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Meta-Analysis of Ultrasound Guided Posterior Lamina Block and Erector Spinae Muscles Plane Block for Postoperative Analgesia and Adverse Reactions in Orthopedic Surgery

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Abstract: *The purpose of this article is to to compare the analgesic effect and adverse reactions of ultrasound-guided retrolaminal block (RLB) and erector spinae plane block (ESPB) in patients undergoing orthopedic surgery by meta-analysis. Rndomized controlled trials (RCTs) comparing the analgesic effects of RLB and ESPB blocks after orthopedic surgery were included by computer searches of PubMed, Embase, Ovid, Web of Science, Cochrane Library, CNKI, Vip Database, Wanfang Database and China Biomedical Full-text Database. The primary outcomes were resting pain scores at 2h, 4h, 6h, 8h, 12h, 24h and 48h postoperatively; Secondary outcomes were perioperative refentanil dosage and adverse effects such as nausea and vomiting, dizziness, and urinary retention. RevMan 5.3 software was used for statistical analysis of the data. Seven RCTs with a total of 487 patients were included, including 249 in the RLB block group and 238 in the ESPB group. The results of meta-analysis showed that compared with ESPB group (control group), the pain score at 2h (MD=-0.36, 95%CI -0.63~-0.09, P<0.05), 12h (MD=0.07, 95%CI 0.01~-0.13, P=0.03), and 24h (MD=0.33, 95%CI 0.24~-0.42, P <0.05) postoperatively and perioperative refentanil consumption were significantly reduced in the RLB group (experimental group). The pain score at 6h postoperatively (MD=0.79, 95% CI 0.65~0.92, P<0.01) was significantly increased in the RLB group (experimental group). There were no significant difference in pain scores at 4h(MD=-0.16, 95%CI -0.52~0.21, P=0.40)and 48h(MD=-0.03, 95%CI -0.19~0.1, P=0.74) postoperatively and in the incidence of adverse reactions such as nausea and vomiting, dizziness and urinary retention between the two groups. The available evidence shows that ultrasound-guided RLB is better than EPSB in postoperative analgesia in orthopedic surgery, and does not increase the occurrence of adverse reactions.*

Keywords: *Ultrasound; Retrolaminar block block; Erector spinal plane block; orthopedic surgery; Meta-analysis*

1. Introduction

According to the revised International Association for the Study of Pain[1], pain is "an unpleasant sensory and emotional experience associated with or associated with actual or potential tissue damage". The World Health Organization has identified pain as the fifth major vital sign after large vital signs of temperature, pulse, breathing, and blood pressure[2]. Studies[3] show that about 80% of patients who undergo orthopedic surgery experience moderate to severe pain within 2~48h after surgery. Postoperative pain not only brings physical pain and psychological burden to patients, but also induces cardiovascular and cerebrovascular diseases, which seriously affects the quality of life of patients and is not conducive to the recovery of the functions of various systems and organs of the body after surgery[4]. Therefore, perfect postoperative analgesia is a key part of the clinical treatment of orthopedic patients after surgery, which is conducive to early wound healing and reduction of complications. Prior venous self-controlled analgesia is one of the most effective methods of postoperative analgesia in orthopedic patients, but it is often associated with a high incidence of adverse reactions (nausea, vomiting, dizziness, etc.), resulting in low patient satisfaction[5]. In recent years, with the development of ultrasound visualization technology and the in-depth exploration of the anatomy of the posterior branch of spinal nerves, ultrasound-guided retrolaminal block (RLB) and erector spinae plane block

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(ESPB) have been more and more widely used in perioperative pain management in orthopedic surgery[6].

However, clinical studies have not yet reached a consistent conclusion on the efficacy of the two postoperative analgesia in orthopedics[7-13]. This study intends to conduct a meta-analysis of randomized controlled trials (RCTs) completed at home and abroad, and screen the literature that meets the quality standards, aiming to systematically review and compare the analgesic effects and adverse effects of RLB and ESPB in orthopedic surgery patients, in order to provide a reference for clinical practice.

