Meta analysis of ultrasound-guided lumbar quadratus muscle block and transverse abdominis muscle plane block on the arcuate ligament for postoperative pain relief and adverse reactions in abdominal surgery

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Abstract: *The purpose of this article is to compare the analgesic effects and adverse reactions of ultrasound-guided quadratus lumborum block (QLB) and transverse abdominis plane block (TAPB) in patients undergoing abdominal surgery using meta-analysis. PubMed, Embase, Ovid, Web of Science, Cochrane Library, CNKI, VIP Database, Wanfang Database, and China Biomedical Full text Database were searched using computers. A randomized controlled trial (RCT) was conducted to compare the analgesic effects of QLB and TAPB on the arcuate ligament under ultrasound guidance for abdominal surgery. The main outcome measures were resting state pain scores at 2, 6, 12, 24, and 48 hours postoperatively, and motor state pain scores at 6, 24, and 48 hours postoperatively. The secondary outcome measure is the intraoperative use of sufentanil and remifentanil; The number of cases of rescue analgesia and the number of effective compressions of the analgesic pump within 48 hours after surgery; The incidence of postoperative nausea and vomiting; Hospitalization time. Perform statistical analysis on the data using RevMan 5.4 software. Four RCT studies were included, with a total of 259 cases, including 128 cases in the QLB group (experimental group) guided by ultrasound on the arcuate ligament and 131 cases in the TAPB group (control group) guided by ultrasound. The meta-analysis results showed that compared with the control group, the experimental group had resting state pain scores at 2 hours post surgery (MD=-1.26, 95% CI -1.66-0.87, P<0.0001), resting state pain scores at 6 hours post surgery (MD=-0.3, 95% CI -0.51-0.08, P=0.008), resting state pain scores at 12 hours post surgery (MD=-0.68, 95% CI -0.91-0.45, P<0.0001), and resting state pain scores at 24 hours post surgery (MD=-0.36, 95% CI -0.57-0.16, P=0.0004) The postoperative pain score at 6 hours (MD=-0.31, 95% CI -0.57-0.06, P=0.02), intraoperative sufentanil dosage (MD=-16.46, 95% CI -18.64-14.27, P<0.0001), intraoperative remifentanil dosage (MD=-0.87, 95% CI -0.99-0.75, P<0.0001), and hospital stay (MD=-1.36, 95% CI -1.76-0.96, P<0.0001) were significantly reduced. Two groups of patients had resting state pain scores (MD=-0.09, 95% CI -0.32-0.15, P=0.47), postoperative 24-hour motor state pain scores (MD=-0.22, 95% CI -0.63-0.20, P=0.31), postoperative 48 hour motor state pain scores (MD=-0.20, 95% CI -0.61-0.22, P=0.36), and the number of cases of rescue analgesia at 48 hours after surgery (RR=0.20, 95% CI 0.09-0.44, P<0.0001) There was no statistically significant difference in the number of effective compressions of the analgesic pump 48 hours after surgery (RR=0.15, 95% CI -0.64-0.95, P=0.70) and the incidence of postoperative nausea and vomiting (RR=0.68, 95% CI 0.30-1.52, P=0.35). Existing evidence suggests that ultrasound-guided QLB on the arcuate ligament is more effective than TAPB for postoperative pain relief in abdominal surgery, and does not increase the incidence of adverse reactions.*

Keywords: *Ultrasound; Arched ligament; Lumbar quadratus muscle block; Abdominal transverse muscle plane block; Abdominal surgery; Meta analysis*

1. Introduction

Abdominal surgery can cause significant trauma, and the surgical procedure can have a certain impact on intestinal motility. In addition, incisional damage to the abdominal wall and visceral traction reactions can lead to a large release of inflammatory factors, causing severe postoperative pain; Opioid analgesics commonly used after surgery [1] have adverse reactions such as inhibiting intestinal peristalsis, nausea

and vomiting, and respiratory depression, which are not conducive to the recovery of patients undergoing abdominal surgery. Multiple enhanced recovery after surgery (ERAS) protocols [2-3] recommend the use of multimodal analgesia strategies, with nerve block being an important component. Various types of inter fascial plane blocks [4-6], such as transverse abdominis plane block (TAPB), quadratus lumborum block (QLB), and erector spinae plane block (ESPB), have been widely used for postoperative analgesia in abdominal surgery. Quadratus lumborum block at the lateral superior ligament (QLB-LSAL) is a new approach for lumbar quadratus block proposed by Li et al.[7] in 2020. It has the advantages of fast onset and long duration of pain relief, and is gradually being applied in clinical practice. Although some small sample clinical studies have confirmed that QLB-LSAL has good pain blocking effects, there is no consensus on which is better or worse compared to TAPB, which has been used for many years. Therefore, this study intends to conduct a meta-analysis of randomized controlled trials (RCTs) that have been completed both domestically and internationally, and screen literature that meets quality standards. The aim is to systematically evaluate and compare the analgesic effects and adverse reactions of QLB-LSAL and TAPB in patients undergoing abdominal surgery, in order to provide reference for clinical practice.

