Efficacy of nerve blocks for postoperative analgesia in lung cancer: A meta-analysis of randomized clinical trials

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Abstract. The management of postoperative pain in patients with lung cancer is a key factor affecting patient comfort and postoperative recovery. The aim of the present review was to compare regional block techniques with traditional analgesic methods, demonstrating their advantages in postoperative analgesia and facilitating patient recovery following thoracoscopic surgery. The effects of different regional analgesic techniques were systematically searched from establishment of the database to April 2024 in Web of Science, Embase and Cochrane. The search strategies were developed using the population, interventions, comparators, outcomes and study design framework, and the results are presented in accordance with the guidelines set out by the preferred reporting items for systematic reviews and meta-analyses statement. The primary outcome was the visual analogue scale (VAS) score, with secondary outcomes including patient self-administered intravenous analgesia, number of patients requiring additional injections of analgesic following surgery and the incidence of adverse reactions as outcome indicators. The present meta-analysis included 14 randomized clinical trials with a total of 1,524 patients and four regional block techniques (paravertebral block, thoracic paravertebral block, serratus anterior plane block, intercostal nerve block). Based on limited evidence, regional block surgery was more effective at relieving postoperative pain and had a lower incidence of adverse reactions, but there was no significant difference in VAS scores between this group and the control group. Compared with the control group, five studies reported a significant decrease in the number of patients requiring additional painkillers following surgery in the group receiving nerve block (I^2=14.9%). A total of seven studies showed a significant improvement in the use of patient-controlled analgesia (I^2=72.5%); seven studies showed a decrease in nausea and vomiting (I^2=22.1%) and four studies reported significant improvement in lung function (I^2=44.8%). Other adverse reactions included delirium, drowsiness, venous thrombosis and intestinal obstruction. The present results indicated a significant decrease in various other adverse side effects in the experimental group (I^2=46.4%), and there was no notable publication bias. Compared with conventional anesthesia, nerve block techniques in pain management following thoracoscopic surgery for lung cancer decreased the patient-controlled analgesia usage and the number of patients requiring additional postoperative analgesic, but the VAS scores remained inconsistent. In addition, nerve block technology had a lower incidence of postoperative complications and improved the quality of life of patients with cancer.

Introduction

Lung cancer presents as a malignant tumor that originates in the epithelial tissue, it is an aggressive and prevalent disease worldwide with a high incidence rate, accounting for 25% of all cancer-associated deaths recorded in 2019 (1). Globally, according to 2020 statistics, lung cancer accounts for 12.4% of all cancer cases worldwide and is the most common cause of cancer-associated fatalities across all age groups (2,3), posing a notable threat to human health and wellbeing.

Minimally invasive thoracic surgery has markedly grown in popularity (4); this includes video-assisted thoracic surgery (VATS), which has become a preferred method due to its use of smaller incisions and decreased impact on surrounding tissues, which collectively result in a quicker healing process compared with conventional thoracotomy (5). Despite these advantages, VATS can lead to acute pain, which has been reported to occur in 50 to 80% of patients, with a substantial subset (30-40%) experiencing severe intensity (6). This pain not only slows the functional healing of the patient but also notably compromises the overall quality of recovery (7). Poor handling of pain escalates the risks of developing post-operative

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lung issues (lung parenchyma, bronchi, pleura), can result in chronic pain conditions and may lead to an increased reliance on pain medications following surgery (8), therefore, ensuring pain relief remains a primary concern for patients undergoing VATS.

Administering opioid medications systemically is the most common method for mitigating postoperative pain following VATS surgery, however, these elicit a range of adverse effects, including postoperative nausea/vomiting and respiratory depression (9,10). Cyclooxygenase-2 inhibitors have a notable effect on postoperative analgesia in patients with lung cancer, however, their clinical application is limited by harmful side effects at effective drug doses, including renal impairment and cardiovascular adverse events (11). At present, there is no set postoperative pain management method for VATS but clinical data indicate that nerve block procedures offer promising analgesic effects during VATS (12,13).

Nerve block refers to the injection of local anesthetic near peripheral nerve trunks and plexuses, cranial nerve roots, sympathetic ganglia and other neural structures. By temporarily blocking nerve conduction, this technique achieves therapeutic goals such as pain relief and improved blood circulation. Its core principle involves using anesthetic drugs (such as lidocaine or ropivacaine) to act on nerve roots or axons, thereby decreasing neural excitability. It can effectively control pain, decrease perioperative analgesic/anesthetic requirements, lower rates of postoperative nausea and vomiting, decrease chronic pain risk, minimize respiratory complications, shorten hospital stays and improve patient satisfaction (14). Thoracic paravertebral block (TPVB) achieves unilateral trunk analgesia by injecting local anesthetics into the thoracic paravertebral space to block the conduction of corresponding spinal nerves (15). PVB is an analgesic technique that blocks the corresponding spinal nerve roots by injecting local anesthetic into the outer orifice of the intervertebral foramen via a puncture needle (16). Serratus anterior plane block (SAPB) is a technique that provides dense analgesia to the lateral chest by blocking the thoracic intercostal nerves, which involves ultrasound-guided injection of anesthetics into the superficial or deep layer of the serratus anterior muscle at the level of the 5th rib on the midaxillary line (17). Intercostal nerve block (ICNB) via pleural cavity blocks intercostal nerves by injecting local anesthetics into the pleural cavity, which act on the ventral branches of the thoracic spinal nerves running in the costal groove (18). Nerve block can be performed with or without image guidance, traditional non-image-guided techniques rely on anatomical landmarks, surface projections and operator experience to determine the puncture site and depth, which may lead to inaccurate targeting, inadequate blockade and higher risks of complications such as vascular injury. By contrast, image-guided nerve blocks markedly improve procedural safety and efficacy, primary imaging modalities used for guidance include ultrasound, fluoroscopy and computed tomography (19). A meta-analysis found that among patients undergoing VATS for lung cancer resection, paraspinal nerve block combined with general anesthesia decreased visual analogue scale (VAS) scores 2-6 h after surgery (20). To the best of our knowledge, however, there is a lack of relevant and comprehensive evaluations of pain management methods. Therefore, the aim of the present meta-analysis was to evaluate the efficacy and safety of nerve block surgery for postoperative analgesia in lung cancer and support evidence-based medicine for the clinical treatment of postoperative pain following VATS in patients with lung cancer.

Materials and methods

Search strategy. Electronic databases, including Web of Science (https://www.webofscience.com), Embase (https://www.embase.com) and Cochrane (https://www.cochranelibrary.com) were systematically searched from the establishment of the database to April 2024, using the search terms 'nerve block', 'chemical neurolysis', 'chemo denervation', 'cancer of the lung', 'nerve blockades', 'lung neoplasm', 'lung cancer', 'pulmonary neoplasms', 'pulmonary cancers' and 'pain'. The search strategy for Cochrane Library, which was also applied to the other databases, is shown in Table I.

Study selection criteria

Types of study. All randomized clinical trials (RCTs) of nerve block in postoperative analgesia in patients with lung cancer, whether single-blinded or double-blinded, were included. Both guided and non-guided nerve block were included and the data were not extracted separately. All patients included in the analysis were diagnosed with lung cancer, with no exclusion based on age, sex, ethnicity or course of disease. All the patients received lung cancer surgery (thoracoscopic or thoracotomy). The treatment plan was nerve block, which included TPVB, PVB, SAPB or ICNB, and the comparators were standard analgesic therapies, which were standard opioid-based multi-modal analgesia, including intravenous sufentanil for intra- and post-operative pain. The search strategies were based on the population, interventions, comparators, outcomes and study design framework, and the findings were reported in alignment with the protocols established by the preferred reporting items for systematic reviews and meta-analyses guidelines (Table II).

Outcome measures. The primary outcome measure was the VAS score used to assess pain intensity at 24, 48 and 72 h following completion of surgery at rest, and the secondary outcome indicators were the number of times the button on the patient-controlled analgesia instrument was pressed at 24 h following surgery, the dosage of analgesics at 48 h after surgery and adverse reactions. In the presence of substantial heterogeneity, subgroup analysis is warranted.

Exclusion criteria. The exclusion criteria were as follows: i) RCTs comparing two types of nerve block surgery, ii) non-RCTs, iii) duplicated data and iv) invalid outcome indices.

Study selection. The literature search results were independently assessed by two researchers according to the inclusion criteria. All documents obtained from the databases were imported into EndNote X9 (Clarivate) to exclude duplicate documents. The titles and abstracts were assessed for initial screening. Of the remaining studies, the full text was read and the final studies for inclusion were discussed. Discrepancies were resolved by discussion with a third examiner. Author name, publication year, anesthesia types, outcomes, pain

Table I. Search strategy in the Cochrane Library.

Order	Search items
#1	(pain):ti,ab,kw
#2	(nerve block or nerve Blockades or chemical Neurolysis or Chemodenervation):ti,ab,kw
#3	(lung neoplasms or pulmonary neoplasms or cancers, lung or pulmonary cancers or cancer of the lung):ti,ab,kw
#4	#1 AND #2 AND #3

Table II. Surgical information from the included studies.

First author, year	Anesthesia	Background analgesic modality	Type of nerve block	Outcomes	Pain scale	ASA stage	(Refs.)
Kang *et al*, 2020	GA	PCA	TPVB	VAS score, incidence of postoperative adverse reactions	VAS	I-III	(21)
Li *et al*, 2018	GA	N/A	PVB	VAS score	VAS	I-II	(22)
Li *et al*, 2017	GA	PCA	ICNB	VAS score, number of patients requiring additional posto-perative analgesic, incidence of postoperative adverse reactions	VAS	I-II	(23)
Liu *et al*, 2022 (A)	GA	PCA	TPVB, SAPB	VAS score, number of administrations of patient-controlled analgesia	VAS	I-II	(24)
Liu *et al*, 2022 (B)	N/A	N/A	SAPB	Incidence of posto-perative adverse reactions	VAS	N/A	(25)
Shang *et al*, 2020	GA	PCA	SAPB	Number of patients requiring additional postoperative analgesic, incidence of postoperative adverse reactions	VAS	I-III	(26)
Viti *et al*, 2022	GA	N/A	SAPB	Number of patients requiring additional postoperative analgesic	NRS	N/A	(27)
Wei *et al*, 2022	GA	PCA	PVB	VAS score, incidence of postoperative adverse reactions	VAS	I-III	(28)
Wu *et al*, 2018	GA	PCA	PVB	VAS score, number of patients requiring additional postopera-tive analgesic, incidence of posto-perative adverse reactions	VAS	N/A	(29)

Table II. Continued.