2. Information and methods

2.1 Sources and search strategies

According to the PRISMA principle, the analgesic efficacy and adverse effects of ultrasound-guided RLB and ESPB after spinal surgery were systematically reviewed. Two investigators independently searched English databases such as PubMed, Embase, Ovid, Web of Science, Cochrane Library and Chinese databases such as CNKI, Weipu Database, Wanfang Database and China Biomedical Full-text Database to find published randomized controlled studies comparing RLB with EPSB for postoperative analgesia in spinal surgery. The search period was from the databases to December 2022. Chinese literature is Ultrasound-guided, erector spinal plane block/erector spinal block/ESPB, retrolaminar block/RLB, spine/cervical/thoracic/lumbar spine, and the English literature is Ultrasound-guided, erector spinae plane block/erector spinal block/ESPB, retrolaminal block/RLB, spine/cervical vertebra/ Lumbar Vertebrae was searched by a combination of subject terms and keywords.

2.2 Inclusion and Exclusion Criteria

Inclusion criteria:

(1) Study subjects: patients undergoing orthopedic surgery, regardless of race, age, gender, height, weight;

(2) Interventions: comparison of ultrasound-guided RLB and ESPB nerve blockade;

(3) Study type: randomized controlled trial (RCT);

(4) Primary outcome indicators: pain scores in resting states of 2, 4, 6, 8, 12, 24 and 48 hours after surgery, including visual analogue scale (VAS) pain score and numerical rating scale (NRS), both of which were 0~10 points;

(5) Secondary outcome indicators: perioperative refentanil dosage and incidence of adverse reactions such as nausea and vomiting, dizziness, and urinary retention.

Exclusion Criteria:

(1) Case reports, reviews, or conference papers;

(2) Non-RCT;

(3) Studies that cannot obtain full text, cannot extract data, and are repeatedly published;

(4) Animal experimental research;

(5) Experimental research on cadavers.

2.3 Literature screening and quality evaluation

The methodological quality of the included literature was evaluated using the Cochran Manual Risk of Bias Assessment Tool (https://www.cochrane.org)[14]. The main contents of the review included: random sequence generation, allocation concealment, double-blinding of participants and personnel, blinding assessment of study outcomes, completeness of outcome data, selective reporting of study results, and other biases, and each assessment was classified as low bias, unclear risk of bias, or high risk of bias. Two independent researchers independently screened and assessed the quality of the retrieved literature in strict accordance with the inclusion and exclusion criteria, and when there were differences, a third independent investigator reviewed and discussed the final results. In order to obtain

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more complete raw data, contact the corresponding author if necessary. Data extraction: name of first author and year of publication, sample size, age, sex, BMI, ASA grade, local anesthetic dosage, primary indexes, secondary indicators, etc.

2.4 Statistical analysis

The data were statistically analyzed using Rev Man version 5.3 software (https://www.cochrane.org/) provided by the International Cochrane Collaboration Network. Measurement data are expressed as mean difference (MD) and its 95% confidence interval (CI); Dichotomy variables were expressed as Relative Risk (RR) and their effect size with 95% CI. The Q test and theI^2 test were used to assess the heterogeneity between studies, and when $P > 0.1$, $I^2 < 50\%$, the heterogeneity of the results was considered to be small, and the fixed-effect model was used for analysis. Conversely, heterogeneity in the results was considered and analysed using a random-effects model. If $P < 0.05$, the difference is considered to have reached a significant difference. Publication bias was visually judged by funnel plots, and sensitivity analyses were performed if necessary to explore the stability of the results. For measurement data expressed by median and quartile intervals or full sample distances, if there is no reply from the original author, the online calculator (http://www.math.hkbu.edu.hk/~tongt/papers/median2mean.html) that has compiled the formula is converted to standard deviation using Wan et al. [15] and Luo et al.[16]. Web Plot Digitizer was used to extract data when the study data were presented as images only and the original author was contacted without a response[17].

3. Results

3.1 Literature search results

The initial search of 54 articles, after layer screening, finally included 7 articles, 6 Chinese literature, 1 English literature, a total of 487 patients. See Figure 1.