2. Materials and Methods

2.1 Data Sources and Retrieval Strategies

A systematic review was conducted on the analgesic effects and adverse reactions of QLB and TAPB on the arcuate ligament under ultrasound guidance following the PRISMA principle after abdominal surgery. Two researchers independently searched English databases such as PubMed, Embase, Ovid, Web of Science, Cochrane Library, as well as Chinese databases such as CNKI, VIP, Wanfang, and China Biomedical Full text Database to search for published randomized controlled studies comparing RLB and EPSB for postoperative analgesia in spinal surgery. The retrieval time is from the establishment of each database to December 2022. Chinese literature was searched using ultrasound, ultrasound-guided ultrasound, B-ultrasound, arcuate ligament, lumbar quadratus muscle block, open surgery, laparoscopy, and transverse plane block. English literature was searched using a combination of theme words and keywords such as ultrasonic guided, ultrasonic, type-b ultrasonic, acute ligaments, quadratus lumbar block, laparometry, laparocopy, and transposus abdominis plane block.

2.2 Inclusion and Exclusion Criteria

Inclusion criteria: ① Study subjects: Patients undergoing orthopedic surgery, regardless of race, age, gender, height, or weight; ② Intervention measures: Comparison of two nerve blockade methods, QLB and TAPB, on the arcuate ligament under ultrasound guidance; ③ Research type: Randomized controlled trial (RCT); ④ Main outcome measures: resting state pain score at 2 hours, 6 hours, 12 hours, 24 hours, and 48 hours postoperatively, and motor state pain score at 6 hours, 24 hours, and 48 hours postoperatively; ⑤ Secondary outcome measures: number of cases of salvage analgesia and effective number of compressions of the analgesic pump 48 hours after surgery; The incidence of postoperative nausea and vomiting; Hospitalization time.

Exclusion criteria: ① Case reports, reviews, or conference papers; ② Non RCT; ③ Unable to obtain full text, unable to extract data, and duplicate published research; ④ Animal experimental research; ⑤ Corpse experimental research.

2.3 Literature screening and quality evaluation

Using the Cochran Handbook Risk Bias Assessment Tool(https://www.cochrane.org)Evaluate the methodological quality of the included literature . The evaluation content mainly includes: random sequence generation, allocation concealment, double-blind trial subjects and researchers, blind evaluation of research outcomes, completeness of outcome data, selective reporting of research results, and other biases. Each evaluation content is divided into low bias, unclear bias risk, or high bias risk. Two independent researchers strictly followed the inclusion and exclusion criteria to independently screen and evaluate the quality of the retrieved literature. In case of disagreement, the third independent researcher reviewed and discussed to determine the final result. In order to obtain more complete raw data, contact the corresponding author if necessary. Data extraction: First author name and publication year, sample size, age, gender, BMI, ASA grading, surgical type, surgical time, local anesthetic dosage,

primary and secondary indicators, etc.

2.4 Statistical analysis

Using the Rev Man 5.4 software provided by the international Cochrane collaboration network(https://www.cochrane.org/)Perform statistical analysis on the data. Quantitative data is represented by mean difference (MD) and its 95% confidence interval (CI); The binary variable is represented by the relative risk (RR) and its 95% CI to indicate its effect size. Use Q-test and I2 test to evaluate heterogeneity between studies, when P>0.1, $I^2 <$ At 50%, it is considered that the heterogeneity of the results is small, and a fixed effects model is used for analysis; On the contrary, it is considered that there is heterogeneity in the results, and a random effects model is used for analysis. If P<0.05, it is considered that the difference has reached a significant level. Use funnel plots to visually determine publication bias, and if necessary, conduct sensitivity analysis to explore the stability of the results. For quantitative data represented by median and interquartile spacing or full sample range, if there is no response from the original author, an online calculator with compiled formulas by Wan et al. [8] and Luo et al. [9] should be used(http://www.math.hkbu.edu.hk/ ~Convert tongt/papers/median2mean. HTML to standard deviation. When the research data is only presented in images and there is no response from the original author, Web Plot Digitizer is used to extract the data [10].

