

Systematic Review

The Efficacy of Erector Spinae Plane Block for Thoracoscopic Surgery: A Meta-Analysis of Randomized Controlled Trials

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Abstract

Background: The efficacy of erector spinae plane block for thoracoscopic surgery remains controversial. We conducted a systematic review and meta-analysis to explore the impact of erector spinae plane block on thoracoscopic surgery. **Methods:** We searched the PubMed, EMBase, Web of science, EBSCO, and Cochrane library databases through February 2022 for randomized controlled trials (RCTs), assessing the effect of erector spinae plane block on thoracoscopic surgery. This meta-analysis was performed using the random-effect model. **Results:** Seven RCTs, involving 439 patients, are included in the meta-analysis. Overall, compared with the control group for thoracoscopic surgery, erector spinae plane block (ESPB) results in significantly reduced pain scores at 1 h (standard mean difference (SMD) = -4.26; 95% confidence interval (CI) = -7.63 to -0.88; $p = 0.01$), 4 h (SMD = -4.08; 95% CI = -4.56 to -3.60; $p < 0.00001$), 8 h (SMD = -4.13; 95% CI = -4.62 to -3.65; $p < 0.00001$), and postoperative anesthesia consumption (SMD = -3.04; 95% CI = -4.58 to -1.50; $p = 0.0001$) and can decrease the incidence of nausea and vomiting (odds ratio (OR) = 0.18; 95% CI = 0.08 to 0.39; $p < 0.001$). **Conclusions:** ESPB can substantially enhance pain relief for thoracoscopic surgery.

Keywords

erector spinae plane block; thoracoscopic surgery; randomized controlled trials; meta-analysis

Introduction

Thoracoscopic surgery has been widely used to treat various diseases, such as esophageal cancer and lung cancer [1–3]. Many patients suffer from postoperative pain, which requires pharmacologic and regional interventions [4–9]. Thoracic surgeries are very painful procedures and need multimodal analgesia methods, such as nonsteroidal anti-inflammatory drugs, opioids, patient-controlled analgesia (PCA), infiltration analgesia, and thoracic epidural block [10].

Due to the limited analgesic efficacy and adverse events, novel analgesic methods should be developed. The ultrasonography guided erector spinae plane block (ESPB) was developed for postoperative analgesia in thoracic and abdominal surgeries in both adult and pediatric patients [11,12]. This technique is easy to apply and has less risk of complications, such as pneumothorax and neuroaxial injury. It quickly gained popularity owing to its ease of administration and relative safety [13].

However, the efficacy of ESPB for thoracoscopic surgery has not been well established. Recently, several studies on the topic have been published, and the results have been conflicting [14–17]. With accumulating evidence, we therefore performed a systematic review and meta-analysis of randomized controlled trials (RCTs) to investigate the efficacy and safety of ESPB for thoracoscopic surgery.

Materials and Methods

Ethical approval and patient consent are not required because this is a systematic review and meta-analysis of previously published studies. The systematic review and meta-analysis were conducted and reported in adherence to PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) [18].

Search Strategy and Study Selection

Two investigators independently searched the following databases (inception to February 2022): PubMed, EMBase, Web of science, EBSCO, and Cochrane. The electronic search strategy was conducted using these keywords: “erector spinae plane block” OR “ESPB” AND “thoracoscopic” OR “thoracoscopy”. We also checked the reference lists of the screened full-text studies to identify other potentially eligible trials.

The inclusion selection criteria were as follows: (i) population: patients undergoing thoracoscopic surgery; (ii) intervention: erector spinae plane block; (iii) comparison: placebo or nothing; (iv) study design: RCT.