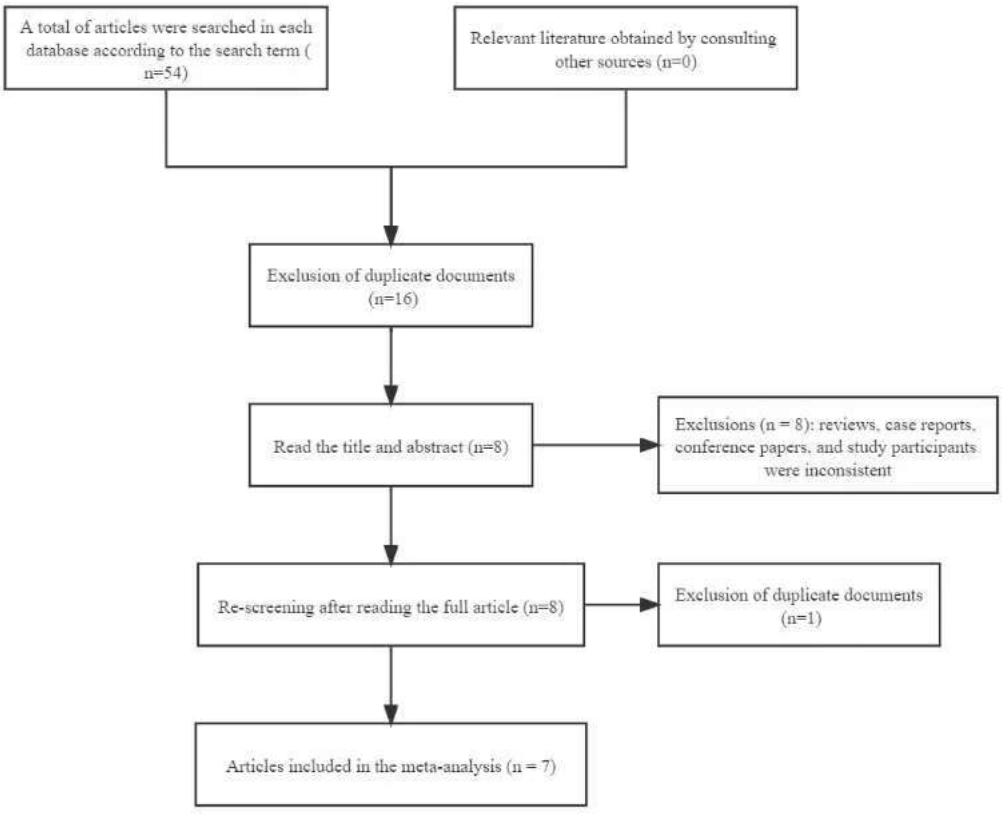

Figure 1: Document screening flowchart

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Table 1 Basic Characteristics of the Included Studies

literature	sample size		Age (years)		Gender (male/female)		BMI(kg/cm^2)		ASA classification (Level I/II)		Local anesthetic dosage		Outcome indicators	
	RLB group	ESPB group	RLB group	ESPB group	RLB group	ESPB group	RLB group	ESPB group	RLB group	ESPB group	RLB group	ESPB group	RLB group	ESPB group
Liu TZ 2019	20	20	56.5±7.1	55.7±7.2	9/11	12/8	24.8±3.9	25.0±2.9	17/3	15/5	0.4% Ropivacaine 20 ml	0.4% Ropivacaine 20 ml	2,5,6,7	2,5,6,7
Tao T 2019	31	28	53.45±8.37	55.54±6.77			22.36±2.46	21.49±2.51			0.375% Ropivacaine 15 ml	0.375% Ropivacaine 15 ml	1,4,5,6,7,9,11	1,4,5,6,7,9,11
Zhang XF 2021	48	40	52.36±3.65	52.98±3.87	25/23	21/19					0.375% Ropivacaine 15 ml	0.375% Ropivacaine 15 ml	3,5,6,9	3,5,6,9
Zou JR 2021	40	40	45.7±2.7	45.6±2.8	27/13	28/12					0.2% Ropivacaine 30 ml	0.2% Ropivacaine 30 ml	3,5,6,9,10	3,5,6,9,10
Cai N 2021	40	40	44.0±12.4	48.1±10.6	27/13	30/10	64.6±7.5	67.2±10.9	31/9	26/14	0.5%Ropivacain0.4 ml /kg	0.5%Ropivacain0.4 ml /kg	1,2,5,6,7,9	1,2,5,6,7,9
Zhao Y2021	40	40	44(23,63)	41(26,62)	30/10	26/14			30/10	34/6	0.5%Ropivacain 20 ml	0.5%Ropivacain 20 m	1,2,5,6,7,8,9	1,2,5,6,7,8,9
Zhang KC 2022	30	30	55.80±6.73	56.37±5.90	13/17	15/15	24.05±2.90	24.34±2.03			0.33%Ropivacain 20 ml	0.33%Ropivacain 20 ml	1,4,6,7,8,9,10,11	1,4,6,7,8,9,10,11

