APPLICATION OF ULTRASOUND-GUIDED THORACIC PARAVERTEBRAL BLOCK IN CLINICAL SURGICAL TREATMENT - A SYSTEMATIC REVIEW AND META-ANALYSIS

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Abstract

Background: There is no consensus on the clinical postoperative analgesic effects of thoracic paravertebral block (TPVB) and erector spinae plane block (ESPB) in randomized controlled trials (RCTs). Therefore, systemic review and meta-analysis were conducted based on the existing randomized controlled studies related to the comparison between TPVB and ESPB.

Methods: PubMed, Embase, MEDLINE, Science Direct, The Cochrane library, Google scholar, China National Knowledge Infrastructure (CNKI), Wanfang Database, and Chinese Sci-tech Periodicals Database were searched by computers. Chinese and English search keywords included Thoracic paravertebral block, TPVB, Erector spinae plane block, ESPB, video-assisted thoracic surgery, VATS, and thoracoscopic surgery and postoperative analgesia. Rev Man 5.3 offered by Cochrane collaboration net was utilized to assess the quality and risks of included articles.

Results: A total of 10 articles were included. The analgesia scores for TPVB group and ESPB group 12 hours and 24 hours after surgery were different. The scores 12 hours after surgery were as follows: Standard mean difference (SMD) was -0.77 with 95% confidence interval (CI) (-1.40, -0.14), and *P*=0.02. The scores 24 hours after surgery were as follows: SMD were -0.64 with 95% CI (-0.98, -0.30), and *P*=0.0002. The total consumption of equivalent morphine 24 hours after surgery between ESPB and TPVB groups did not show statistical differences. Mean difference (MD) was -2.32 with 95% CI (-4.92, 0.28), and *P*=0.08. Besides, the incidence of postoperative nausea and vomiting between TPVB and ESPB groups did not demonstrate significant statistical differences. Relative ratio (RR) was 0.90 with 95% CI (0.52, 1.54), and *P*=0.70. In addition, postoperative rescue analgesia times between TPVB and ESPB groups revealed remarkable statistical differences. RR was 0.46 with 95% CI (0.30, 0.71), and *P*=0.0004.

Conclusion: The results of meta-analysis confirmed that the pain scores of clinical postoperative analgesia by TPVB during cough 12 hours and 24 hours after surgery were lower than that by ESPB. Postoperative rescue analgesia was obvious, and a more precise analgesic effect was shown.

Keywords: video-assisted thoracic surgery; thoracic paravertebral block; erector spinae plane block; post-operative analgesia; meta-analysis

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Introduction

In recent years, the gradual maturity of surgical technology and the updating of surgical instruments as well as equipment promote the gradual conversion of thoracic surgery into video-assisted thoracic surgery (VATS) (1). In terms of surgical incisions, a large incision requiring open thoracic cages is gradually transformed into that requiring only 3 orifices or 2 orifices, and finally into a thoracoscope with a single orifice (2-4). Because the incision of operating orifice in thoracic walls is small in thoracic surgery, the distinctive feature of the microtraumatic surgical method is fast postoperative recovery of patients. Compared with thoracotomy, various postoperative lung complications caused by the microtraumatic surgical method are obviously reduced, which facilitates early restoration of exercise for patients (5). However, recovery progress is seriously affected by the imperfect analgesia management of acute pains around early surgical incisions and closed thoracic drainage orifices, ineffective postoperative pain relief, and ineffective patient emotion pacification. Finally, severe chronic pains probably occur. Besides, dissatisfaction among patients and their family members are caused, time and costs spent in hospitals are increased, and the pressures on hospitals and patients are aggravated (6,7). The adoption of effective analgesia management measures after VATS is gradually valued by anesthetists. Thoracic epidural analgesia used to be regarded as the "gold standard" for analgesia after thoracic surgery. Nevertheless, the procedure is difficult with a high failure rate. In addition, it is time-consuming and causes more and more significant complications. As a result, there are fewer clinical applications of the surgical method (8). It is imperative for anesthetists to search for a post-VATS analgesia management technology with good patient tolerance, safe and effective analgesic methods, and effective reduction in dependence on opiates.

The popularization and promotion of ultrasound visualization technology facilitates the invention and innovation of portable ultrasound equipment. The effectiveness and safety of peripheral nerve block technology are gradually verified in the postoperative analgesia of various types of surgeries (9). With thoracic paravertebral block (TPVB) technology, local anesthetic is injected into the interval beside thoracic vertebra body and then it diffuses inside the interval. In addition, it blocks spinal nerves piercing through the interval. As a result, the conduction of homolateral somatic movement and sensory nerves adjacent to multiple thoracic nerve distributed segments are realized, which is applied mainly in rib fracture analgesia and post-thoracotomy analgesia (10-12). The dependence of traditional TPVB merely on body surface marker for location is blind detective, which requires the mastery of relevant anatomical structure and blocks operation skills by operators. Therefore, the operation causes high failure rate of block and the risk of pneumothorax by puncturing pleura (13,14). With the innovation of ultrasound equipment, ultrasonic screening imaging is clearer. In addition, real-time ultrasound guided TPVB can not only shorten block operation, but also effectively reduce the incidence of complications of operation with blind detective.

With erector spinae plane block (ESPB) technology, local anesthetic is injected into fascia interval between the deep side of erector spinae and parapophysis to enable drug to gradually infiltrate, diffuse, and block spinal nerves. ESPB is a newly developed local block technology adopted to alleviate postoperative acute pains and treat chronic pains (15). A meta-analysis of the application of ESPB in VATS and breast surgery reveals that the demand for opiates for 24 hours can be obviously reduced in ESPB group compared with that in non-ESPB group. In addition, the resting and visual analogue pain scores during cough of patients in ESPB group are lower, and the incidence of postoperative nausea and vomiting is reduced (16).