3. Results

3.1 Literature search results

Ten articles were initially retrieved, and after layer by layer screening, four articles were ultimately included, including three Chinese articles and one English article, with a total of 259 patients. See Figure 1.
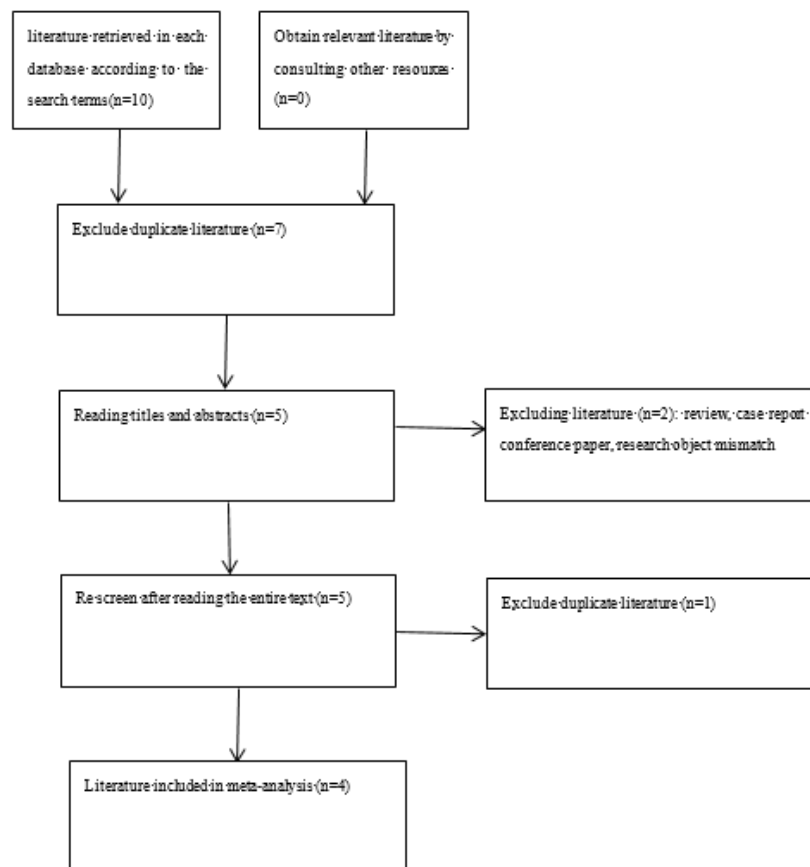

Figure 1: Literature Screening Process

3.2 Basic information and risk assessment of bias included in the literature

The basic characteristics of the included literature are shown in Table 1; The risk assessment of literature bias is shown in Figure 2.

Table 1: Basic characteristics of included studies

literature	sample size		Age (years)		Gender (male/Female)		BMI(kg/cm²)		ASA classification (Level I/II/III)		Surgical type	operative time (min)		Local anesthetic dosage		Outcome indicators	
	Experimental group	control group	Experimental group	control group	Experimental group	control group	Experimental group	control group	Experimental group	control group		Experimental group	control group	Experimental group	control group	Experimental group	control group
Zhu KL 2022[11]	19	21	60.37±7.20	62.42±8.41	11/8	13/8	22.96±1.13	22.39±1.09	0/16/3	0/19/2	Open liver surgery			0.5% ropivacaine 40ml	0.5% ropivacaine 40ml	1、3-5、9-11、13	
Liao CY 2022[12]	30	30	49.5±8.4	50.2±6.7	0/30	0/30	25.4±2.6	25.6±2.1	18/12/0	21/9/0	hysterectomy	121.4±13.3	124.9±15.2	0.375% ropivacaine 20 ml	0.375% ropivacaine 20 ml	2、4-7、8、11-14	
Mao Y 2023[13]	29	30	58.0(48.5, 64.0)	59.0(53.0, 64.3)	23/6	24/6	24.6±3.1	23.5±3.1	0/27/2	0/24/6	Open liver surgery	219.7±62.3	233.8±68.2	0.5% ropivacaine 20 ml	0.5% ropivacaine 20 ml	1-5、6-11、13-14	
Zhang H 2023[14]	50	50	56.02±11.13	55.40±9.65	24/26	26/24	23.23±2.92	23.56±3.10	2/42/6	2/43/5	Open liver surgery	203.00(134.00, 250.00)	197.50(129.00, 250.00)	3.3g/L ropivacaine 30ml	3.3g/L ropivacaine 30ml	2-5、12-14	