First author, year	Anesthesia	Background analgesic modality	Type of nerve block	Outcomes	Pain scale	ASA stage	(Refs.)
Xu *et al*, 2021	GA	PCA	ICNB	VAS score, number of administrations of patient-controlled analgesia, incidence of postoperative adverse reactions	VAS	I-II	(30)
Zhang *et al*, 2020	GA	PCA	TPVB	VAS score	VAS	I-II	(31)
Zhao *et al*, 2022	GA	PCA	PVB, ICNB	VAS score, number of administrations of patient-controlled analgesia, incidence of postoperative adverse reactions	VAS	I-II	(32)
Chen *et al*, 2015	GA	PCA	PVB	VAS score, number of patients requiring additional postoperative analgesic, number of administrations of patient-controlled analgesia	VAS	I-II	(33)
Gao *et al*, 2022	GA	PCA	SAPB	VAS score, number of patients requiring additional postoperative analgesic, incidence of postoperative adverse reactions	VAS	II-III	(34)

TPVB, thoracic paravertebral block; PVB, paravertebral block; SAPB, serratus anterior plane block; ICNB, intrapleural intercostal nerve block; GA, general anesthesia; ASA, American Society of Anesthesiologists; PCA, patient-controlled analgesia; N/A, not applicable; VAS, visual analogue score; NRS, numerical rating scale.

rating scales and American Society of Anesthesiologists stage was collected from all the included studies.

Statistical analysis. Stata version 16.0 (StataCorp LP) was used to analyze the results. Dichotomous and continuous data are presented as the relative risk and mean difference, respectively, with 95% confidence intervals. $P<0.05$ was considered to indicate statistical significance. The random-effects model was used for meta-analysis, regardless of the I^2 values.

Results

Search results and characteristics of studies. The literature search identified 116 articles, of which five duplicates were removed. After reviewing the titles and abstracts of the remaining articles, 37 articles were excluded according to the inclusion and exclusion criteria, leaving 58 full texts. After assessing the full texts, 14 studies were deemed to meet the inclusion criteria (Fig. 1, Table III) (21-34).

Risk of bias assessment. Using the Cochrane risk of bias tool, the risk of bias was rated as low, unclear or high independently by two researchers. This included random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessments, incomplete outcome data, selective reporting and other sources of bias. Discrepancies were resolved by a third reviewer. The symmetry of the funnel plot demonstrated that there was no publication bias. The risk of bias assessment is summarized in Fig. 2, which indicated that the included studies exhibited the lowest risk of bias in random sequence generation and completeness of outcome data, while demonstrating the highest risk of bias in blinding of investigators

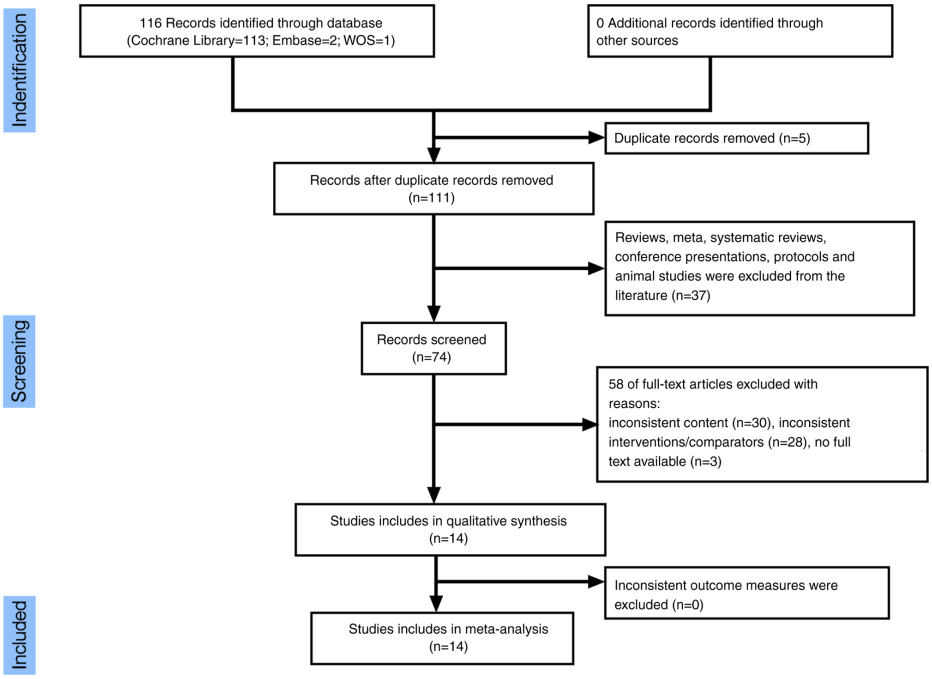

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow chart. WOS, Web of Science.

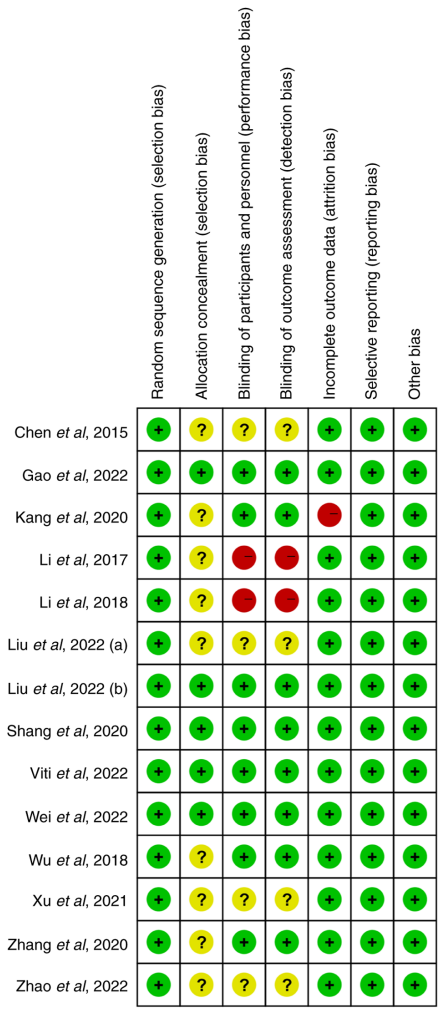

Figure 2. Risk of bias. The overall quality of the included studies was considered adequate. Green: Indicates low bias risk Yellow: Indicates unclear bias risk Green: Indicates high bias risk.

and participants (performance bias). Other domains, such as allocation concealment and selective reporting, showed overall lower risk of bias. This meta-analysis included 14 studies, of which 3 had at least one study with a risk of partial bias. The remaining 11 studies did not explicitly report details regarding the implementation of randomization and blinding.

VAS scores. A total of 11 studies (21-24,28-34) reported pain scores at rest, with 11 reporting scores after 24 h (I^2=97.8%, Fig. 3), 9 (21-24,28,29,31,33,34) reporting scores after 48 h (I^2=97.7%, Fig. 4) and 5 (21,23,29,31,34) extending at 72 h post-intervention (I^2=94.2%, Fig. 5). The forest plot showed a high degree of heterogeneity, sensitivity analyses were conducted, yet significant heterogeneity persisted. The pooled data indicated that compared against the conventional anesthesia groups, nerve block techniques yielded comparable levels of discomfort. At each time interval, the severity of pain measured by standardized scales failed to demonstrate any significant difference between treatment modalities.

Number of individuals requiring additional postoperative analgesic. A total of 5 studies (25,26,29,33,34) studies reported the use of additional postoperative analgesics and included interventions. In the group receiving neural blockade, there was a significant decrease in the number of patients who required additional pain medication postoperatively (I^2=0.0%, Fig. 6).

Administration of patient-controlled analgesia. A total of 4 studies (24,30,32,34) reported the administration of patient-controlled analgesia and included interventions. The nerve block cohort required significantly fewer patient-controlled analgesia interventions compared with the control (I^2=72.5%, Fig. 7).

Incidence of postoperative adverse reactions

Table III. Characteristics of the included studies.

First author, year	Country	Number of patients		Age, years		Sex, male/female		(Refs.)
		Experimental	Control	Experimental	Control	Experimental	Control	
Kang *et al*, 2020	China	41	34	51.60±11.00	56.10±9.80	21/20	16/18	(21)
Li *et al*, 2018	China	20	20	59.40±10.77	54.80±13.02	8/12	9/11	(22)
Li *et al*, 2017	China	30	30	23-77	23-77	35	25	(23)
Liu *et al*, 2022 (A)	China	44 (TPVB); 44 (SAPB)	44	59.23±9.71; 59.16±9.68	58.95±9.64	29/15; 28/16	26/18	(24)
Liu *et al*, 2022 (B)	China	30	30	56.21±7.21	58.21±9.02	15/15	13/17	(25)
Shang *et al*, 2020	China	30	30	56.20±7.20	58.23±9.03	15/15	17/13	(26)
Viti *et al*, 2022	Italy	46	44	67.80±9.30	71.00±7.90	28/18	30/14	(27)
Wei *et al*, 2022	China	170	168	76.20±6.30	73.50±7.10	83/87	80/88	(28)
Wu *et al*, 2018	China	86	85	58.00	58.00	42/44	49/36	(29)
Xu *et al*, 2021	China	50	45	51.28±6.39	50.97±7.20	31/19	30/15	(30)
Zhang *et al*, 2020	China	38	37	56.00±15.00	50.00±13.00	18/24	19/22	(31)
Zhao *et al*, 2022	China	50 (PVB); 50 (ICNB)	50	52.44±9.22; 54.98±10.94	51.82±11.37	29/21, 25/25	28/21	(32)
Chen *et al*, 2015	China	20	20	53.00±12.00	55.00±11.00	11/9	12/8	(33)
Gao *et al*, 2022	China	60	60	55.40±11.10	57.20±10.30	33/22	32/21	(34)

TPVB, thoracic paravertebral block; PVB, paravertebral block; SAPB, serratus anterior plane block; ICNB, intrapleural intercostal nerve block.