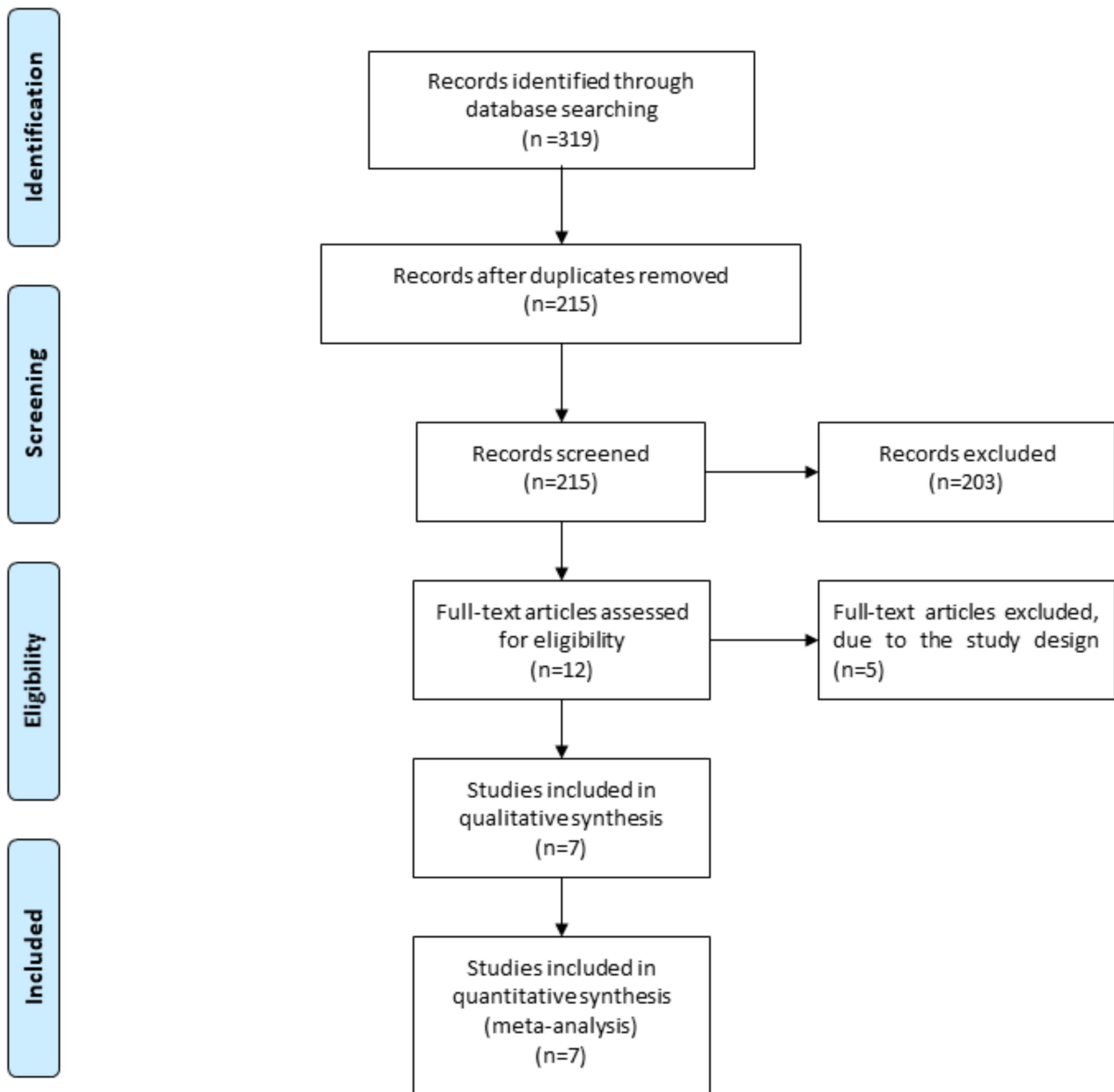


Fig. 1. Flow diagram of study searching and selection process.

Data Extraction and Outcome Measures

We extracted the following information: author, number of patients, age, male, body mass index, American Society of Anesthesiologists (ASA, I/II), and detail methods in each group, *etc.* Data independently were extracted by two investigators, and discrepancies were resolved by consensus. We also contacted the corresponding author to obtain the data, when necessary.