Note: 1, 2, 3, 4, 5, 6, and 7 are pain scores at 2, 4, 6, 8, 12, 24, and 48 hours after surgery, respectively; 8. Remifentanil consumption; 9. Nausea and vomiting; 10. Dizziness; 11. Urinary retention.

3.2 Basic information and risk of bias assessment were included.

The basic characteristics of the included literature are shown in Table 1; Risk of bias in the literature was assessed in Figure 2.

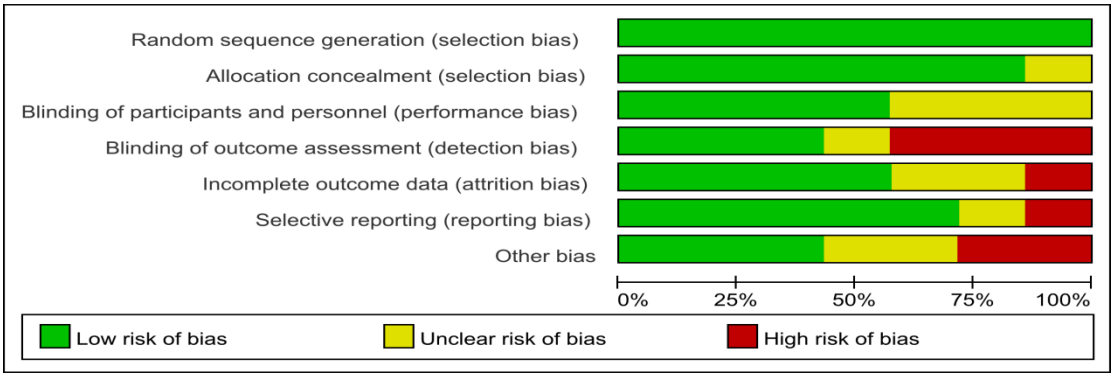

Figure 2 Risk of bias assessment chart

3.3 Results of meta-analysis

3.3.1 Pain scores in resting state at different time points after surgery in two groups

Four studies[8,11-13] compared the pain score at rest at 2 h postoperative with significant heterogeneity (I^2=70%, P=0.02), and using a random-effects model, meta-analysis showed that the QLB group had significantly lower pain scores at 2 h at rest than ESPB (MD=-0.36, 95% CI -0.63~-0.09, P <0.05) (Figure 3-A). Three studies[7,11-12] compared the pain scores at rest at 4 h postoperative with no significant heterogeneity (I^2=33%, P=0.22), using a fixed-effect model, and the results of meta-analysis showed that there was no significant difference in pain scores at rest at 4 h after surgery between the two groups (MD=-0.16, 95% CI -0.52~0.21, P=0.40) (Figure 3-B). Two articles[9-10] compared the pain score of 6 h resting state after surgery, with significant heterogeneity (I^2=99%, P<0.01), using a random-effects model, the results of meta-analysis showed that the pain score of 6 h postoperative rest state in the QLB group was significantly higher than that in the ESPB group (MD=0.79, 95% CI 0.65~0.92, P). <0.01) (Figure 3-C). Two studies[8,13] compared the pain score at rest at 8 h postoperative with significant heterogeneity (I^2=75%, P=0.05), and using a random-effects model, meta-analysis showed that there was no significant difference in pain score at 8 h postoperative between the two groups (MD=-0.14, 95%CI -0.30~0.01, P=0.08) (Figure 3-D). Six studies[7-12] compared the pain score at rest at 12 h postoperative with significant heterogeneity (I^2=97%, P<0.01), using a random-effects model, and the meta-analysis results showed that the QLB group had significantly lower pain scores at 12 h at rest than the ESPB group (MD=0.07, 95%CI 0.01~-0.13, P=0.03) (Figure 3-E). Seven studies[7-13] compared the pain score at 24 h postoperative with significant heterogeneity (I^2=98%, P<0.01), using a random-effects model, and the meta-analysis results showed that the QLB group had significantly lower pain scores at 24 h at rest than the ESPB group (MD=0.33,

