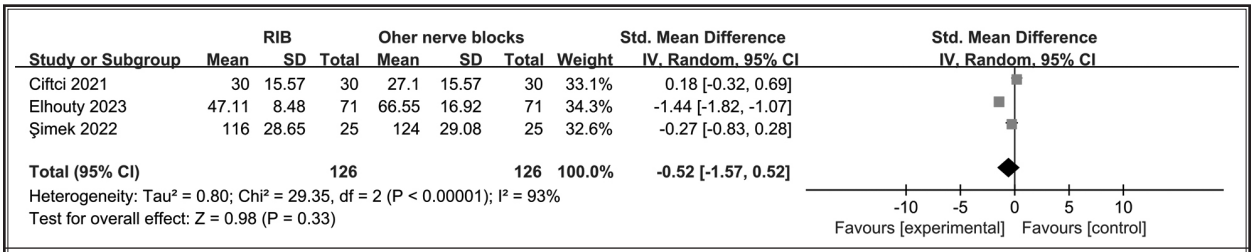

Fig. 7. *Forest plot comparing postoperative opioid consumption in the RIB group to that of other nerve block groups (RIB, rhomboid intercostal block).*

quality experiments should be conducted to investigate whether RIB has advantages over other types of blocks.

Multiple factors in the present meta-analysis, including differences in general anesthesia drugs, surgical types, and control groups, led to high clinical heterogeneity. Consequently, we used the random-effects model with low I^2 values in the present study.

Nevertheless, the present meta-analysis has some limitations. First, because of the insufficient data, we did not conduct any subgroup analysis to investigate

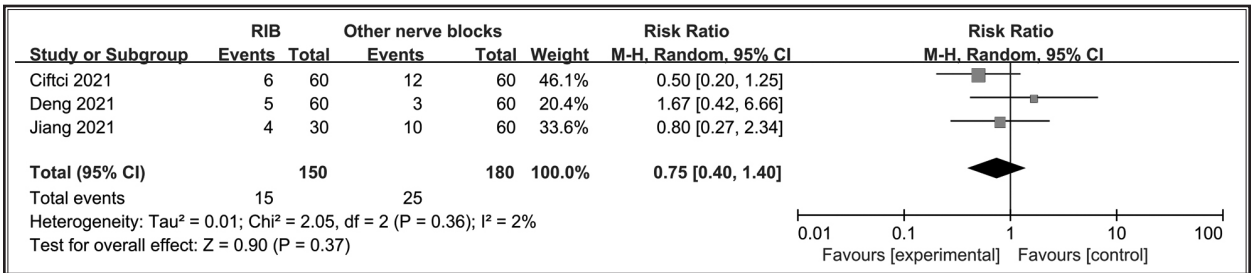

Fig. 8. *Forest plot comparing the incidence of PONV in the RIB group to that in other nerve block groups (PONV, postoperative nausea and vomiting; RIB, rhomboid intercostal block).*

Table 2. *The summary of GRADE.*

Outcome	Included Studies (n)	Patients (n)	Quality of Evidence	Reasons
RIBVS, no block				
Pain score at 2 postoperative hours	6	408	⊕⊕⊕◯ MODERATE	"Inconsistency" was downgraded to "serious."
Pain score at 4 postoperative hours	5	352	⊕⊕⊕◯ MODERATE	"Inconsistency" was downgraded to "serious."
Pain score at 6 postoperative hours	4	308	⊕⊕⊕◯ MODERATE	"Inconsistency" was downgraded to "serious."
Pain score at 8 postoperative hours	2	100	⊕⊕⊕⊕ HIGH	None
Pain score at 12 postoperative hours	4	308	⊕⊕⊕◯ MODERATE	"Inconsistency" was downgraded to "serious."
Pain score at 24 postoperative hours	5	348	⊕⊕⊕◯ MODERATE	"Inconsistency" was downgraded to "serious."
Postoperative opioid consumption	7	468	⊕⊕⊕◯ MODERATE	"Inconsistency" was downgraded to "serious."
Incidence of PONV	5	416	⊕⊕⊕⊕ HIGH	None.
RIB vs. no other blocks				
Pain score at 2 postoperative hours	3	248	⊕⊕⊕⊕ HIGH	None.
Pain score at 4 postoperative hours	3	248	⊕⊕⊕⊕ HIGH	None.
Pain score at 6 postoperative hours	2	192	⊕⊕⊕◯ MODERATE	"Inconsistency" was downgraded to "serious."
Pain score at 12 postoperative hours	2	192	⊕⊕⊕◯ MODERATE	"Inconsistency" was downgraded to "serious."
Pain score at 24 postoperative hours	3	248	⊕⊕⊕◯ MODERATE	"Inconsistency" was downgraded to "serious."
Postoperative opioid consumption	3	252	⊕⊕⊕◯ MODERATE	"Inconsistency" was downgraded to "serious."
Incidence of PONV	3	330	⊕⊕⊕⊕ HIGH	None.

Abbreviations: GRADE, Grading of Recommendations Assessment, Development, and Evaluation; RIB, rhomboid intercostal block; PONV, postoperative nausea and vomiting.

the sources of heterogeneity. Second, we compared RIB to other types of nerve blocks; however, the quality of evidence was limited due to the sample size and types of blocks. Third, we did not investigate the optimal concentrations and volumes of local anesthetics during the use of RIB.

Conclusion

For postoperative analgesia following chest and breast surgery, the RIB might be considered a new option. More high-quality clinical research is warranted before the RIB's comparative advantages and disadvantages over those of other nerve blocks can be confirmed.

Acknowledgments

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