The primary outcomes were pain scores at 1 h, 4 h, and 8 h. Secondary outcomes included postoperative anesthesia consumption, nausea, and vomiting.

Quality Assessment in Individual Studies

Methodological quality of the included studies was independently evaluated using the modified Jadad scale [19,20]. There are three items for the Jadad scale: randomization (0–2 points), blinding (0–2 points), dropouts and withdrawals (0–1 points). The score of the Jadad scale varies from 0 to 5 points. An article with Jadad score ≤ 2 is considered to be of low quality. If the Jadad score ≥ 3 , the study is thought to be of high quality [21].

Table 1. Characteristics of included studies.

NO.	Author	ESPB group						Control group						Jada scores
		Number	Age (years)	Male (n)	Body mass index (kg/m ²)	ASA (I/II)	Methods	Number	Age (years)	Male (n)	Body mass index (kg/m ²)	ASA (I/II)	Methods	
1	Zhang 2022 [14]	22	54.41 ± 7.61	11	25.56 ± 3.01	7/15	ESPB with 30 mL of 0.5% ropivacaine hydrochloride	23	52.13 ± 6.55	11	25.01 ± 2.45	7/16	no block	4
2	Pişkin 2022 [15]	40	50.50 ± 18.64	28	-	2/17	ESPB with 20 mL of 0.25% bupivacaine	36	50.42 ± 16.00	24	-	2/14	no block	3
3	Liu 2021 [17]	40	57.1 ± 10.6	15	-	10/30	ESPB with 25 mL 0.4% ropivacaine	40	55.5 ± 12.8	17	-	8/32	no block	4
4	Yao 2020 [23]	37	56.0 (50.5–62.0), median (interquartile range)	14	-	5/32	ESPB with 25 mL of 0.5% ropivacaine	38	58.0 (52.0–61.0)	15	-	3/35	placebo	5
5	Shim 2020 [24]	21	62.8 ± 10.2	10	23.9 ± 2.4	-	ESPB with 30 mL of 0.5% ropivacaine	22	62.4 ± 10.0	15	24.2 ± 2.1	-	placebo	5
6	Çiftçi 2020 (1) [25]	30	47.33 ± 10.21	15	-	16/14	ESPB with 20 mL of 0.25% bupivacaine	30	45.13 ± 7.98	17	-	17/13	no block	4
7	Çiftçi 2020 (2) [26]	30	48.13 ± 9.32	16	-	20/10	ESPB with 20 mL of 0.25% bupivacaine	30	46.43 ± 7.65	15	-	18/12	no block	4

Abbreviations: ESPB, erector spinae plane block; ASA, American Society of Anesthesiologists.

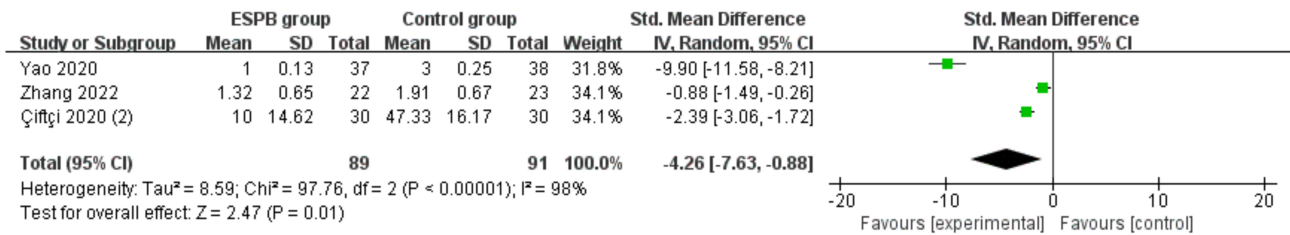


Fig. 2. Forest plot for the meta-analysis of pain scores at 1 h. Abbreviations: SD, Standard Deviation; std., Standard Deviation; IV, Information Value