At present, there is an inconsistency between the results of the RCTs on the comparison of the analgesic effects of TPVB and ESPB in clinical postoperative treatment. Besides, the dispute on the analgesic effects of the two technologies in clinical postoperative treatment still exists. There are few relevant systemic reviews and meta-analyses at the moment. Hence, the systemic review and meta-analysis are implemented based on the existing relevant RCTs on the comparison of TPVB and ESPB. The innovation lies in the assessment of pain reliving effects and operational safety of the application of TPVB and ESPB in clinical postoperative analgesia by the pain scores at multiple time points, the demand for opiates, and other outcome indexes after surgery. The assessment provided evidence-based medical theoretical basis for the selection of appropriate postoperative analgesic plans by anesthetists.

Materials and methods:

Article inclusion and exclusion standards

The inclusion standards were as follows. i) the type was RCTs on TPVB and ESPB. ii) the subjects were adult patients at 18 years old or above and received

thoracoscopic surgery. iii) the intervention measure was the comparison of TPVB and ESPB adopted as postoperative analgesic methods without limits in type, dosage, and block time of local anesthetics. iv) outcome indexes included the resting and the pain scores during cough 1 hour, 12 hours, 24 hours, and 48 hours after surgery, the total consumption of morphine 24 hours after surgery, the incidence of postoperative nausea and vomiting, and postoperative rescue analgesia times.

The exclusion standards were as follows. i) the article focused on individual cases, or was overview, meeting, comment, and other non-RCTs. ii) the article was related to animal experiments. iii) the data of the article was incomplete so that original data was unavailable.

Article retrieval

PubMed, Embase, MEDLINE, Science Direct, The Cochrane Library, Google scholar, Chinese National Knowledge Infrastructure (CNKI), Wanfang Database, and Chinese Sci-tech Periodicals Database were searched by computers. The articles related to RCTs on the application of TPVB and ESPB in analgesia after VATS and published from the establishment of database to October 21, 2021, were retrieved. Besides, professional journals were manually searched to avoid omission.

The retrieval strategies were as follows. English search keywords included thoracic paravertebral block, TPVB, erector spinae plane block, ESPB, video-assisted thoracic surgery, VATS, and thoracoscopic surgery and postoperative analgesia. Multiple retrievals were performed by the combination of keywords to obtain articles that could be included, and then search engines were utilized to trace each article. After that, Rev Man 5.3 offered by Cochrane collaboration was adopted to assess the quality of included articles.

Outcome indexes

The outcome indexes included the resting status and the pain scores during cough 1 hour, 12 hours, 24 hours, and 48 hours after surgery, the total consumption of morphine 24 hours after surgery, postoperative rescue analgesia times, and the incidence of postoperative nausea and vomiting.

All opiates were transformed into equivalent analgesic doses of intravenous morphine for analysis and comparison. Intravenous morphine 10mg=oral morphine 30mg=intravenous tramadol 100mg=oral oxycodone 20mg=intravenous fentanyl 100ug=intravenous sufentanil 10ug (17). Because visual analogue scale (VAS) and numeric rating scale (NRS) were both measured in units 0-10, and "0" referred to no pain and "10" represented the highest level of pain, they proved to be intrinsically consistent and interchangeable (18).

Data extraction

The uniform Microsoft Excel was utilized for independent article screening and data extraction by two professionals. The needed outcome indexes were sorted out into tables. If there was a disagreement, they needed to negotiate with each other to address it. The main extracted data were as follows. i) basic information included in the research, including title, first author, publication time, and article source. ii) Basic features of included research, including sample size, nerve block methods, thoracoscopic surgical methods, puncture position, and type as well as dosage of local anesthetics. iii) Outcome indexes, including the resting status and the pain scores during cough 1 hour, 12 hours, 24 hours, and 48 hours after surgery, the total consumption of morphine 24 hours after surgery, the incidence of postoperative nausea and vomiting, and postoperative rescue analgesia times.

Quality evaluation and bias risk assessment

According to Cochrane 5.0 handbook, the quality evaluation and risk assessment of the included articles were carried out strictly by two professionals. The independent assessment was repeated, and the results were cross-checked. If there was a disagreement, they needed to negotiate with each other to address it. The evaluation standards were as follows. i) whether random sequence was generated correctly and normatively. ii) whether allocation concealment was carried out strictly. iii) whether blind method was adopted for subjects, interveners, and outcomes. iv) whether there was withdrawal or follow-up loss, and whether data were complete. v) the number of patients in each included group, the comparability of age, the judgment of selective bias, and whether there was an opportunity impact and its magnitude. "Low risk", "high risk", and "unclear" were adopted to grade the above evaluation standards and evaluate the quality of included articles.

Statistical methods

The bias risk evaluation diagram of Rev Man 5.3 (Cochrane of the United States) was adopted to assess the risk bias of included articles. Besides, data were sorted out, screened, and then input into software to draw diagrams. Continuous variables with the same units were expressed by mean difference (MD) and 95% confidence interval (CI), and continuous data with different units were

denoted by standard mean difference (SMD) and its 95% CI. Dichotomous data were expressed by relative ratio (RR) and its 95% CI. Besides, the heterogeneity among each article was tested by I^2. $I^2 \geq 50\%$ indicated that there was significant heterogeneity among each trial group. Random effect model was adopted to calculate combined statistics. In contrast, $I^2 < 50\%$ revealed that the heterogeneity among each article was insignificant. A fixed effect model was utilized to calculate combined statistics. $P<0.05$ showed that the differences demonstrated statistical meaning.

Sensitivity analysis

The funnel plots of different diagnostic indexes were adopted to test potential publication bias. The sensitivity of diagnostic indexes was analyzed by changing effect model (random effect model/fixed effect model) to assess the reliability of the obtained conclusion.

Results

Retrieval results and article basic information

A total of 126 articles were obtained by database retrieval. 84 journals were obtained by manual retrieval, 65 articles with duplicate publication were excluded, 42 disqualified articles were excluded, and 16 articles were excluded for other reasons. The remaining 87 articles were included by title selection. After abstracts and titles were viewed, 31 articles were deleted, and 56 articles were kept. In addition, 35 research reports and overviews were excluded, and 21 articles were kept. After the whole texts were viewed, 10 articles were excluded. Because the outcome index data could not be further extracted, 4 articles were excluded. There were 6 non-RCTs articles and 1 cadaveric article. Finally, a total of 10 articles (19-28) were included in the meta-analysis. Figure 1 showed the flow chart of article retrieval.