Nausea and vomiting. A total of 6 studies (25,26,29,30,32,34) reported nausea and vomiting, including interventions. The pooled outcome indicated that, compared with control group, subjects who received regional numbing techniques exhibited fewer instances of nausea and emesis following surgery (I^2=29.5%, Fig. 8).

Pulmonary adverse reactions. A total of 4 studies (21,23,28,34) reported the pulmonary adverse reactions (I^2=44.8%; Fig. 9). In comparison with the control group, patients in the experimental cohort exhibited a notable improvement in lung function.

Other adverse reactions. A total of 4 studies (28-30,34) reported other adverse reactions, which included delirium, hypersomnia, venous thrombosis and intestinal obstruction. Compared with the control group, individuals within the experimental cohort experienced fewer instances of other side effects (I^2=31.3%, Fig. 10).

Summary and analysis of results. Of 14 studies included in the present meta-analysis, there was no significant disparity in the VAS score between the nerve block group and the control group. Sensitivity analyses was implemented by excluding studies with a high risk of bias. Wei *et al* (28)'s study population consisted entirely of elderly patients (>65 years old), the control group in Wu *et al* (29) used the potent opioid sufentanil and all patients uniformly received non-steroidal anti-inflammatory drugs as background analgesia, resulting in a high intensity of analgesia in the control group. Furthermore, these two studies had large sample sizes and marked weight in the analysis. Their exclusion was performed to test the robustness of the overall meta-analysis results. Marked heterogeneity persisted after excluding Wei *et al* (28) (I^2=95.3%, Fig. S1), and this persisted after excluding Wu *et al* (29) (I^2=97.7%, Fig. S2). In addition, after excluding both Wei *et al* (28) and Wu *et al* (29), no notable changes in the level of heterogeneity were observed (I^2=95.1%,

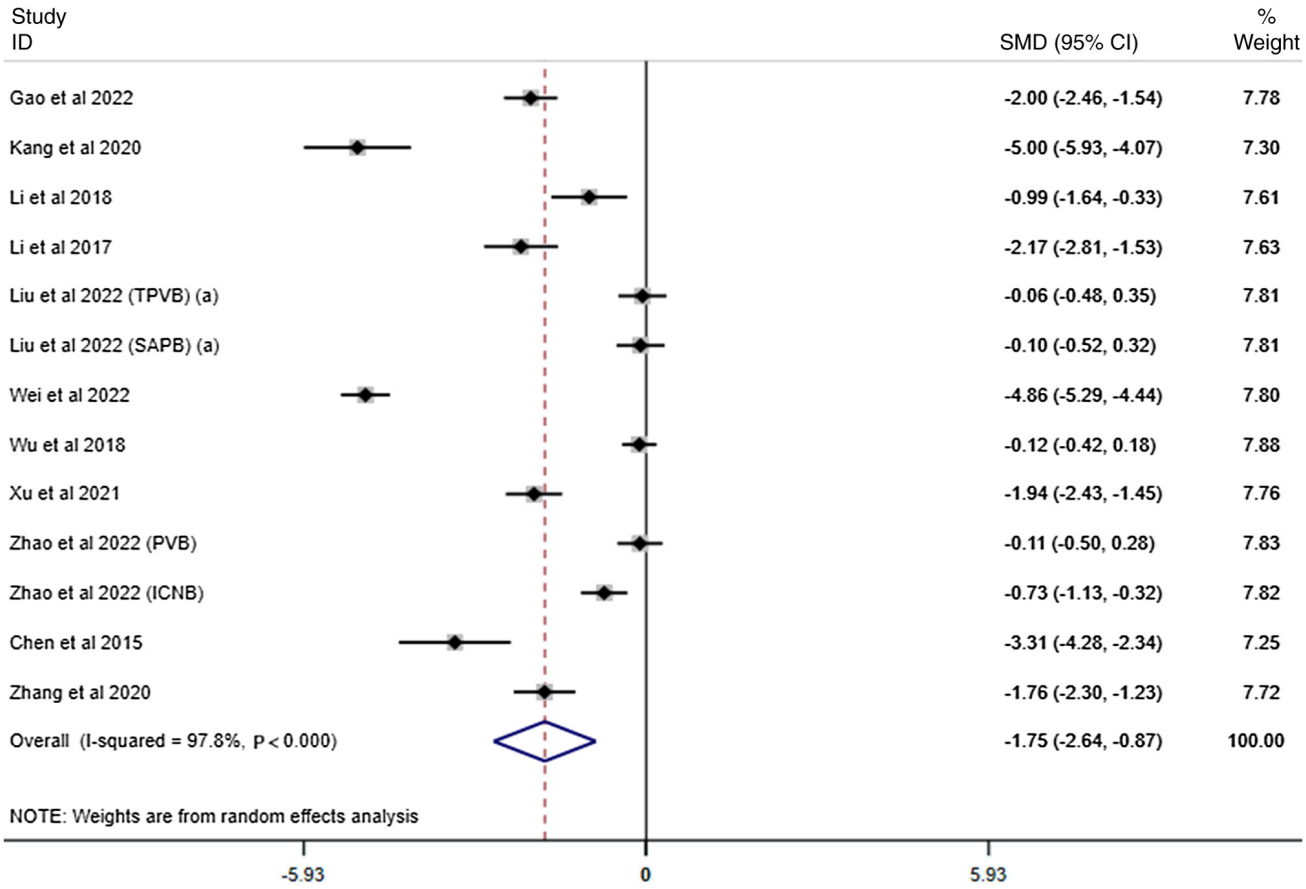

Figure 3. Visual analogue scale score after 24 h. Weights calculated from random effects analysis. CI, confidence interval. SMD, standardized mean difference. PVB, paravertebral block; TPVB, thoracic paravertebral space to block; SAPB, serratus anterior plane block; ICNB, intercostal nerve block.

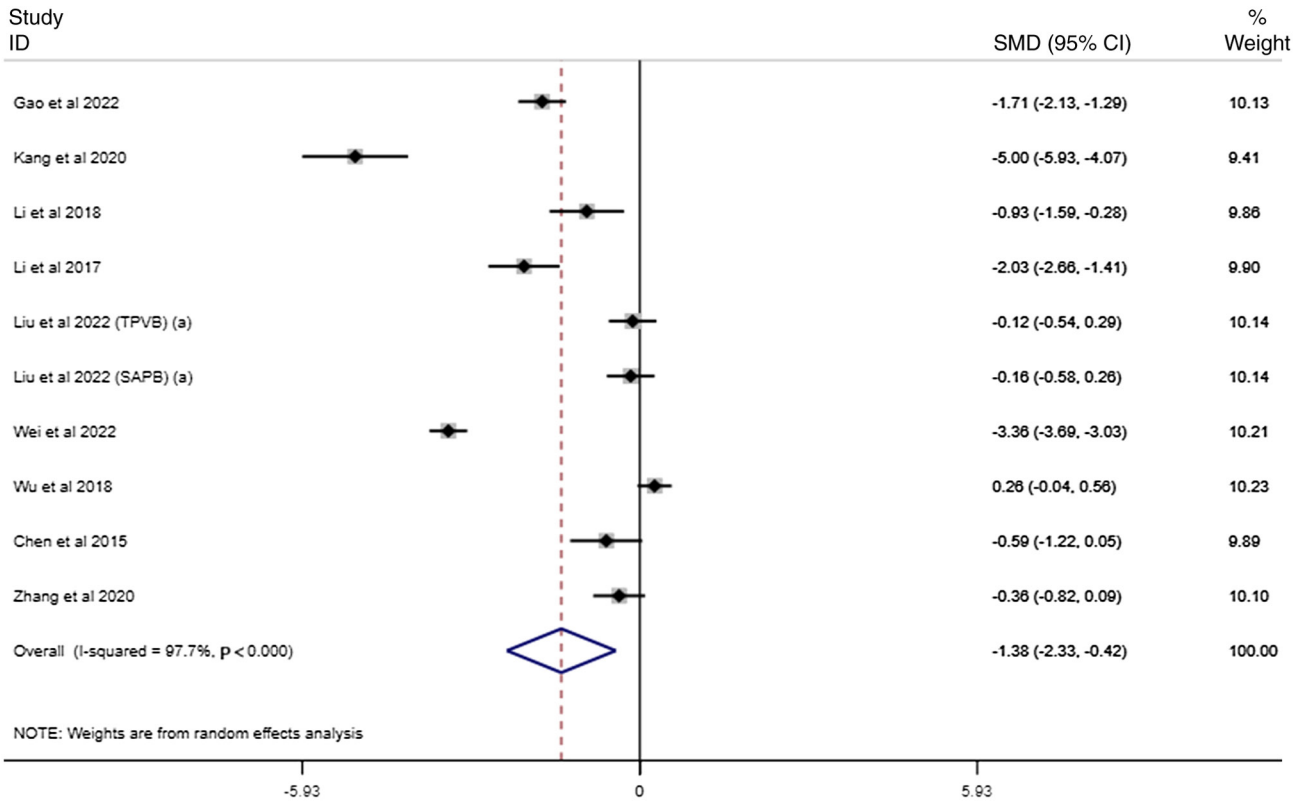

Figure 4. Visual analogue scale score after 48 h. CI, confidence interval; SMD, standardized mean difference; PVB, paravertebral block; TPVB, thoracic paravertebral space to block; SAPB, serratus anterior plane block.