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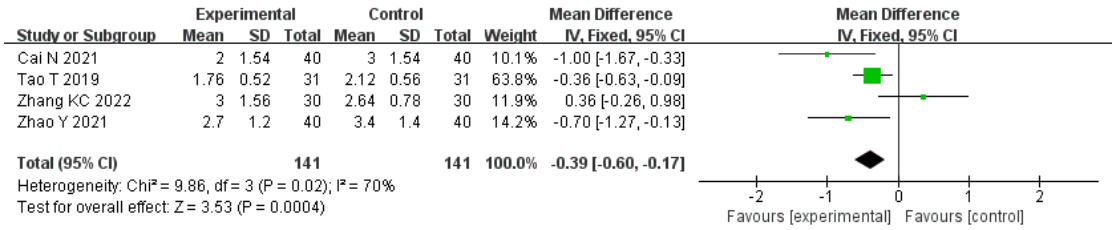
95% CI 0.24~-0.42, P). <0.05) (Figure 3-E). Five studies[7-8, 11-13] compared the pain scores at 48 h postoperative rest without significant heterogeneity (I^2=0%, P=0.99), and using a fixed-effect model, meta-analysis showed that there was no significant difference in pain scores at 48 hours after surgery between the two groups (MD=-0.03, 95%CI -0.19~0.1, P=0.74) (Fig. 3-F).

A



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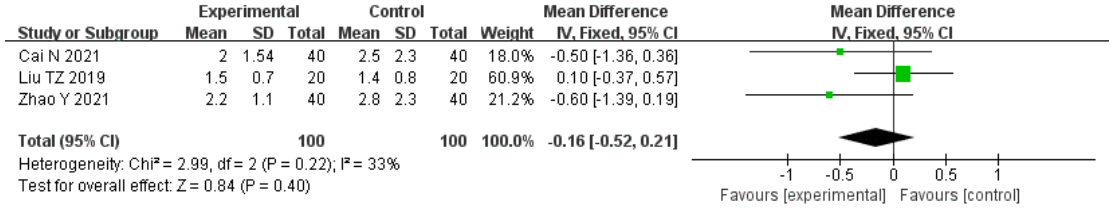

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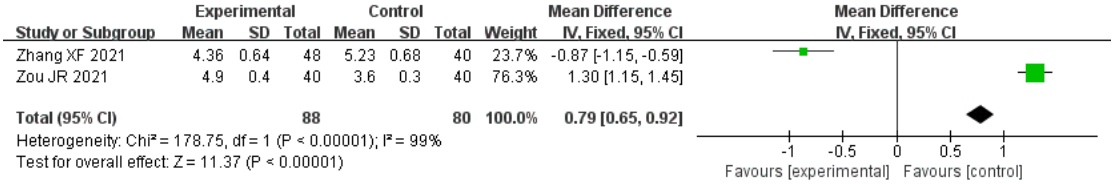