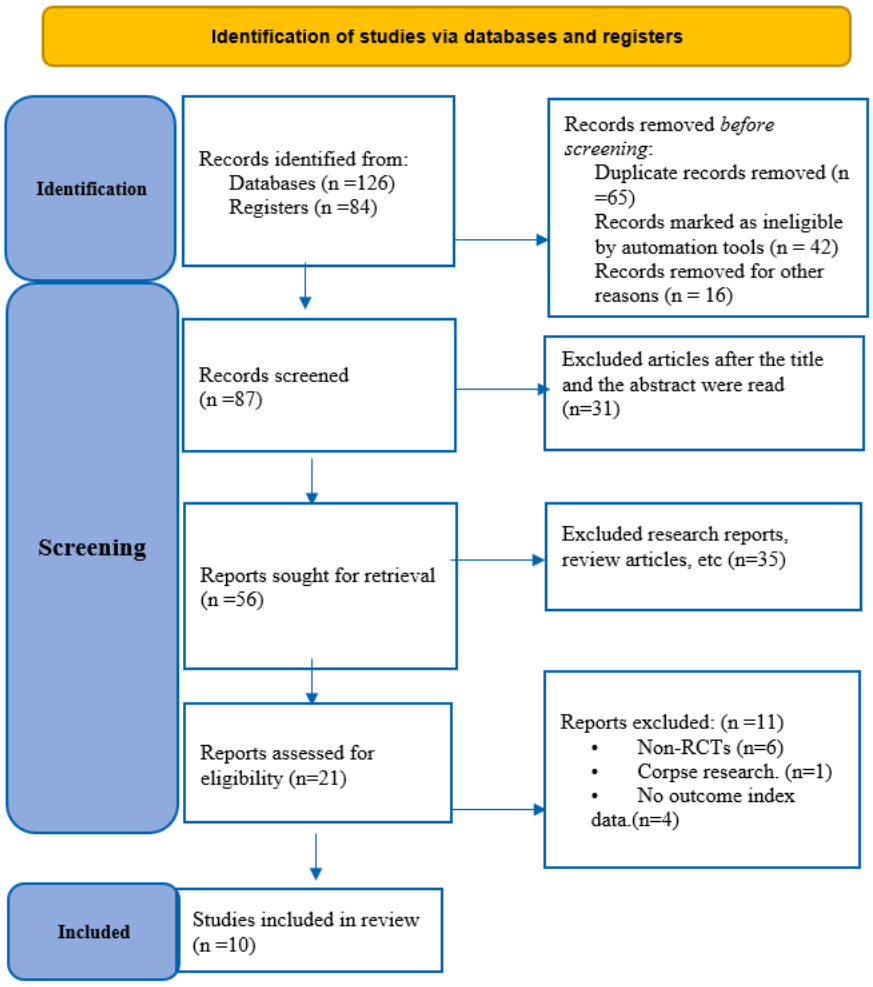

Figure 1: Flow chart of article retrieval.

The results of quality evaluation demonstrated that the evaluation level of 6 articles was A (60%), the evaluation level of 2 articles was B (20%), and the evaluation level of 2 articles was C (20%). Among 10 articles conforming to inclusion standards, there were 673 patients. The sample size of 10 articles ranged from 48 to 94 cases. In 10 articles, the resting status and pain scores during cough 1 hour,

12 hours, 24 hours, and 48 hours after surgery were described in detail. In addition, the total consumption of morphine 24 hours after surgery, the incidence of postoperative nausea and vomiting, and postoperative rescue analgesia times were also depicted in detail. Table 1 displays the basic features of included articles.

Table 1: Basic features of included articles

Intervention measures		Surgical type	Number of cases		Year	The first author
ESPB	TPVB		ESPB	TPVB		
Single ultrasonic guidance ESPB-T5	Multiple ultrasonic guidance TPVB-T5+T6+T7	VATS	24	24	2020	Chen (19)
Single ultrasonic guidance ESPB-T5	Single ultrasonic guidance TPVB-T5	Improved radical mammectomy	35	35	2019	El Ghamry (20)
Single ultrasonic guidance ESPB-T5	Single ultrasonic guidance TPVB-T5	Thoracotomy	47	47	2019	Fang (21)
Single ultrasonic guidance ESPB-T4	Single ultrasonic guidance TPVB-T4	Breast cancer unilateral breast surgery	25	25	2020	Gürkan (22)
Single ultrasonic guidance ESPB-T5	Single ultrasonic guidance TPVB-T5	Thoracoscopic pulmonary lobectomy	20	34	2021	Kukreja (23)
Single ultrasonic guidance ESPB-T5	Single ultrasonic guidance TPVB-T5	Improved radical mammectomy	45	45	2020	Moustafa (24)
Single ultrasonic guidance ESPB-T5	Single ultrasonic guidance TPVB-T5	Total mastectomy	25	25	2021	Stewart (25)
Single ultrasonic guidance ESPB-T5	Single ultrasonic guidance TPVB-T5	Thoracoscopic lung cancer radical surgery	40	41	2019	Taketa (26)
Single ultrasonic guidance ESPB-T5	Single ultrasonic guidance TPVB-T5	VATS	35	35	2021	Turhan (27)
Multiple ultrasonic guidance ESPB-T4+T6	Multiple ultrasonic guidance TPVB-T4+T6	VATS	33	33	2020	Zhao (28)