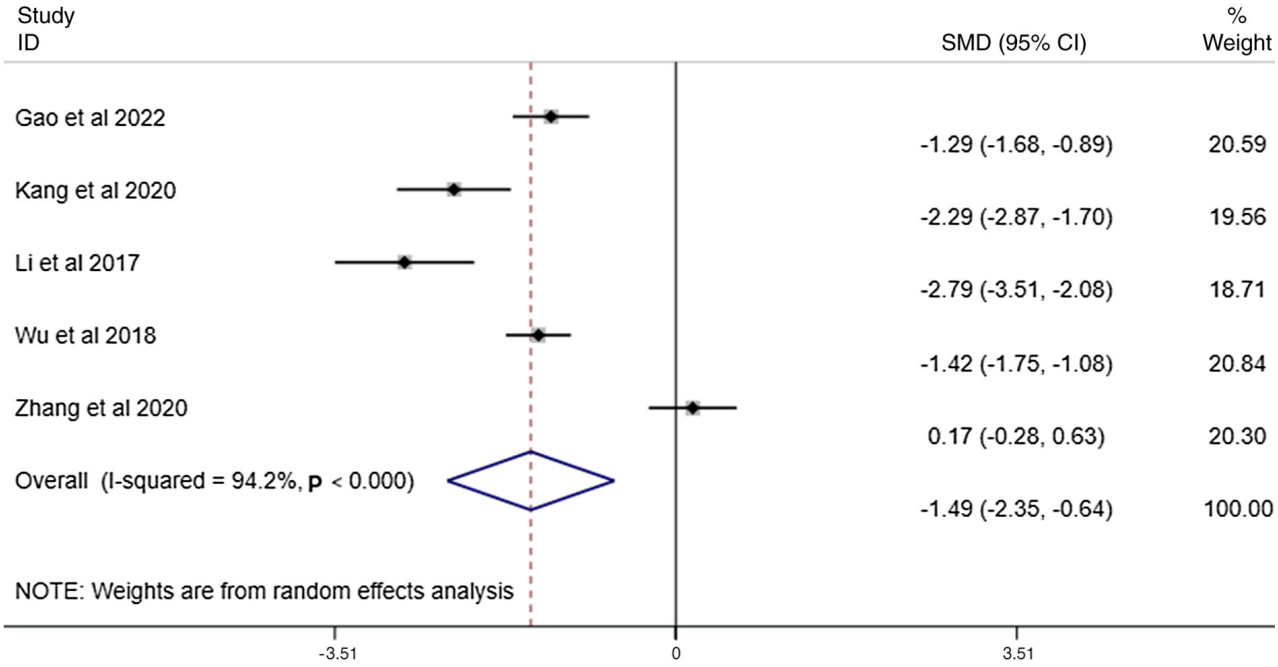

Figure 5. Visual analogue scale score after 72 h. CI, confidence interval; SMD, standardized mean difference.

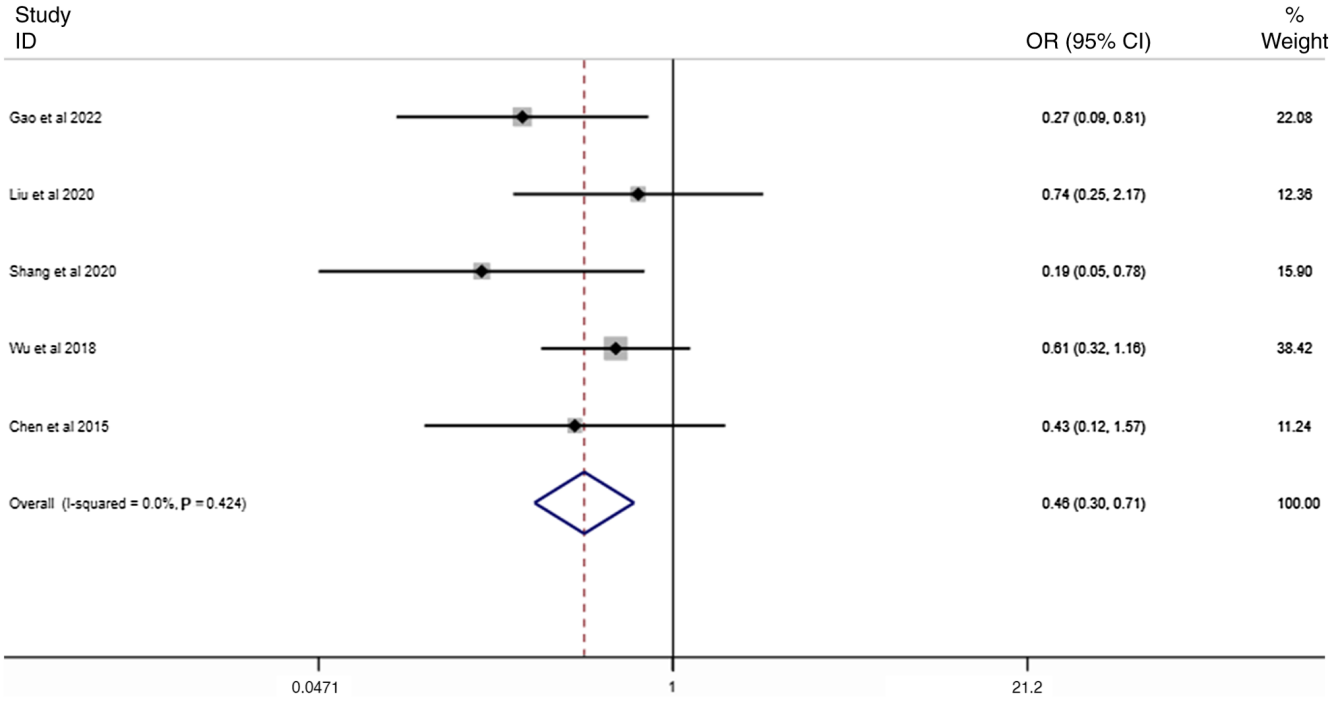

Figure 6. Number of individuals requiring additional postoperative analgesic. CI, confidence interval; OR, odds ratio.

Fig. S3). Subgroup analysis based on different nerve block areas for heterogeneity testing was then performed (Figs. 11-16), the heterogeneity among groups could not be clearly explained. Meta-regression was not performed in due to the limited number of included studies. With only 14 RCTs, the statistical power for a meta-regression would be low, increasing the risk of false-negative findings and model instability (35). Key potential effect modifiers, such as the specific type and concentration of local anesthetic, technical nuances of the nerve blocks and patient-specific factors such as baseline pain tolerance, were reported inconsistently across studies, precluding their systematic extraction and synthesis. The considerable heterogeneity observed, particularly in pain score outcomes, may arise from a combination of clinical and methodological diversity. In the absence of comprehensive and uniformly reported covariate data, meta-regression would be unlikely to explain the sources of this heterogeneity and could lead to spurious conclusions (36). Due to inconsistent drug concentrations and technical details, it was

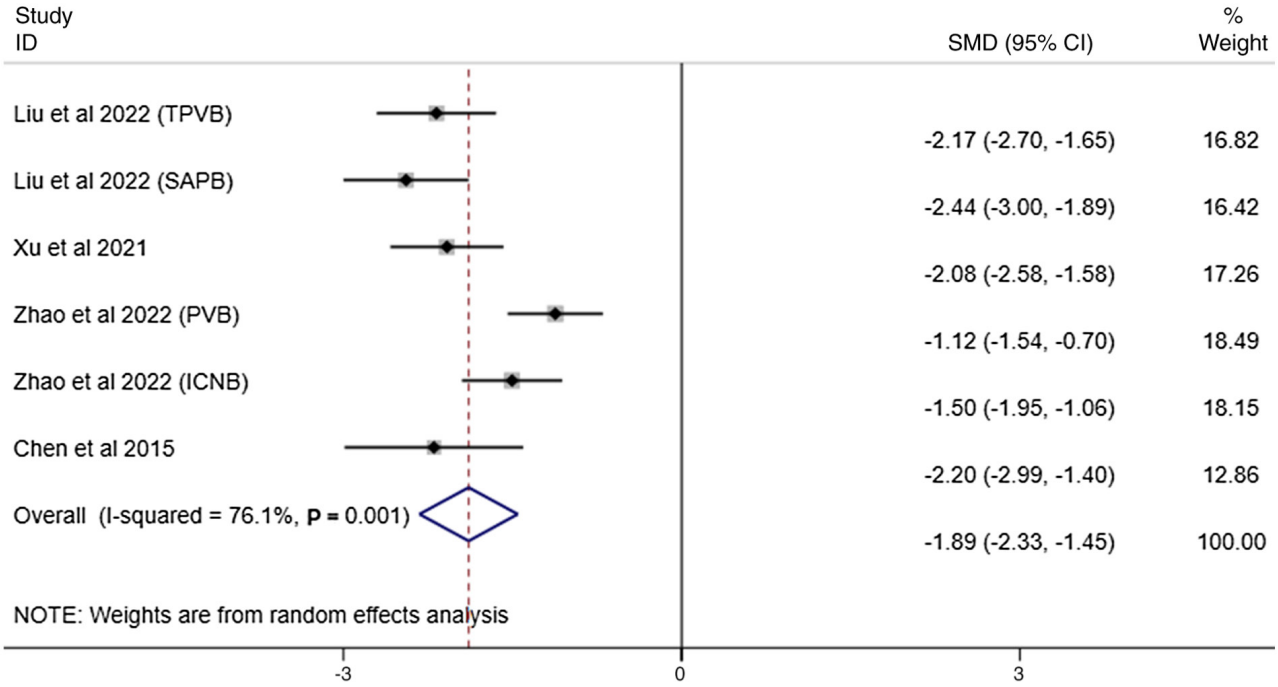

Figure 7. Number of instances of patient-controlled analgesia. CI, confidence interval; SMD, standardized mean difference.