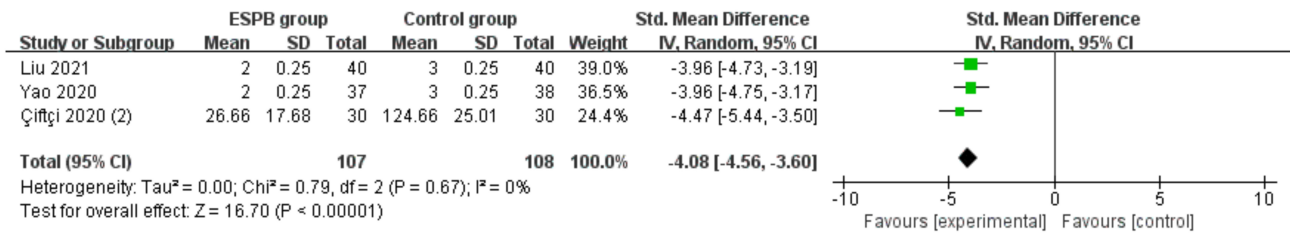


Fig. 3. Forest plot for the meta-analysis of pain scores at 4 h.

Statistical Analysis

We estimated the standard mean difference (SMD) with 95% confidence interval (CI) for continuous outcomes and odd ratio (OR) with 95% CI for dichotomous outcomes. A random-effects model was used regardless of heterogeneity. Heterogeneity was reported using the I² statistic, and I² > 50% indicates significant heterogeneity [22]. Whenever significant heterogeneity was present, we searched for potential sources of heterogeneity via omitting one study in turn for the meta-analysis or performing subgroup analysis. Publication bias was not evaluated because of the limited number (<10) of included studies. All statistical analyses were performed using Review Manager Version 5.3 (The Cochrane Collaboration, Software Update, Oxford, UK). The PRISMA checklist was used when doing the systematic review (Supplementary Table 1), the PROSPERO registered number is CRD42067238145.

Results

Literature Search, Study Characteristics, and Quality Assessment

A detailed flowchart of the search and selection results is shown in Fig. 1. We initially identified 319 potentially relevant articles. Finally, seven RCTs met our inclusion criteria and were included in the meta-analysis [14,15,17,23–26].

The baseline characteristics of the seven eligible RCTs in the meta-analysis are summarized in Table 1 (Ref. [14, 15,17,23–26]). The seven studies were published between 2020 and 2022, and sample sizes ranged from 43 to 80 for

a total of 439. ESPB were performed by using bupivacaine or ropivacaine. Among the seven studies included, three studies reported pain scores at 1 h [14,23,25], three studies reported 4 h and 8 h [17,23,26], six studies reported postoperative anesthesia consumption [14,15,17,23–25], as well as six studies reported nausea and vomiting [14,15,17,23,25,26]. Jadad scores of the seven included studies vary from 3 to 5, and all seven studies were considered to be high-quality ones, according to quality assessment.

Primary Outcomes—Pain Scores at 1 h, 4 h, and 8 h

These outcome data were analyzed with the random-effects model, and the results suggested that compared with the control group for thoracoscopic surgery, ESPB is associated with significantly reduced pain scores at 1 h (SMD = -4.26; 95% CI = -7.63 to -0.88; p = 0.01) with significant heterogeneity among the studies (I² = 98%, heterogeneity p < 0.00001, Fig. 2), 4 h (SMD = -4.08; 95% CI = -4.56 to -3.60; p < 0.00001) with no heterogeneity among the studies (I² = 0%, heterogeneity p = 0.67, Fig. 3), and 8 h (SMD = -4.13; 95% CI = -4.62 to -3.65; p < 0.00001) with no heterogeneity among the studies (I² = 0%, heterogeneity p = 0.44, Fig. 4).