Table 1 continued

Outcome indexes	Nerve block anesthetic and dosage	
	ESPB	TPVB
VAS, morphine dosage, nausea and vomiting, and postoperative rescue analgesia times	0.375% ropivacaine 20mL	0.375% ropivacaine 6.7mL including T5, T6, and T7
Morphine dosage 24 hours after surgery, first postoperative analgesia time, postoperative VAS, and nausea and vomiting	0.25% bupivacaine 20mL	0.25% bupivacaine 20mL
VAS in resting status and during cough 1 hour, 24 hours, and 48 hours after surgery, patient-controlled intravenous analgesia effective press times 24 hours after surgery, and nausea and vomiting	0.25% bupivacaine 20mL	0.25% bupivacaine 20mL
Morphine consumption 24 hours after surgery, NRS, and nausea and vomiting	Tramadol 100mg	Tramadol 100mg
Postoperative VAS, and nausea and vomiting	Oral morphine equivalent	Oral morphine equivalent
morphine consumption 24 hours after surgery and NRS	0.25% bupivacaine 20mL	0.25% bupivacaine 20mL
NRS in resting status and during cough and morphine consumption 24 hour after surgery	Intravenous injection of 0.2-0.5mg hydromorphone every 4 hours	Intravenous injection of 0.2-0.5mg hydromorphone every 4 hours
NRS in resting status and during cough, nausea and vomiting, and postoperative rescue analgesia times	0.2% bupivacaine 20mL	0.2% bupivacaine 20mL
VAS, morphine dosage, nausea and vomiting, and postoperative rescue analgesia times	0.5% bupivacaine 20mL	0.5% bupivacaine 20mL
NRS, morphine dosage, and postoperative rescue analgesia times	0.4% ropivacaine 30mL	0.4% ropivacaine 30mL

Note: TPVB: Thoracic paravertebral block; ESPB: Erector spinae plane block; VATS: Video-assisted thoracic surgery; VAS: Visual analogue scale; NRS: Numeric rating scale

Evaluation results of risk bias of references

Among 10 RCTs, random number table method was adopted in grouping in 8 articles. Allocation concealment was described in 1 article, blind method was not utilized in 1 article, and all trial outcome indexes were complete. Figures 2 and 3 demonstrated specific article quality assessment.

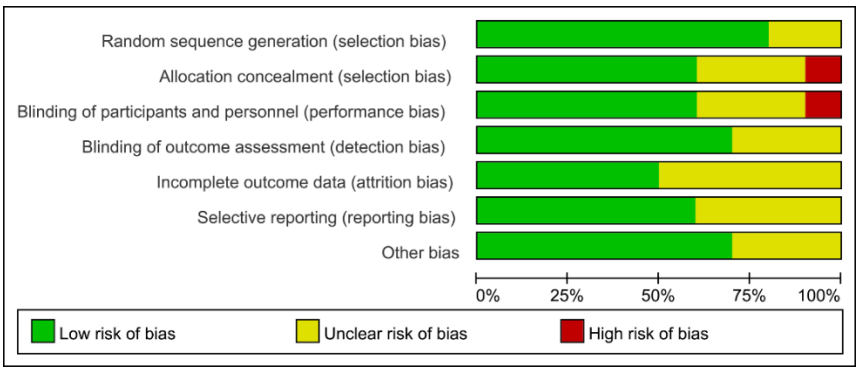

Figure. 2 Risk bias evaluation diagram of included articles.

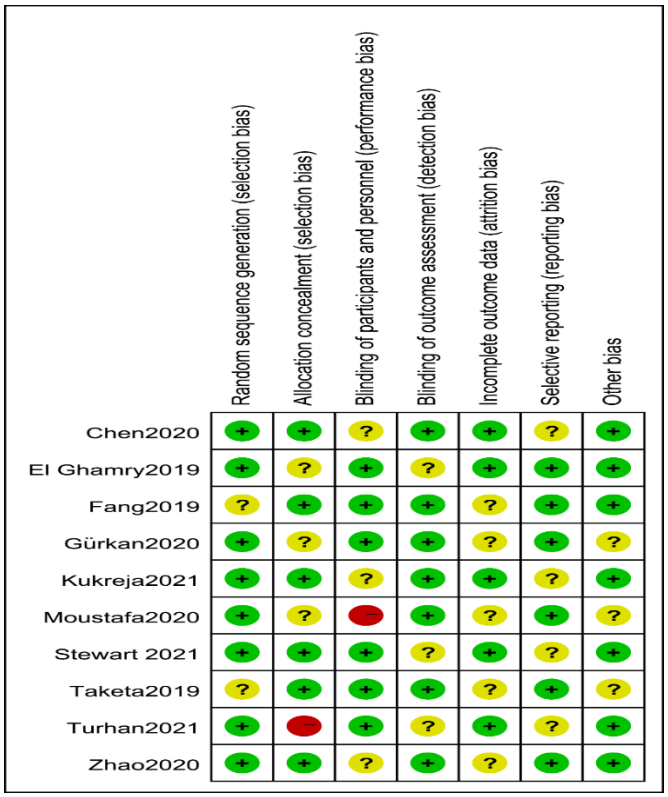

Figure 3: Evaluation and summary diagram of risk bias of included articles.
Note: "+" referred to low risk, "-" indicated high risk, and "?" denoted "unclear"

Meta-analysis results of pain scores of postoperative resting statuses

In meta-analysis, the pain scores of postoperative resting statuses 1 hour, 12 hours, 24 hours, and 48 hours were assessed. There was a total of 8 included articles, including 19-21, 23, and 25-28. The results showed that I^2>50% at each postoperative relevant time point. Besides, there was remarkable heterogeneity among each article included in resting status pain scoring. Therefore, random effect model was adopted to calculate combined effect size.

The pain scores of TPVB group and ESPB group showed differences 1 hour after surgery. SMD: -0.64, 95% CI (-0.87, -0.40), and *P*<0.00001, as illustrated in Figure 4.

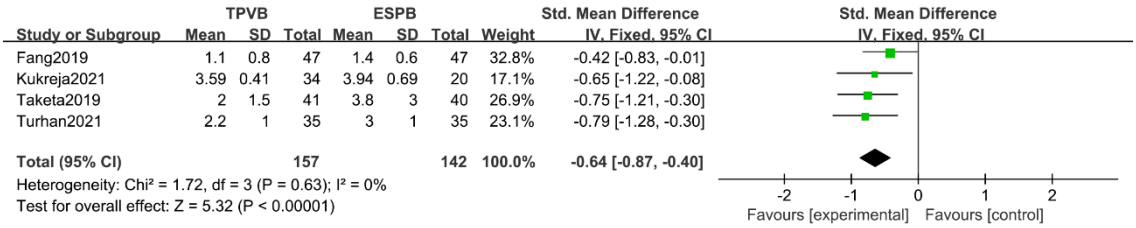

Figure 4: Forest plot of pain scores in resting status 1 hour after surgery.
CI: Confidence interval; df: degree of freedom; TPVB: Thoracic paravertebral block; ESPB: Erector spinae plane block

At the 12th hour after surgery, SMD: -0.77, 95% CI (-1.73, 0.19), and *P*=0.12, as illustrated in Figure 5.