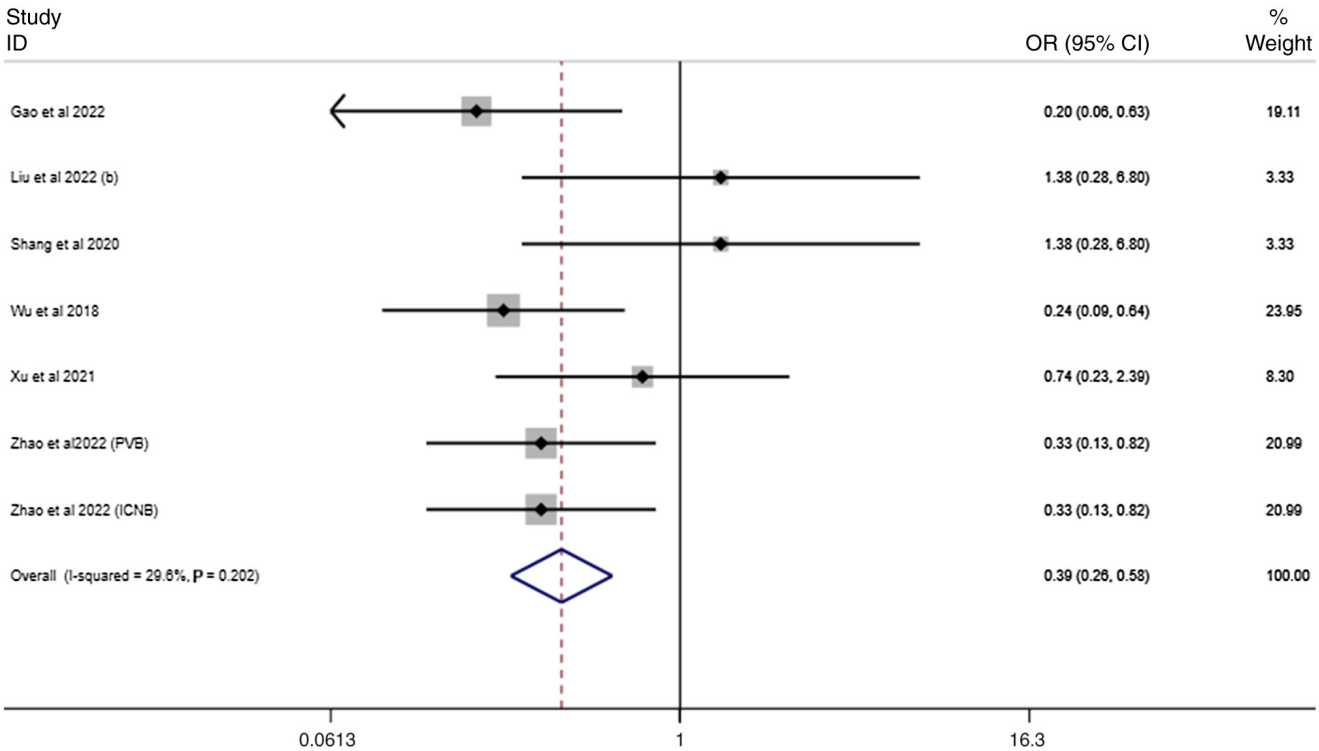

Figure 8. Number of instances of nausea and vomiting. CI, confidence interval; OR, odds ratio.

not possible to identify the cause of heterogeneity. Nevertheless, nerve block demonstrated notable efficacy in decreasing the number of patients requiring additional analgesics post-surgery and the frequency of patient-initiated pain relief button presses. Overall, nerve block alleviated postoperative pain in patients and they lowered the incidence of postoperative adverse reactions, effectively facilitating a quicker recovery.

Discussion

Life expectancy of patients with cancer is affected by a variety of factors (37). Pain is a key factor that not only enhances the stress response of the body but also triggers the release of inflammatory factors, which can trigger intense stress responses, leading to massive catecholamine release and

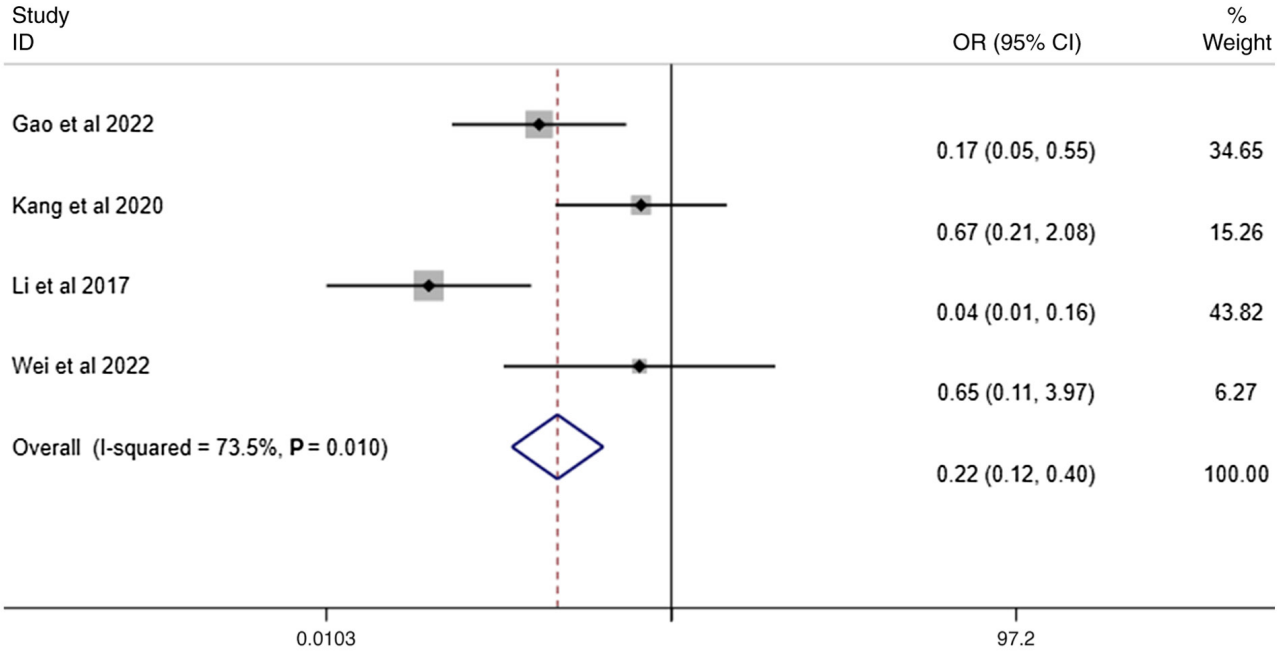

Figure 9. Number of instances of pulmonary adverse reactions. CI, confidence interval; OR, odds ratio.

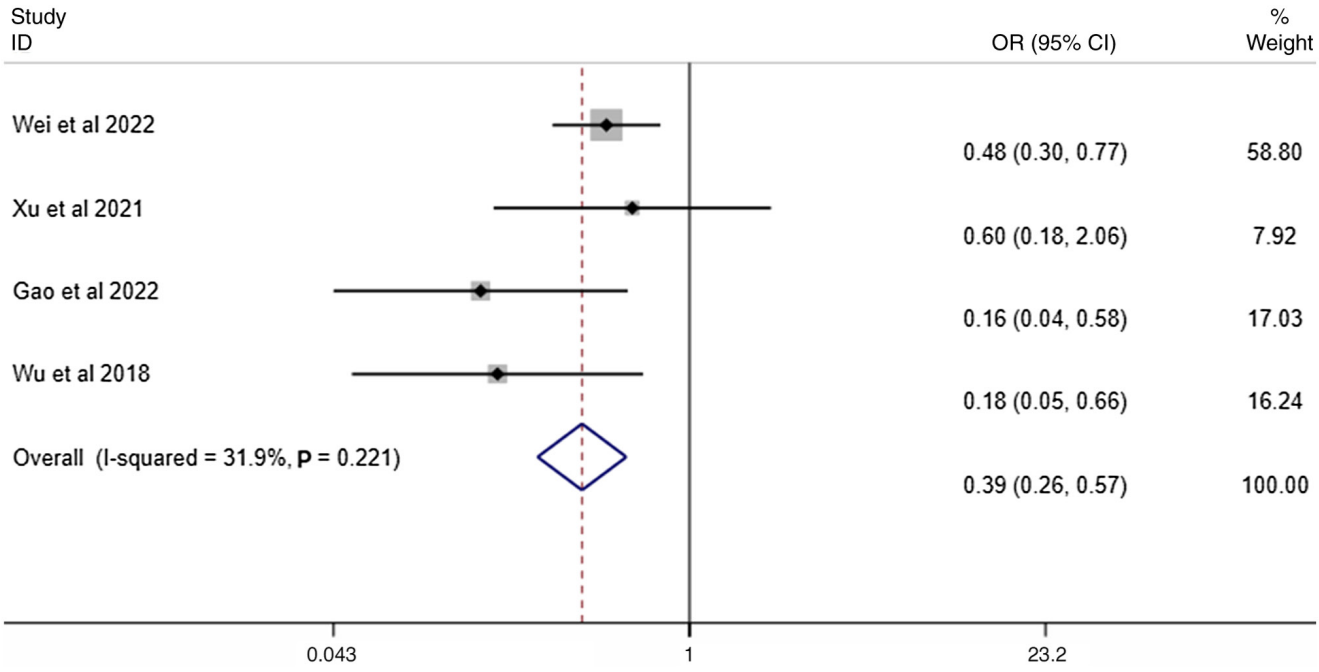

Figure 10. Number of instances of other adverse reactions. CI, confidence interval; OR, odds ratio.

increasing the risk of myocardial ischemia in high-risk patients, and exacerbates postoperative lung injury (38). Therefore, improving postoperative pain management methods is key for improving the quality of life and extending the life expectancy of patients with cancer. Pain relief allows patients to breathe more freely and cough up sputum effectively, helping to keep the airways open, as well as keeping blood pressure and heart rate relatively stable and allowing for smoother urination. This decreases the risk of respiratory complications such as atelectasis and pneumonia, cardiovascular complications, urinary tract infection and urinary retention (39).