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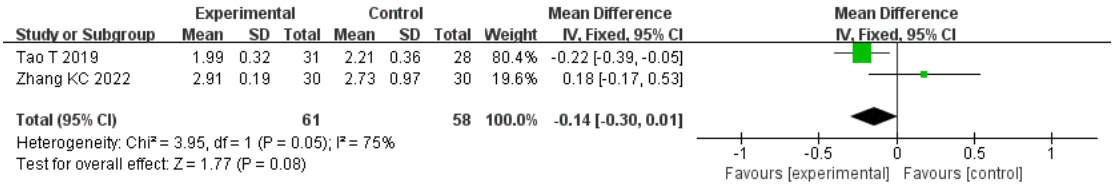

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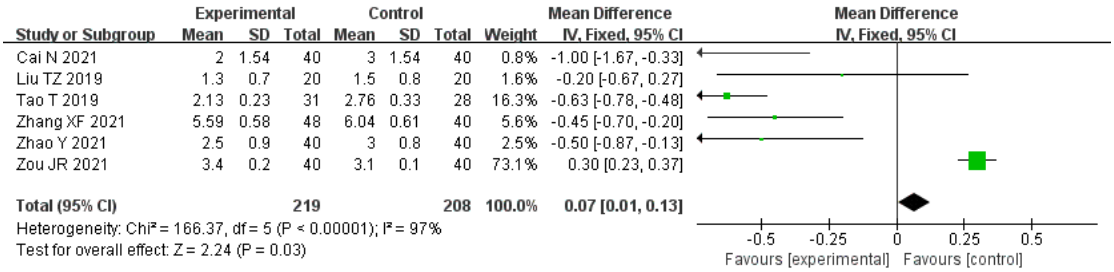

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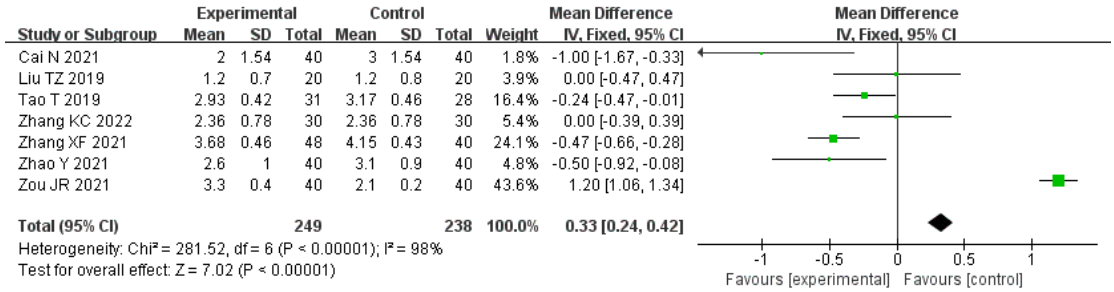

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G

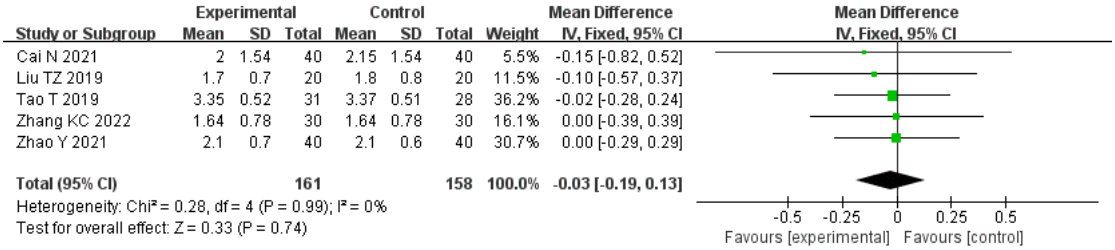


Figure 3. Postoperative resting state pain scores at different time points

3.3.2 Perioperative refentanil dosage

Two studies[12-13] compared the dosage of perioperative rephentanil with no significant heterogeneity (I^2=0%, P=0.70) using a fixed-effect model, and the meta-analysis results showed that the perioperative rephene dosage in the QLB group was significantly lower than that in the ESPB group (MD=-103.02, 95%CI -165.43~-40.62, P=0.001). (Figure 4).