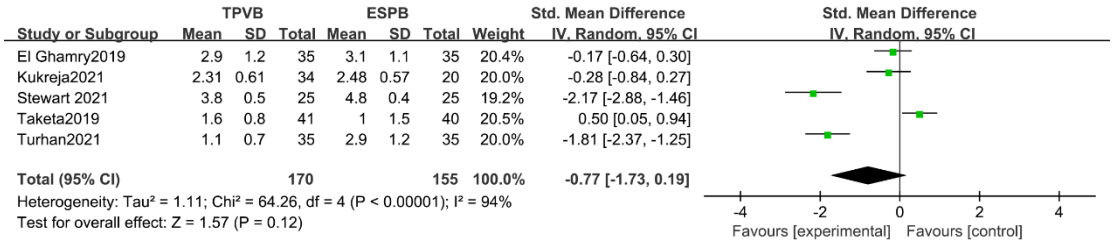

Figure 5: Forest plot of pain scores in resting status 12 hours after surgery.

At the 24th hour after surgery, SMD: -0.46, 95% CI (-1.04, 0.11), and *P*=0.12, as illustrated in Figure 6.

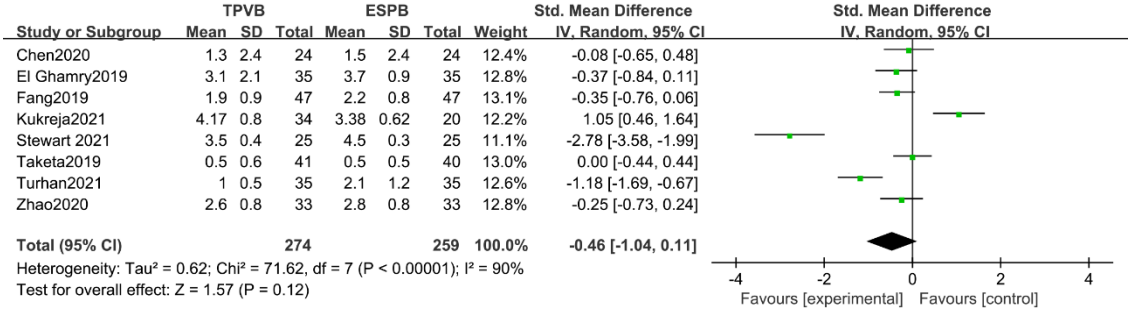

Figure 6: Forest plot of pain scores in resting status 24 hours after surgery.

At the 48th hour after surgery SMD: -0.42, 95% CI (-1.04, 0.20), and *P*=0.18, as illustrated in Figure 7.

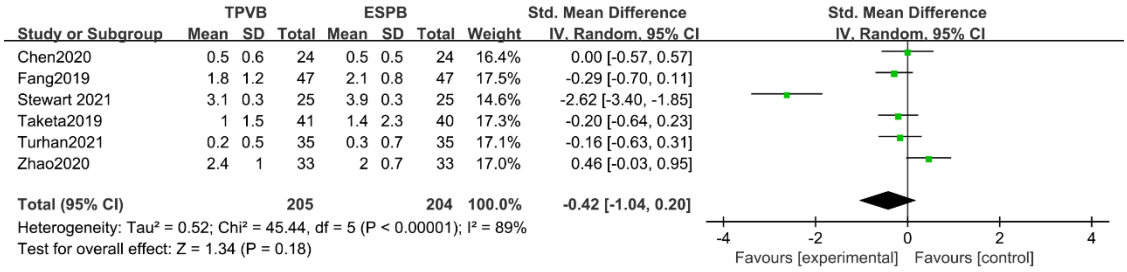

Figure 7: Forest plot of pain scores in resting status 48 hours after surgery.

The results revealed that there was no difference between the effects of ESPB and TPVB on the pains in resting status 12 hours, 24 hours, and 48 hours after surgery.
The funnel plot of the pain score in resting status 24 hours after surgery showed that the included circles were generally concentrated near the middle line, which demonstrated no publication bias but high reliability, as Figure 8 illustrated.

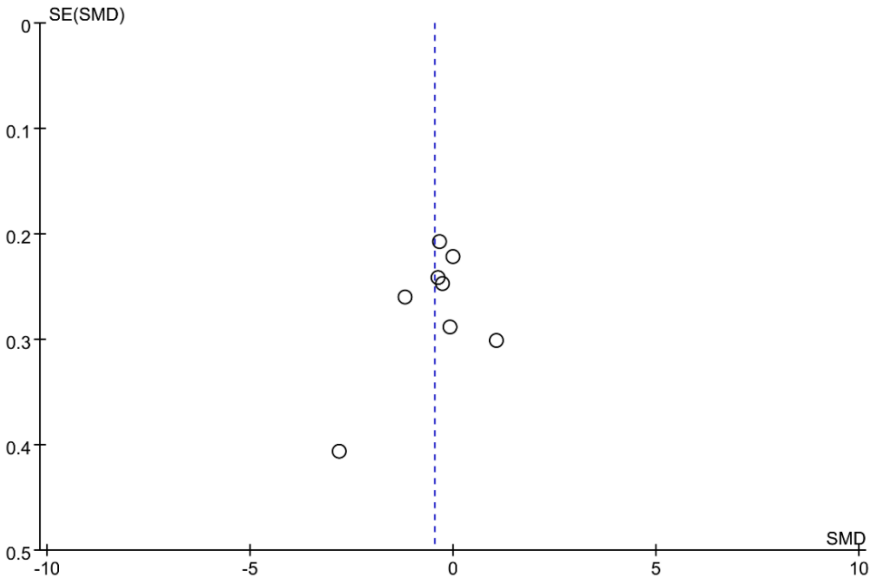

Figure 8: Funnel plot of pain scores in resting status 24 hours after surgery.