Hade *et al* (40) showed that a significant proportion of patients experienced moderate to severe rebound pain following neurosurgical procedures, with marked discomfort during surgery and intense pain in the recovery room. This may explain the substantial variation in VAS score observed between nerve block and general anesthesia in the present study. The patients with lung cancer included in the present meta-analysis covered multiple stages, and patients at stage II-III required adjuvant therapy following surgery. Adjuvant chemotherapeutic drugs often cause adverse reactions such as nausea, vomiting and fatigue (41), which may interfere with the

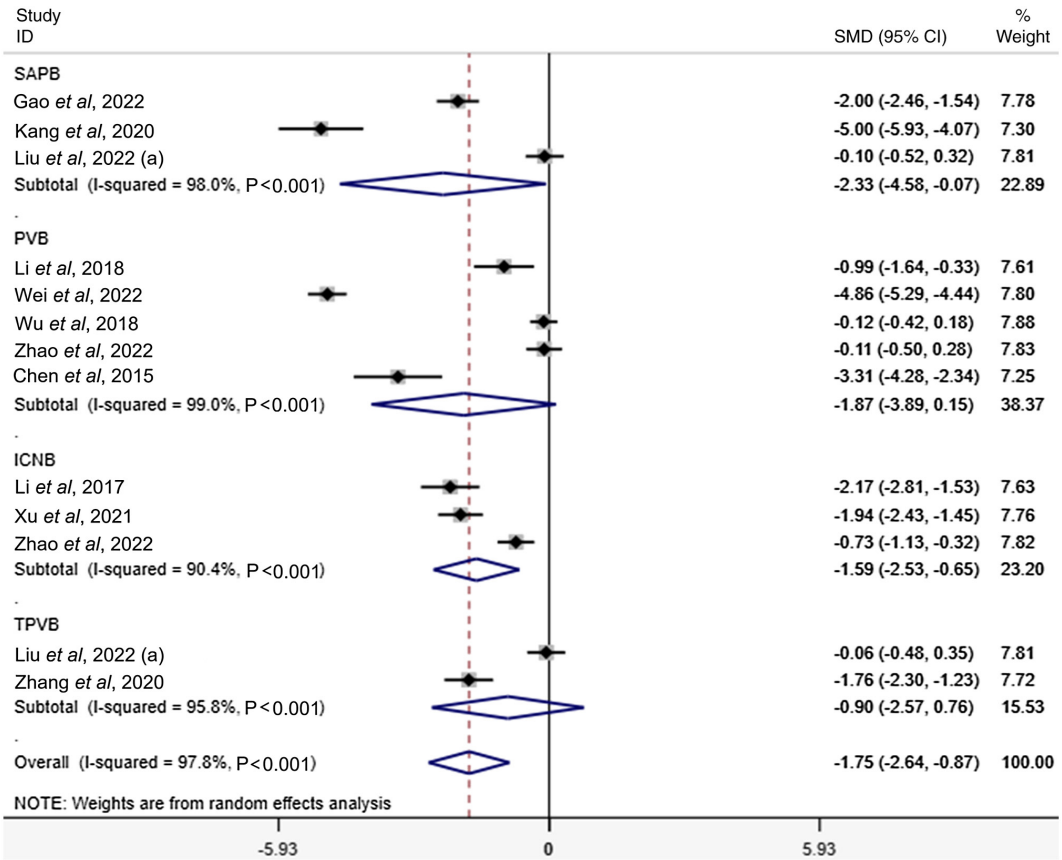

Figure 11. Forest plot of the visual analogue scale scores after 24 h. CI, confidence interval; SMD, standardized mean difference; PVB, paravertebral block; TPVB, thoracic thoracic paravertebral block; SAPB, serratus anterior plane block; ICNB, intercostal nerve block via pleural cavity.

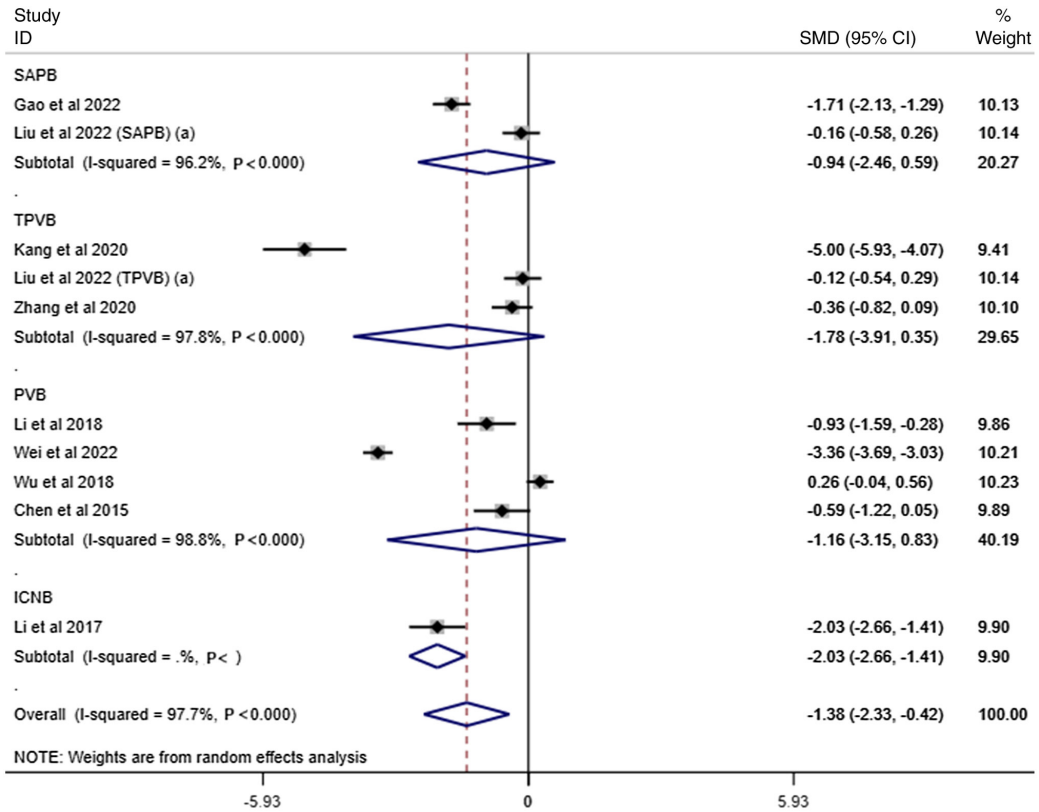

Figure 12. Forest plot of the visual analogue scale scores after 48 h. CI, confidence interval; SMD, standardized mean difference; PVB, paravertebral block; TPVB, thoracic paravertebral block; SAPB, serratus anterior plane block; ICNB, intercostal nerve block. For subgroups with one study only, statistical heterogeneity (I^2 statistic) and its corresponding P-value cannot be calculated, as these metrics need at least two studies for between-study variance comparison.

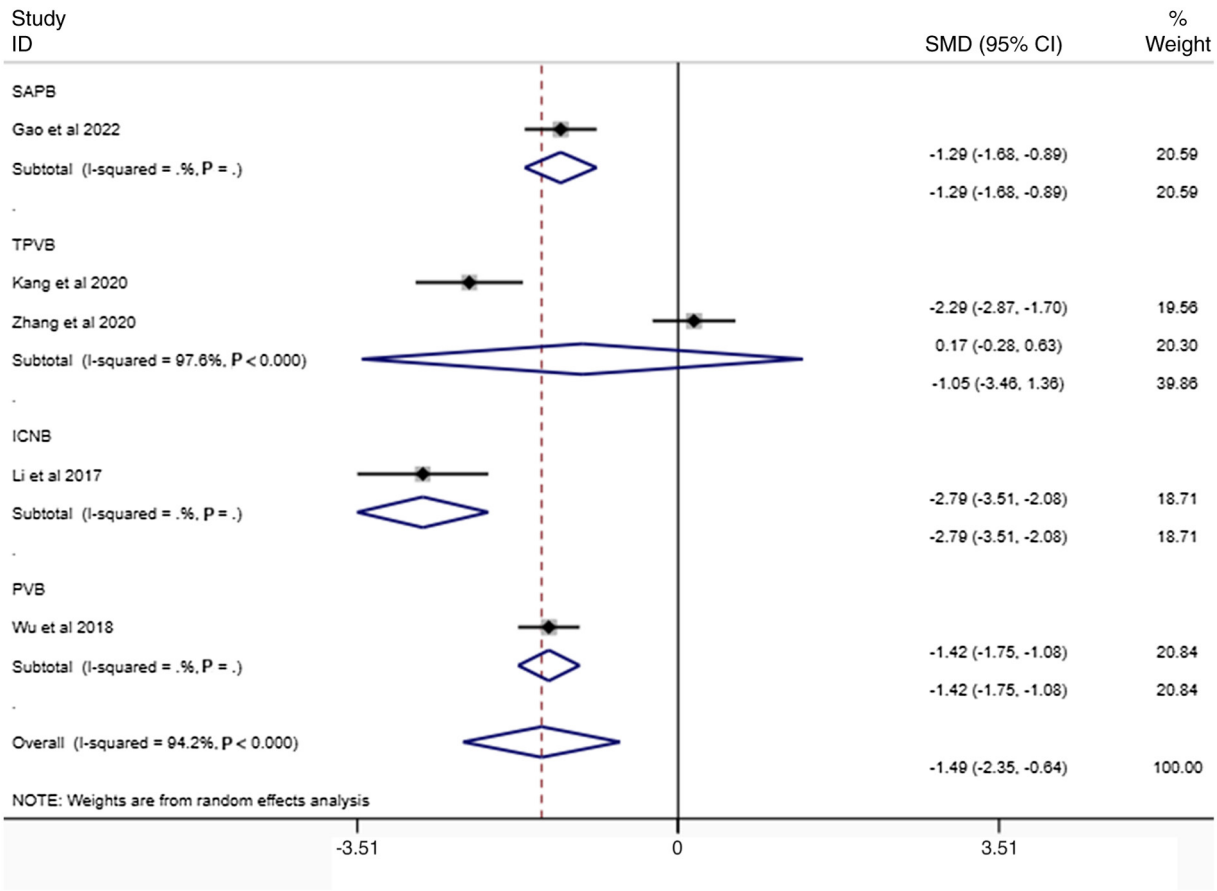

Figure 13. Forest plot of the visual analogue scale scores after 72 h. CI, confidence interval; SMD, standardized mean difference; PVB, paravertebral block; TPVB, thoracic paravertebral block; SAPB, serratus anterior plane block; ICNB, intercostal nerve block.

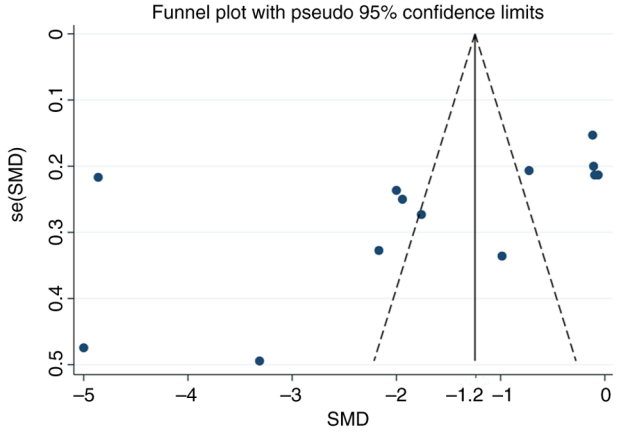

Figure 14. Funnel plot of the visual analogue scale scores after 24 h. se(SMD), standard error of SMD; SMD, standardized mean difference.