Sensitivity Analysis

Significant heterogeneity was only observed among the included studies for pain scores at 1 h, but there was still significant heterogeneity after when performing sensitivity analysis via omitting one study in turn or subgroup analysis based on anesthetic drugs to detect the heterogeneity.

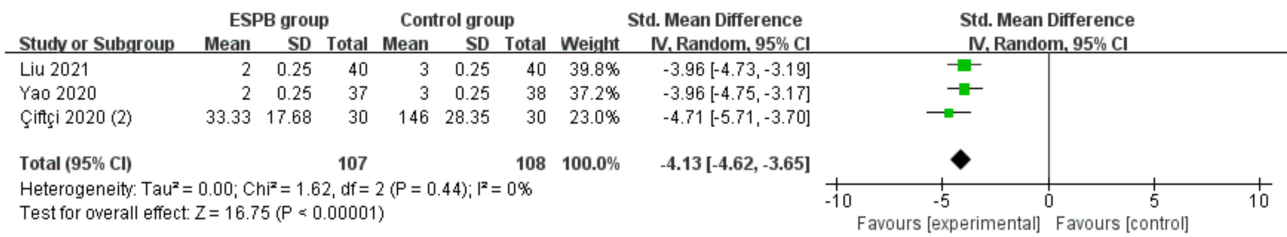


Fig. 4. Forest plot for the meta-analysis of pain scores at 8 h.

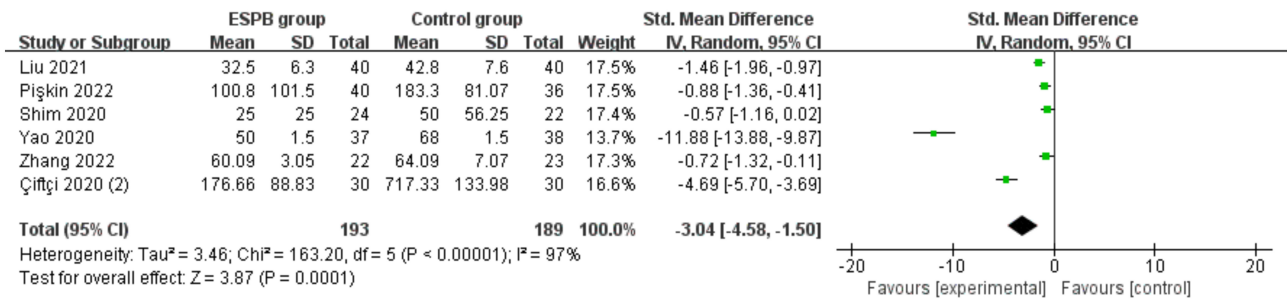


Fig. 5. Forest plot for the meta-analysis of analgesic consumption.

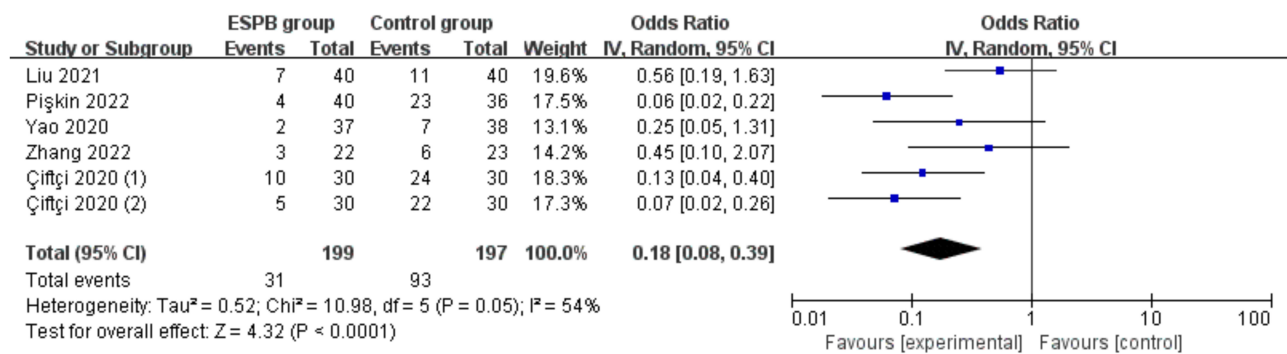


Fig. 6. Forest plot for the meta-analysis of nausea and vomiting.