Meta-analysis results of pain scores during postoperative cough status

In the meta-analysis, the pain scores during cough status 1 hour, 12 hours, 24 hours, and 48 hours after surgery were analyzed. There was a total of 6 included articles, including 19, 21, and 25-28. The results showed that I^2>50% at each postoperative relevant time point. In addition, there was remarkable heterogeneity among each article included in cough status pain scoring. Hence, random effect model was adopted to calculate combined effect size.

The pain scores of TPVB group and ESPB group showed differences between 12 hours and 24 hours after surgery. At the 12th hour after surgery, SMD: -0.77, 95% CI (-1.40, -0.14), and *P*=0.02, as illustrated in Figure 9.

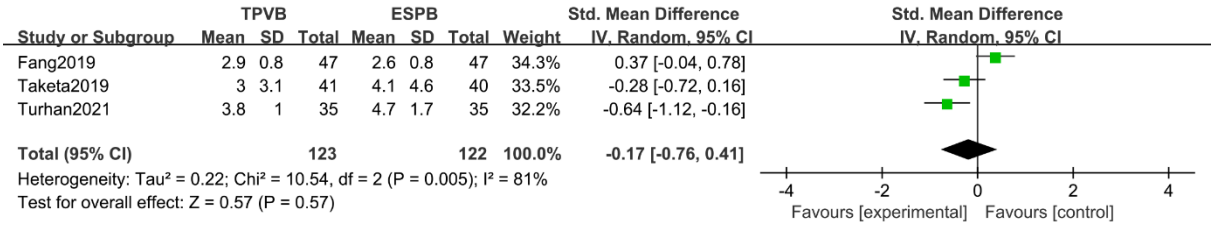

Figure 9: Forest plot of pain scores during cough 1 hour after surgery.
CI: Confidence interval; df: degree of freedom.

At the 24th hour after surgery, SMD: -0.64, 95% CI (-0.98, -0.30), and *P*=0.0002, as illustrated in Figure 10.

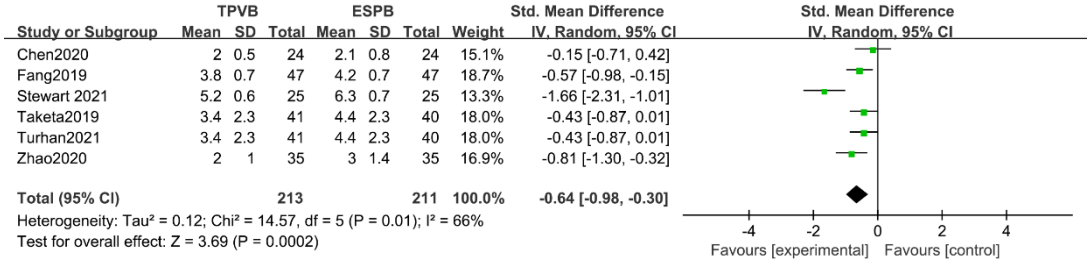

Figure 10: Forest plot of pain scores during cough 12 hours after surgery.

The above differences demonstrated that the analgesic effects of TPVB group were better than those of ESPB group in terms of cough pain scores 12 hours and 24 hours after surgery.

The pain scores of TPVB group and ESPB group 1 hour and 48 hours after surgery showed no

differences. At the 1st hour after surgery, SMD: -0.17, 95% CI (-0.76, 0.41), and *P*=0.57, as illustrated in Figure 11.

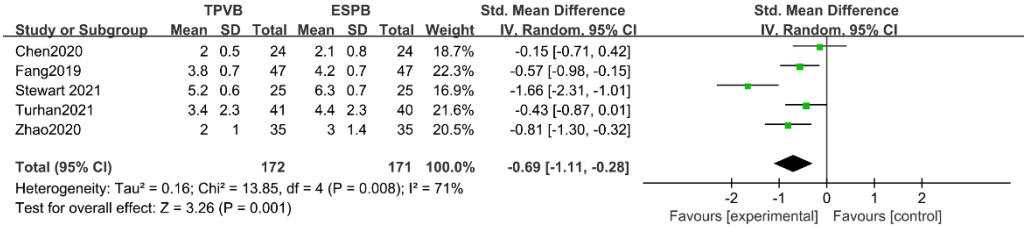

Figure 11: Forest plot of pain scores during cough 24 hours after surgery.

At the 48th hour after surgery, SMD: -0.32, 95% CI (-0.85, 0.21), and *P*=0.24, as illustrated in Figure 12.

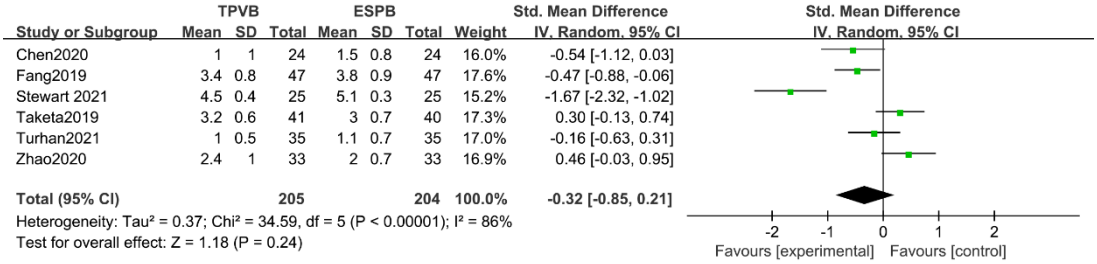

Figure 12: Forest plot of pain scores during cough 48 hours after surgery.

The results demonstrated that the analgesic effects of TPVB group and ESPB group showed no differences in terms of cough pain scores 1 hour and 48 hours after surgery.

The funnel plot of cough status pain scores 24 hours after surgery showed that the included circles were generally concentrated near the middle line, which indicated no publication bias but high reliability, as Figure 13 illustrated.