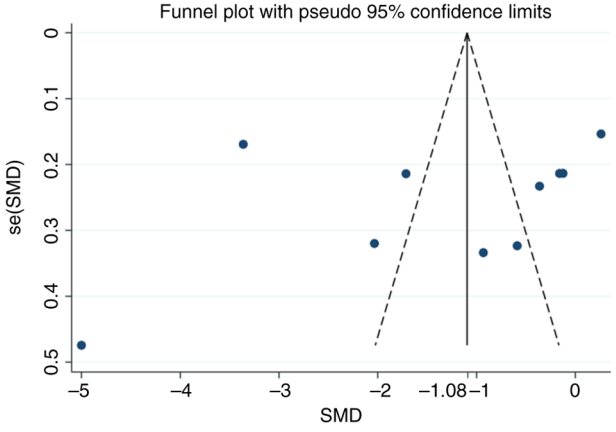

Figure 15. Funnel plot of the visual analogue scale scores after 48 h. se(SMD), standard error of SMD; SMD, standardized mean difference.

perception and expression of pain; joint pain caused by targeted therapies may also affect the accurate assessment of the effect of nerve blocking techniques. Therefore, the advantages of nerve block technology in postoperative pain management of patients with lung cancer are difficult to evaluate accurately.

Mitigating postoperative side effects can markedly improve the quality of life of patients and serves a vital role in the recovery process (42). Reduced nausea and vomiting can reduce the stress response of the gastrointestinal tract and maintain normal peristalsis and digestive function of the gastrointestinal tract (43). To allow the gastrointestinal tract to resume normal emptying and absorption functions faster, allowing patients to resume consumption of their normal diet sooner, clinicians should ensure effective intake of nutrients, provide sufficient energy and nutritional support for physical recovery and promote wound healing and recovery of the body functions. When severe pain and frequent nausea and vomiting are relieved, the psychological pressure is decreased, thus

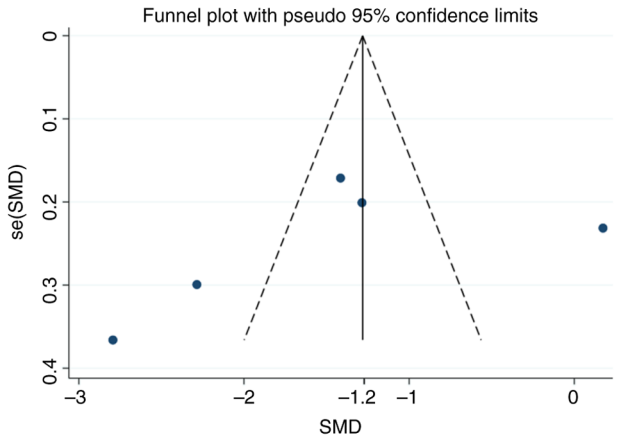

Figure 16. Funnel plot of the visual analogue scale scores after 72 h. se(SMD), standard error of SMD; SMD, standardized mean difference.

improving the quality of life at the psychological level (44). Guerra-Londono *et al* (45) indicated that intercostal nerve block analgesia is associated with a decreased risk of nausea and vomiting when compared with systemic analgesia, in agreement with the results of the present study. Cancer rehabilitation is a critical process that helps patients restore physical function and improve quality of life through several methods (46), therefore, quality of life is a key outcome indicator for cancer rehabilitation. The present study did not include direct quality of life data. Although secondary outcomes (such as reduced analgesic requirements and fewer complications) suggest potential quality of life benefits, it was not possible to perform a quantitative synthesis as the original studies did not use a standardized quality of life scale (47,48).

Given the potential for related bias in the meta-analysis, there is a critical need for more robustly designed, large-scale RCTs, coupled with extensive long-term follow-up, to provide more definitive findings. Future studies should emphasize larger, multi-center trials to validate the present results and investigate the long-term impacts of nerve block across various populations.

Among 16 RCTs in the present meta-analysis, 15 (93.8%) originated from China, with only one (21) from Italy. Variations in genetics, pain tolerance, anesthesia technique, drug choices (such as ropivacaine concentration) and postoperative management across populations restrict generalizability. Addressing this geographical bias requires future studies to include diverse cohorts such as American and African cohorts.

The present study has several limitations, firstly, the meta-analysis included 3 studies, at least 1 of which had a high risk of bias in certain areas, whereas the other 11 studies failed to provide clear explanations regarding randomization and blinding procedures. Secondly, high heterogeneity was observed in the VAS score, possibly due to inconsistencies in drug concentration and technical details. The time points for measuring pain scores were not always represented by accurate values (the actual timing of pain score measurements may vary and is not always entirely accurate). The present study did not separately analyze image-guided and non-guided nerve block. Patients have different tolerance standards for pain. In addition, the research regions were limited, with the majority coming from China. Furthermore, there was a lack of direct quality of life evidence. Finally, due to the limited number of studies and total sample size, subgroup analysis did not identify causes for heterogeneity.

In conclusion, the present meta-analysis compared the efficacy of regional analgesic techniques in enhancing postoperative pain control in VATS. Compared with other meta-analyses (45,49,50), the patients included in the present study all had lung cancer and underwent VATS surgery. All the studies included in the analysis compared VATS with conventional anesthetic techniques. Nerve block demonstrated clear advantages in postoperative pain management and concurrently exhibited lower incidences of associated complications following surgery. Further research comparing nerve block technology with conventional anesthetic techniques for thoracic procedures will clarify differences between the two approaches in terms of analgesic efficacy, medical costs, and patient tolerance, thereby guiding precise clinical implementation.

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Availability of data and materials

The data generated in the present study may be requested from the corresponding author.

Authors' contributions

JW performed data extraction in duplicate and contributed to manuscript drafting and critical revision. YXL analyzed and interpreted data. SZ conducted database searches and initial screening, assisted in data synthesis and interpretation. BA acted as senior reviewer, resolving discrepancies in screening, data extraction, and risk of bias assessment; provided senior supervision throughout the study; and critically revised and approved the final manuscript. JW and YXL confirm the authenticity of all the raw data. All authors have read and approved the final version of the manuscript.

Ethics approval and consent to participate

Not applicable.