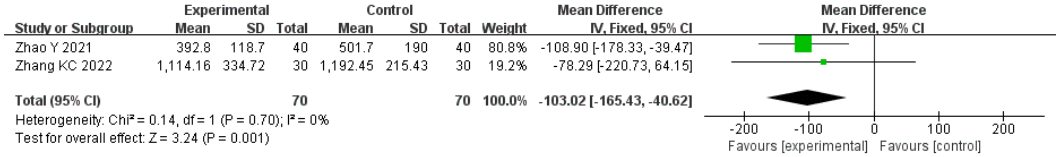
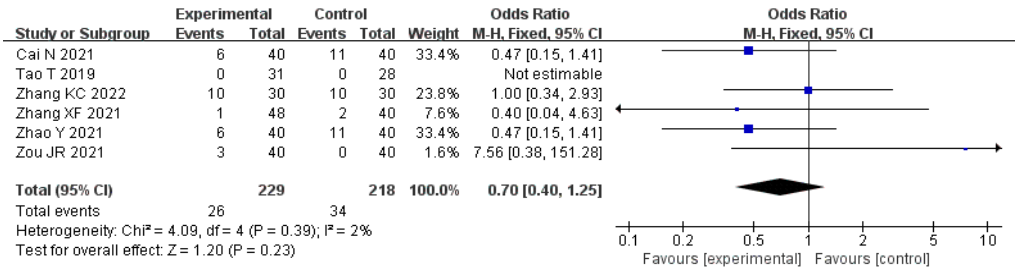


Figure 4 Perioperative dosage of refentanil

3.3.3 Incidence of postoperative adverse reactions

Six studies[8-13] mentioned the occurrence of postoperative nausea and vomiting, two studies[10,13] mentioned postoperative dizziness, and two studies[8,13] mentioned postoperative urinary retention. There was no significant heterogeneity I^2=2%, P=0.39;I2=0%, P=0.35; I^2=0%, P=0.96), and the meta-analysis results showed that there was no significant difference in the incidence of adverse reactions between the two groups (RR=0.70, 95%CI 0.40~1.25, P=0.23; RR=1.72, 95%CI 0.68~4.37, P=0.25; RR=0.95, 95%CI). 0.13~6.97, P=0.96). (Figure 5).

A



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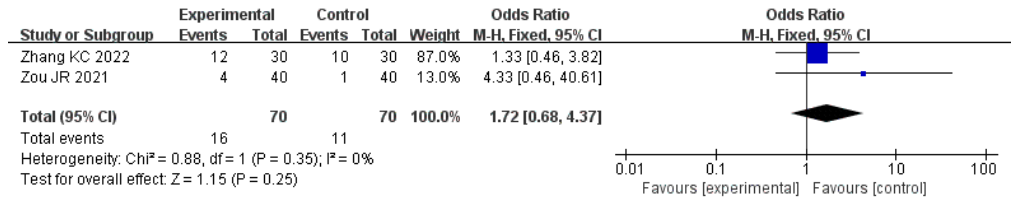

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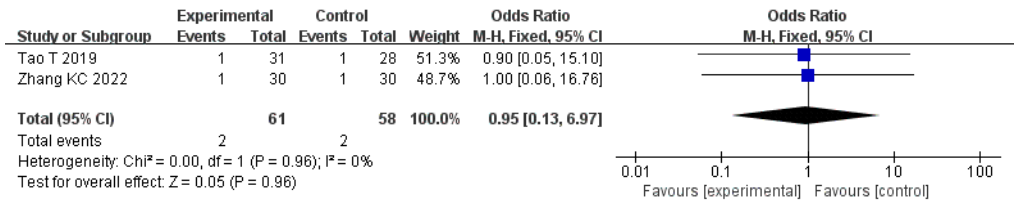

Figure 5 Adverse reaction incidence rate

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3.3.4 Publication bias

The funnel plot was plotted based on the pain score of the resting state 24 h after surgery in the two groups, and the results showed that the distribution of the included studies had the possibility of publication bias. (Figure 6).