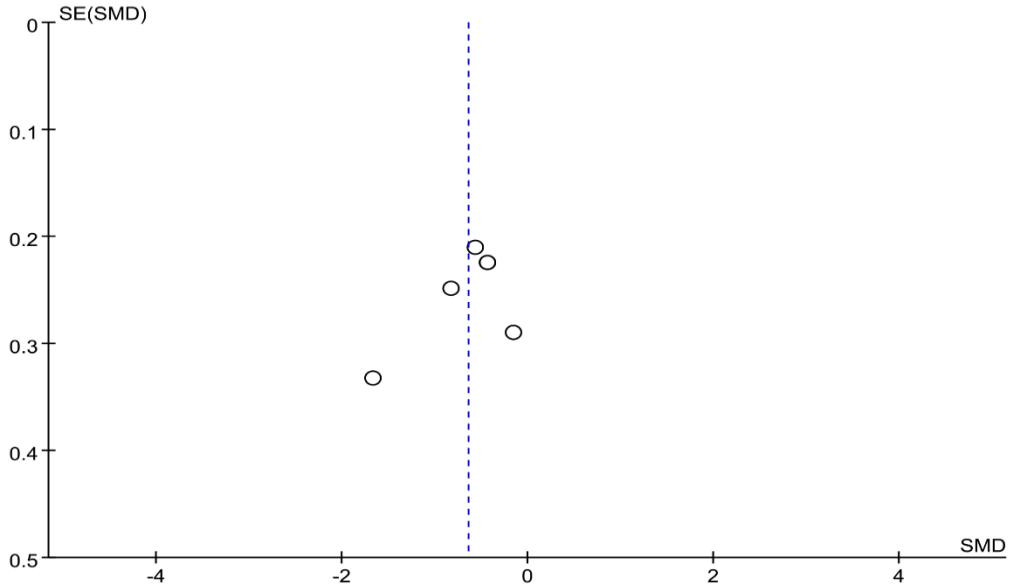

Figure 13: Funnel plot of pain scores during cough 24 hours after surgery.
SE: Standard error; SMD: Standard mean difference

Meta-analysis results of equivalent morphine consumption 24 hours after surgery

In 4 articles, including 19, 20, 24, and 27, the total consumption of equivalent morphine 24 hours after surgery was reported. The heterogeneity among each article was significant (I^2>50%). Therefore, random effect model was adopted to calculate combined effect size. Besides, there was no

statistical difference in the total consumption of equivalent morphine 24 hours after surgery between ESPB and TPVB groups. MD: -2.32, 95% CI (-4.92, 0.28), and *P*=0.08, as illustrated in Figure 14.

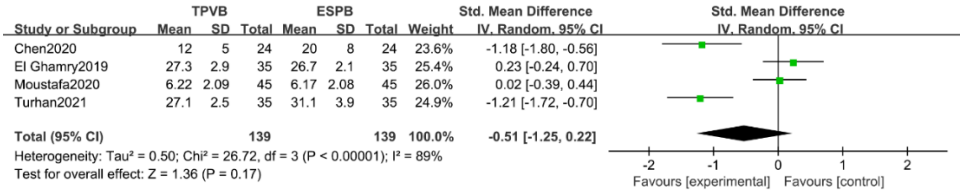

Figure 14: Forest plot of equivalent morphine consumption 24 hours after surgery.

Meta-analysis results of incidence of postoperative nausea and vomiting

There was a total of 6 articles, including 20-23, 26, and 27. In the above articles, the incidence of postoperative nausea and vomiting was analyzed. There was heterogeneity among each article (I^2>50%). Hence, random effect model was adopted to calculate combined effect size. The incidence of postoperative nausea and vomiting between TPVB group and ESPB group showed no significant statistical differences. RR=0.90, 95% CI (0.52, 1.54), and *P*=0.70, as illustrated in Figure 15.

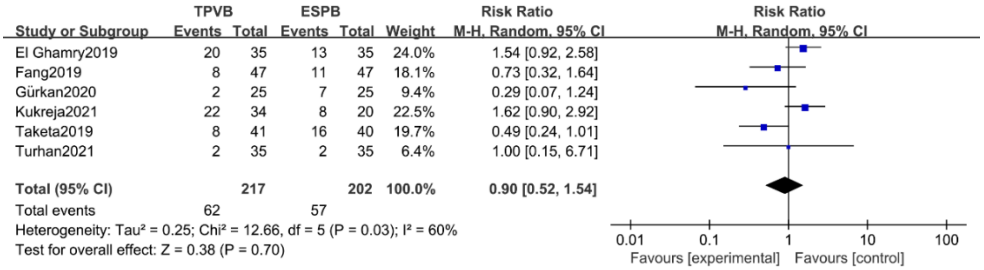

Figure 15: Forest plot of incidence of postoperative nausea and vomiting.

The funnel plot of the incidence of postoperative nausea and vomiting demonstrated that the included circles were generally concentrated near the middle line, which showed no publication bias but high reliability, as Figure 16 illustrated.