Patient consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

References

1. Maconachie R, Mercer T, Navani N and McVeigh G; Guideline Committee: Lung cancer: diagnosis and management: Summary of updated NICE guidance. BMJ 364: l1049, 2019.
2. Alexander M, Kim SY and Cheng H: Management of non-small cell lung cancer. Lung 198: 897-907, 2020.
3. Bray F, Laversanne M, Sung H, Ferlay J, Siegel RL, Soerjomataram I and Jemal A: Global cancer statistics 2022: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin 74: 229-263, 2024.
4. Batchelor TJP, Rasburn NJ, Abdelnour-Berchtold E, Brunelli A, Cerfolio RJ, Gonzalez M, Ljungqvist O, Petersen RH, Popescu WM, Slinger PD and Naidu B: Guidelines for enhanced recovery after lung surgery: Recommendations of the enhanced recovery after surgery (ERAS®) Society and the European Society of Thoracic Surgeons (ESTS). Eur J Cardiothorac Surg 55: 91-115, 2019.
5. Klapper J and D'Amico TA: VATS versus open surgery for lung cancer resection: Moving toward a minimally invasive approach. J Natl Compr Canc Netw 13: 162-164, 2015.
6. Bendixen M, Jørgensen OD, Kronborg C, Andersen C and Licht PB: Postoperative pain and quality of life after lobectomy via video-assisted thoracoscopic surgery or anterolateral thoracotomy for early-stage lung cancer: A randomised controlled trial. Lancet Oncol 17: 836-844, 2016.
7. Nagahiro I, Andou A, Aoe M, Sano Y, Date H and Shimizu N: Pulmonary function, postoperative pain, and serum cytokine level after lobectomy: A comparison of VATS and conventional procedure. Ann Thorac Surg 72: 362-365, 2001.
8. Sandeep B, Huang X, Li Y, Xiong D, Zhu B and Xiao Z: A comparison of regional anesthesia techniques in patients undergoing video-assisted thoracic surgery: A network meta-analysis. Int J Surg 105: 106840, 2022.
9. Mathew B, Lennon FE, Siegler J, Mirzapoiazova T, Mambetsariev N, Sammani S, Gerhold LM, LaRiviere PJ, Chen CT, Garcia JG, *et al*: The novel role of the mu opioid receptor in lung cancer progression: A laboratory investigation. Anesth Analg 112: 558-567, 2011.
10. Rodrigues P, Bangali H, Hammoud A, Mustafa YF, Al-Hetty HRAK, Alkhafaji AT, Deorari MM, Al-Taee MM, Zabibah RS and Alsalamy A: COX 2-inhibitors; a thorough and updated survey into combinational therapies in cancers. Med Oncol 41: 41, 2024.
11. Steegers MA, Snik DM, Verhagen AF, van der Drift MA and Wilder-Smith OH: Only half of the chronic pain after thoracic surgery shows a neuropathic component. J Pain 9: 955-961, 2008.
12. Fenta E, Kibret S, Hunie M, Tamire T, Mekete G, Tiruneh A, Fentie Y, Dessalegn K and Teshome D : The analgesic efficacy of erector spinae plane block versus paravertebral block in thoracic surgeries: A meta-analysis. Front Med (Lausanne) 10: 1208325, 2023.
13. Blanco R, Parras T, McDonnell JG and Prats-Galino A: Serratus plane block: A novel ultrasound-guided thoracic wall nerve block. Anaesthesia 68: 1107-1113, 2013.
14. Chen N, Qiao Q, Chen R, Xu Q, Zhang Y and Tian Y: The effect of ultrasound-guided intercostal nerve block, single-injection erector spinae plane block and multiple-injection paravertebral block on postoperative analgesia in thoracoscopic surgery: A randomized, double-blinded, clinical trial. J Clin Anesth 59: 106-111, 2020.
15. Pei L, Zhou Y, Tan G, Mao F, Yang D, Guan J, Lin Y, Wang X, Zhang Y, Zhang X, *et al*: Ultrasound-assisted thoracic paravertebral block reduces intraoperative opioid requirement and improves analgesia after breast cancer surgery: A randomized, controlled, single-center trial. PLoS One 10: e0142249, 2015.
16. Gabriel RA, Curran BP, Swisher MW, Sztain JF, Tsuda PS, Said ET, Alexander B, Finneran JJ IV, Abramson WB, Black JR, *et al*: Paravertebral versus Pectoralis-II (Interpectoral and Pectoserratus) nerve blocks for postoperative analgesia after nonmastectomy breast surgery: A randomized, controlled, observer-masked noninferiority trial. Anesthesiology 141: 1039-1050, 2024.
17. Jackson JC, Tan KS, Pedoto A, Park BJ, Rusch VW, Jones DR, Zhang H, Desiderio D, Fischer GW and Amar D: Effects of serratus anterior plane block on early recovery from thoracoscopic lung resection: A randomized, blinded, placebo-controlled trial. Anesthesiology 142: 588, 2025.
18. Chi Y, Su X, Liu S, Wen J, Hu M, Li H, Huang H, Zhang Z and Xie H: Liposomal bupivacaine intercostal nerve block for pain control in thoracoscopic surgery: A randomized controlled trial. Front Med (Lausanne) 12: 1647324, 2025.
19. Rekatsina M and Peng PWH: The importance of image guidance in common spine interventional procedures for pain management: A comprehensive narrative review. Pain Ther 14: 841-863, 2025.
20. Zhang L, Shen J and Luo Y: The impact of paravertebral nerve blockade on postoperative surgical site wound pain management in patients undergoing video-assisted thoracoscopic surgery for pulmonary carcinoma resection. Int Wound J 21: e14608, 2024.
21. Kang K, Meng X, Li B, Yuan J, Tian E, Zhang J and Zhang W: Effect of thoracic paravertebral nerve block on the early postoperative rehabilitation in patients undergoing thoracoscopic radical lung cancer surgery. World J Surg Oncol 18: 298, 2020.
22. Li X, Cui X, Zhang S and Fu Z: Ameliorative effects of parecoxib in combination with ultrasound-guided paravertebral block (UGPB) on stress and inflammatory responses following thoracoscopic surgery. Trop J Pharm Res 17: 1171-1175, 2018.
23. Li Y, Gong L, Xu F, Zhao H, Chen Y and Wang C: Effects of ropivacaine as intercostal nerve blocker on postoperative pain after video-assisted thoracic surgery of lung cancer patients. Chin J Clin Oncol 44: 605-607, 2017.
24. Liu X and An J: Effects of serratus anterior plane block and thoracic paravertebral nerve block on analgesia, immune function and serum tumor markers in patients after thoracoscopic radical resection of lung cancer. Nagoya J Med Sci 84: 506-515, 2022.
25. Liu Y, Li Y, Wu C and Li H: Effects of nalbuphine combined with anterior serratus plane block in elderly patients undergoing thoracoscopic surgery. J Healthc Eng 2022: 7408951, 2022.
26. Shang LH, Xiao ZN, Zhao YL and Long B: Analgesic effect of serratus anterior plane block after thoracoscopic surgery: A randomized controlled double-blinded study. Ther Clin Risk Manag 16: 1257-1265, 2020.
27. Viti A, Bertoglio P, Zamperini M, Tubaro A, Menestrina N, Bonadiman S, Avesani R, Guerriero M and Terzi A : Serratus plane block for video-assisted thoracoscopic surgery major lung resection: A randomized controlled trial. Interact Cardiovasc Thorac Surg 30: 366-372, 2020.
28. Wei W, Zheng X, Gu Y, Fu W, Tang C and Yao Y: Effect of general anesthesia with thoracic paravertebral block on postoperative delirium in elderly patients undergoing thoracoscopic lobectomy: A randomized-controlled trial. BMC Anesthesiol 22: 1, 2022.
29. Wu Z, Fang S, Wang Q, Wu C, Zhan T and Wu M: Patient-controlled paravertebral block for video-assisted thoracic surgery: A randomized trial. Ann Thorac Surg 106: 888-894, 2018.
30. Xu J, Pu M, Xu X, Xiang J and Rong X: The postoperative analgesic effect of intercostal nerve block and intravenous patient-controlled analgesia on patients undergoing lung cancer surgery. Am J Transl Res 13: 9790-9795, 2021.
31. Zhang W, Cong X, Zhang L, Sun M, Li B, Geng H, Gu J and Zhang J: Effects of thoracic nerve block on perioperative lung injury, immune function, and recovery after thoracic surgery. Clin Transl Med 10: e38, 2020.
32. Zhao X, Li X, Wang Y, Xiao W, Zhang B, Meng X and Sun X: Efficacy of intrathoracic intercostal nerve block on postoperative acute and chronic pains of patients undergoing video-assisted thoracoscopic surgery. J Pain Res 15: 2273-2281, 2022.
33. Chen J, Zhang Y, Huang C, Chen K, Fan M and Fan Z: Effects of thoracic paravertebral block on postoperative analgesia and serum level of tumor marker in lung cancer patients undergoing video-assisted thoracoscopic surgery. Zhongguo Fei Ai Za Zhi 18: 104-109, 2015 (In Chinese).
34. Gao W, Yang XL, Hu JC, Gu H, Wu XN, Hu SS, Wang S, Chai XQ and Wang D: Continuous serratus anterior plane block improved early pulmonary function after lung cancer surgical procedure. Ann Thorac Surg 113: 436-443, 2022.
35. Cumpston M, Li T, Page MJ, Chandler J, Welch VA, Higgins JP and Thomas J: Updated guidance for trusted systematic reviews: A new edition of the cochrane handbook for systematic reviews of interventions. Cochrane Database Syst Rev 10: ED000142, 2019.
36. Stogiannis D, Siannis F and Androulakis E: Heterogeneity in meta-analysis: A comprehensive overview. Int J Biostat 20: 169-199, 2023.

37. Planchard D, Popat S, Kerr K, Novello S, Smit EF, Faivre-Finn C, Mok TS, Reck M, Van Schil PE, Hellmann MD, *et al*: Metastatic non-small cell lung cancer: ESMO clinical practice guidelines for diagnosis, treatment and follow-up. Ann Oncol 29: iv192-iv237, 2018.
38. Polański J, Tański W, Dudek K and Jankowska-Polańska B: Pain and coping strategies as determinants of malnutrition risk in lung cancer patients: A cross-sectional study. Nutrients 16: 2193, 2024
39. Chou R, Gordon DB, de Leon-Casasola OA, Rosenberg JM, Bickler S, Brennan T, Carter T, Cassidy CL, Chittenden EH, Degenhardt E, *et al*: Management of postoperative pain: A clinical practice guideline from the American Pain Society, the American Society of Regional Anesthesia and Pain Medicine, and the American Society of Anesthesiologists' Committee on Regional Anesthesia, Executive Committee, and Administrative Council. J Pain 17: 131-157, 2016.
40. Hade AD, Okano S, Pelecanos A and Chin A. Factors associated with low levels of patient satisfaction following peripheral nerve block. Anaesth Intensive Care 49: 125-132, 2021.
41. Chen YK, Boden KA and Schreiber KL: The role of regional anaesthesia and multimodal analgesia in the prevention of chronic postoperative pain: A narrative review. Anaesthesia 76 (Suppl 1): S8-S17, 2021.
42. Gouez M, Delrieu L, Bouleuc C, Girard N, Raynard B and Marchal T: Association between nutritional status and treatment response and survival in patients treated with immunotherapy for lung cancer: A retrospective french study. Cancers (Basel) 14: 3439, 2022.
43. Lan T, Chen L and Wei X: Inflammatory cytokines in cancer: Comprehensive understanding and clinical progress in gene therapy. Cells 10: 100, 2021.
44. Morrison EJ, Novotny PJ, Sloan JA, Yang P, Patten CA, Ruddy KJ and Clark MM: Emotional problems, quality of life, and symptom burden in patients with lung cancer. Clin Lung Cancer 18: 497-503, 2017.
45. Guerra-Londono CE, Privorotskiy A, Cozowicz C, Hicklen RS, Memtsoudis SG, Mariano ER and Cata JP: Assessment of intercostal nerve block analgesia for thoracic surgery: A systematic review and meta-analysis. JAMA Netw Open 4: e2133394, 2021.
46. Li D, Sun CL, Kim H, Soto-Perez-de-Celis E, Chung V, Koczywas M, Fakih M, Chao J, Cabrera Chien L, Charles K, *et al*: Geriatric assessment-driven intervention (GAIN) on chemotherapy-related toxic effects in older adults with cancer: A randomized clinical trial. JAMA Oncol 7: e214158, 2021.
47. Wolf AMD, Oeffinger KC, Shih TY, Walter LC, Church TR, Fontham ETH, Elkin EB, Etzioni RD, Guerra CE, Perkins RB, *et al*: Screening for lung cancer: 2023 guideline update from the American Cancer Society. CA Cancer J Clin 74: 50-81, 2024.
48. de Rooij BH, van den Hurk C, Smaardijk V, Fernandez-Ortega P, Navarro-Martin A, Barberio L, Guckenberger M, Schmid S, Walraven I, Vallow S, *et al*: Development of an updated, standardized, patient-centered outcome set for lung cancer. Lung Cancer 173: 5-13, 2022.
49. Capuano P, Hileman BA, Martucci G, Raffa GM, Toscano A, Burgio G, Arcadipane A and Kowalewski M: Erector spinae plane block versus paravertebral block for postoperative pain management in thoracic surgery: A systematic review and meta-analysis. Minerva Anestesiol 89: 1042-1050, 2023.
50. Gonçalves JPF, Duran ML, Barreto ESR, Antunes Júnior CR, Albuquerque LG, Lins-Kusterer LEF, Azi LMTA and Kraychete DC: Efficacy of erector spinae plane block for postoperative pain management: A meta-analysis and trial sequential analysis of randomized controlled trials.