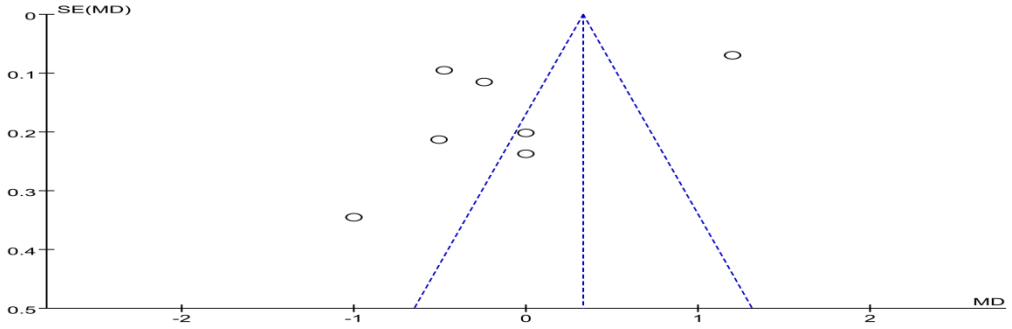

Figure 6 Funnel plot of publication bias in postoperative 24-hour resting state pain score

4. Discussion

Pain is the most common symptom in the early period after orthopedic surgery, mostly related to bone and soft tissue injury and inflammatory edema, postoperative fixation of plaster casts, and overperfusion after tourniquet release[18]. Persistent postoperative pain can not only release a large number of strong vasoconstrictors (eg, serotonin), aggravate tissue ischemia, hypoxia, and necrosis, but also interfere with the patient's postoperative recovery process, weaken or inhibit physical functions, and eventually lead to serious complications such as deep vein thrombosis and lung infection[19-20]. Therefore, for orthopedic patients, finding an appropriate analgesic solution has become an urgent problem to be solved in the perioperative period. Currently, regional nerve blocks are considered an excellent way to maximize pain control after orthopedic surgery while minimizing opioid consumption[21]. For the ideal perioperative regional nerve block technique, most anesthesiologists prefer to choose a safe, simple, and minimally invasive approach that can be performed in less time and provide appropriate analgesia[22]. In recent years, ultrasound-guided paravertebral block (PVB) has been widely used in orthopedic surgery[23]. However, due to its narrow anatomical space, the puncture and injection area is close to the pleural and spinal nerves, which can lead to serious complications such as pneumothorax, hypotension, and nerve injury[24]. At present, the new method of PVB has been the focus of many studies. As improved technologies of PVB, RLB and ESPB are two new types of regional blocks discovered in recent years, which can effectively block the dorsal branch of the spinal nerve to produce the analgesic effect of the dorsal branch innervating muscles and skin, and have been gradually used in clinical practice[7]. In clinical RLB, the target area of local anesthetic injection is the posterior superior lamina[25], while the area of local anesthetic injection of ESBP is the deep area of the erector spinal muscle group, that is, the posterior transverse process[26]. Studies[27] have shown that because posterior laminar block tends to spread to the deep paravertebral space and nerve roots, and its block site is closer to the axon, the blocking effect is more precise and perfect, which is better than the erector spinal plane block. The results of meta-analysis in this study suggest that compared with the ultrasound-guided ESPB group, the rest pain score in the early postoperative period (2h, 12 h and 24 h) in the ultrasound-guided RLB group was significantly reduced, and the dosage of perioperative refentanil was also significantly reduced, which was consistent with the previous study. The significantly higher pain score in the ultrasound-guided RLB group at rest 6 hours after surgery may be due to too few studies included in the analysis.

The following shortcomings in this systematic review were found:

(1) The anesthesia methods, nerve block localization methods, local anesthetic drug concentrations and doses of some studies included in the literature were not identical, which may increase clinical heterogeneity;

(2) There are relatively few high-quality literature in the included literature;

(3) Pain assessment differed between studies, which may have caused measurement bias;

(4) The funnel plot suggested possible publication bias. Combined with the above shortcomings, due to the limitation of the current number of original studies, the conclusions of this study need to be

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verified by multi-center, large-sample and high-quality RCTs.

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