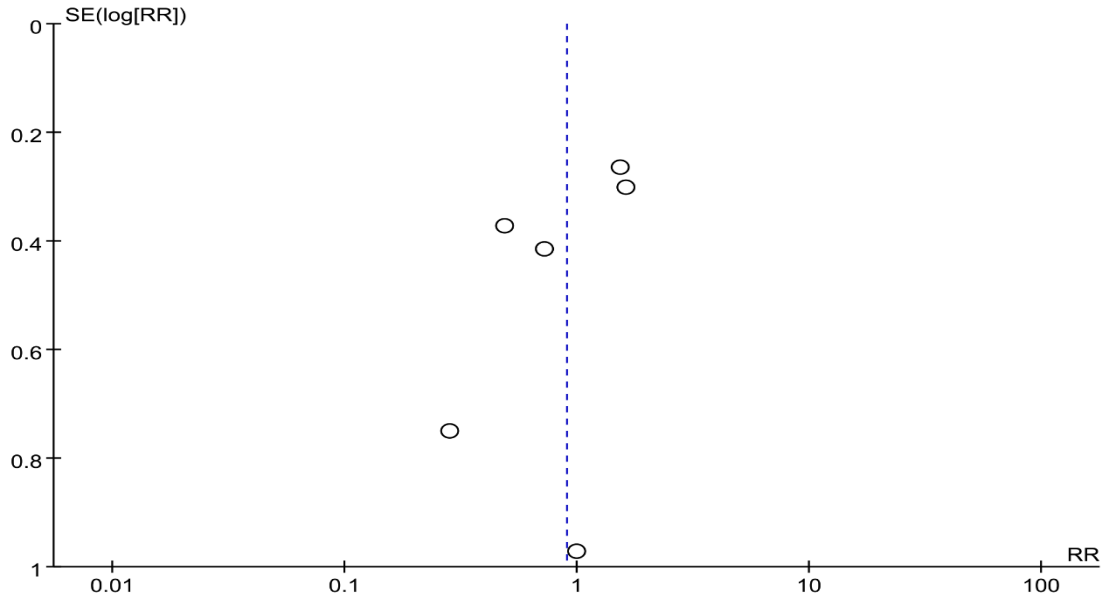

Figure 16: Funnel plot of incidence of postoperative nausea and vomiting.
SE: Standard error; RR: Risk ratio

Meta-analysis results postoperative rescue analgesia times

There was a total of 3 articles, including 19, 26, and 28. In the above articles, postoperative rescue analgesia times was analyzed. There was heterogeneity among each article (I^2<50%).

Therefore, a fixed effect model was adopted to calculate combined effect size. The postoperative rescue analgesia times of TPVB group and ESPB group showed remarkable statistical differences. RR=0.46, 95% CI (0.30, 0.71), and *P*=0.0004, as illustrated in Figure 17. The differences indicated that the postoperative rescue analgesia times of ESPB group was obviously greater than that of TPVB group.

Figure 17: Postoperative rescue analgesia times.

Sensitivity analysis

After the pain score during cough 12 hours after surgery was changed and 1 low-quality article was excluded, heterogeneity was remarkably reduced. After effect size was combined with fixed effect model. The effects were the same as before, which revealed that meta-analysis results were relatively steady and reliable.

Discussion

After thoracic surgery, patients suffer from great pains. The key step in accelerating rehabilitation surgery is the effective control of postoperative pains. In the implementation of TPVB, anesthetic is directly injected into paravertebral interval under the guidance of ultrasound to block the somatic and sympathetic nerves adjacent to multiple segments on the homolateral side of the injection position. Based on the method, the impacts of pain stimulus on hemodynamics can be effectively controlled. Therefore, ultrasound guided TPVB is a very safe and effective anesthetic technique in most articles (29). Ultrasound-guided ESPB is the latest trunk nerve block technology, which is gradually being applied in clinical practice from the 21st century. Local anesthetic is injected into the interval between the deep side of erector spinae and parapophysis. After that, the injected anesthetic diffuses and plays roles in paravertebral interval by anesthetizing dorsal branch, ventral branch, and communicating branch of spinal nerves (30).

In the systemic review and meta-analysis, the meta-analysis of the application of TPVB and ESPB in postoperative analgesia was compared. Based on outcome indexes, the pain scores in resting and during cough, the total consumption of morphine 24 hours after surgery, the incidence of postoperative nausea and vomiting, and postoperative rescue analgesia times of the application of TPVB and ESPB in the analgesia after thoracotomy or breast cancer surgical resection were compared. The results showed that the pain scores in resting status 12 hours, 24 hours, and 48 hours after surgery of TPVB and ESPB demonstrated no significant statistical differences. Besides, the analgesic effects during cough 12 hours and 24 hours after surgery of TPVB were superior to those of ESPB. The postoperative pain of patients' surgical incisions during cough was acute than that in resting status. The total consumption of opiates 24 hours after surgery between TPVB and ESPB showed no obvious differences. The postoperative rescue analgesia times of TPVB group was obviously less than that of ESPB group. In general, the analgesic effects of TPVB on the pain during cough 12 hours and 24 hours after surgery were superior to those of ESPB, which was consistent with the results obtained by Ivanusic et al. (2018) (31).

With TPVB technology, drug was directly injected into paravertebral intervals to block spinal nerves, which came into effect more quickly and accurately (32). The operation of TPVB was difficult. In 10 RCTs included in the meta-analysis, pneumothorax, hematoma at puncture position, and other severe complications were not reported. The prediction of real-time ultrasound guidance was related to clear anatomical structure levels and important structure identification. Previous serious operational complications were common in TPVB under blind detective according to body surface markers. The incidence of nausea and vomiting between TPVB and ESPB showed no obvious differences, which demonstrated that the application of local nerve block technology reduced postoperative dosage of opiates and the risk of postoperative respiratory depression. The result was consistent with that obtained by Frauenknecht et al. (2019) (33).

In terms of sensitivity analysis, it was found out that the results were the same as before by changing the pain score during cough 12 hours after surgery and effect model combined effect size. The consistency indicated that meta-analysis

results were relatively steady and reliable. However, there were still some limitations in the meta-analysis. For example, some outcome indexes were shown in the form of line charts during data extraction in articles. Inevitably, there were some differences between the data acquired by indirect data conversion and original data. Nevertheless, the best drug type and dosage of TPVB and ESPB were not determined. It was expected that further investigation would be carried out by sufficient RCTs publications in future articles.

Conclusion

In the meta-analysis, the articles related to the application of ultrasound-guided TPVB and ESPB in clinical surgical treatment were screened to investigate the effectiveness and safety of the application of TPVB and ESPB in clinical postoperative pain management. Meta-analysis results proved that the pain score during cough in clinical postoperative analgesia 12 hours and 24 hours after surgery of TPVB was lower than that of ESPB. Besides, TPVB obviously reduced postoperative rescue analgesia times and showed more accurate analgesic effects. Nevertheless, the above conclusions still needed to be further demonstrated deeply since the best drug type and dosage were not determined, and there were some disadvantages in experimental design and methodology in existing articles. To sum up, it was expected that more RCTs would be included in the meta-analysis in future and local anesthetic type as well as concentration would be classified in more detail. Hopefully, subsequent articles will provide evidence reference for clinical decision-making and offer the evidence-based medical theoretical basis to the selection of appropriate postoperative analgesic plans by anesthetists.

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