Secondary Outcomes

Compared with the control group for thoracoscopic surgery, ESPB significantly can reduce postoperative anesthesia consumption (SMD = -3.04; 95% CI = -4.58 to -1.50; $p = 0.0001$, Fig. 5) and result in the decrease in nausea and vomiting (OR = 0.18; 95% CI = 0.08 to 0.39; $p < 0.0001$, Fig. 6).

Discussion

Thoracoscopic surgery has gained popularity because of reduced hospital stay and morbidity, as well as minimal invasion and early recovery [27]. Although thoracoscopic surgery is one common minimal invasive surgery with reduced pain intensity, these patients still suffer from moderate to severe pain scores [28]. Our meta-analysis suggests that compared with control intervention for thoracoscopic

surgery, ESPB is associated with substantially decreased pain scores at 1 h, pain scores at 4 h, pain scores at 8 h, and postoperative anesthesia consumption.

Indeed, there are many nerve block methods that are developed for thoracoscopic surgery. Thoracic epidural analgesia (TEA) is a commonly used method for analgesia following thoracotomy. Although TEA is accepted as the gold standard in thoracic surgery, it is one invasive method with a high risk of complications [29], and thus the use of TEA as a minimally invasive analgesic method in video-assisted thoracoscopic (VATS) is debatable [30]. Thoracic paravertebral block (TPVB) is an alternative regional analgesia method [10]. It is less invasive compared with TEA, but may lead to the increase in risks of pneumothorax and neuroaxial injury [31]. ESPB has been developed with less risk of complications, such as pneumothorax and neuroaxial injury compared with other methods. Its efficacy for thoracoscopic surgery has been confirmed in this meta-analysis.

Regarding the sensitivity analysis, there still is significant heterogeneity when performing the analysis by omitting one study in turn or subgroup analysis based on anesthetic drugs. Several reasons may explain this significant heterogeneity. First, different drugs are applied for ESPB, including ropivacaine and bupivacaine. Second, these anesthetic drugs have various concentrations, such as ropivacaine 0.25% and 0.5%. Third, the detail methods and procedures of thoracoscopic surgery are different due to various diseases.

In addition, ESPB results in the decrease in nausea and vomiting than control intervention for thoracoscopic surgery. This meta-analysis has several potential limitations. First, our analysis was based on only seven RCTs, and all had a relatively small sample size. Overestimation of the treatment effect was more likely in smaller trials compared with larger samples. Next, the types, concentrations, and methods of anesthetic drugs in included RCTs are different, which may have an influence on the pooling results. Finally, thoracoscopic surgeries are performed for various diseases and operation procedures.

Conclusions

ESPB has important beneficial effects on pain control for thoracoscopic surgery.

Availability of Data and Materials

Datasets used and/or analyzed for this study are available from the corresponding author upon appropriate request.

Author Contributions

LL and YZ made substantial contribution to the conception and design of the work; YH and WP made contribution to the acquisition, analysis, HH and LL made contribution to the interpretation of data for the work. All authors read and approved the final manuscript. All authors have participated sufficiently in the work to take public responsibility for appropriate portions of the content and agreed to be accountable for all aspects of the work in ensuring that questions related to its accuracy or integrity.

Ethics Approval and Consent to Participate

Not applicable.

Acknowledgment

Not applicable.

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Conflict of Interest

The authors declare no conflict of interest.

Supplementary Material

Supplementary material associated with this article can be found, in the online version, at <https://doi.org/10.59958/hsf.5349>.

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