1, 2, 3, 4, and 5 are the resting state pain scores at 2 hours, 6 hours, 12 hours, 24 hours, and 48 hours postoperatively, respectively; 6. 7 and 8 are pain scores for motor status at 6h, 24h, and 48h after surgery, respectively; 9. 10 represents the intraoperative dosage of sufentanil and remifentanil, respectively; 11. 12 refers to the number of cases of rescue analgesia and the number of effective compressions of the analgesic pump 48 hours after surgery, respectively; 13 is the incidence of postoperative nausea and vomiting; 14 is the length of hospital stay.
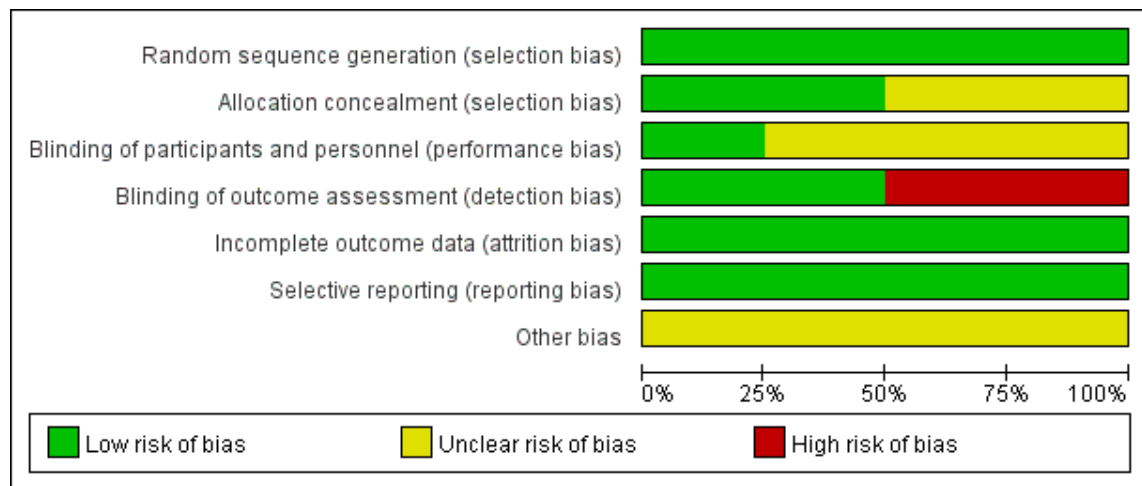

Figure 2: Bias Risk Assessment Chart

3.3 Meta analysis results

3.3.1 Resting state pain scores at different time points after surgery for two groups of patients

Two articles [11, 13] compared the resting state pain scores at 2 hours after surgery, with no significant heterogeneity (I^2=58%, P=0.12). Using a fixed effects model, meta-analysis results showed that the resting state pain scores in the experimental group were significantly lower than those in the control group at 2 hours after surgery (MD=-1.26, 95% CI -1.66-0.87, P<0.0001) (Figure 3-A). Three articles [12-14] compared the resting state pain scores at 6 hours after surgery, with no significant heterogeneity (I^2=0%, P=0.53). Using a fixed effects model, meta-analysis results showed that the resting state pain scores at 6 hours after surgery in the experimental group were significantly lower than those in the control group (MD=-0.3, 95% CI -0.51-0.08, P=0.008) (Figure 3-B). Three articles [11,13-14] compared the resting state pain scores at 12 hours post surgery, showing significant heterogeneity (I^2=94%, P<0.0001). Using a random effects model, meta-analysis results showed that the resting state pain scores in the experimental group were significantly lower than those in the control group at 12 hours post surgery (MD=-0.68, 95% CI -0.91-0.45, P<0.0001) (Figure 3-C). Three articles [11-13] compared the resting state pain scores at 24 hours after surgery, with no significant heterogeneity (I^2=0%, P=0.84). Using a fixed effects model, meta-analysis results showed that the resting state pain scores in the experimental group were significantly lower than those in the control group (MD=-0.36, 95% CI -0.57-0.16, P=0.0004) (Figure 3-D). Three articles [11-13] compared the resting state pain scores at 48 hours post surgery, with no significant heterogeneity (I^2=0%, P=0.71). Using a fixed effects model, meta-analysis results showed no statistically significant difference in resting state pain scores between the two groups of patients at 48 hours post surgery (MD=-0.09, 95% CI -0.32-0.15, P=0.47) (Figure 3-E).

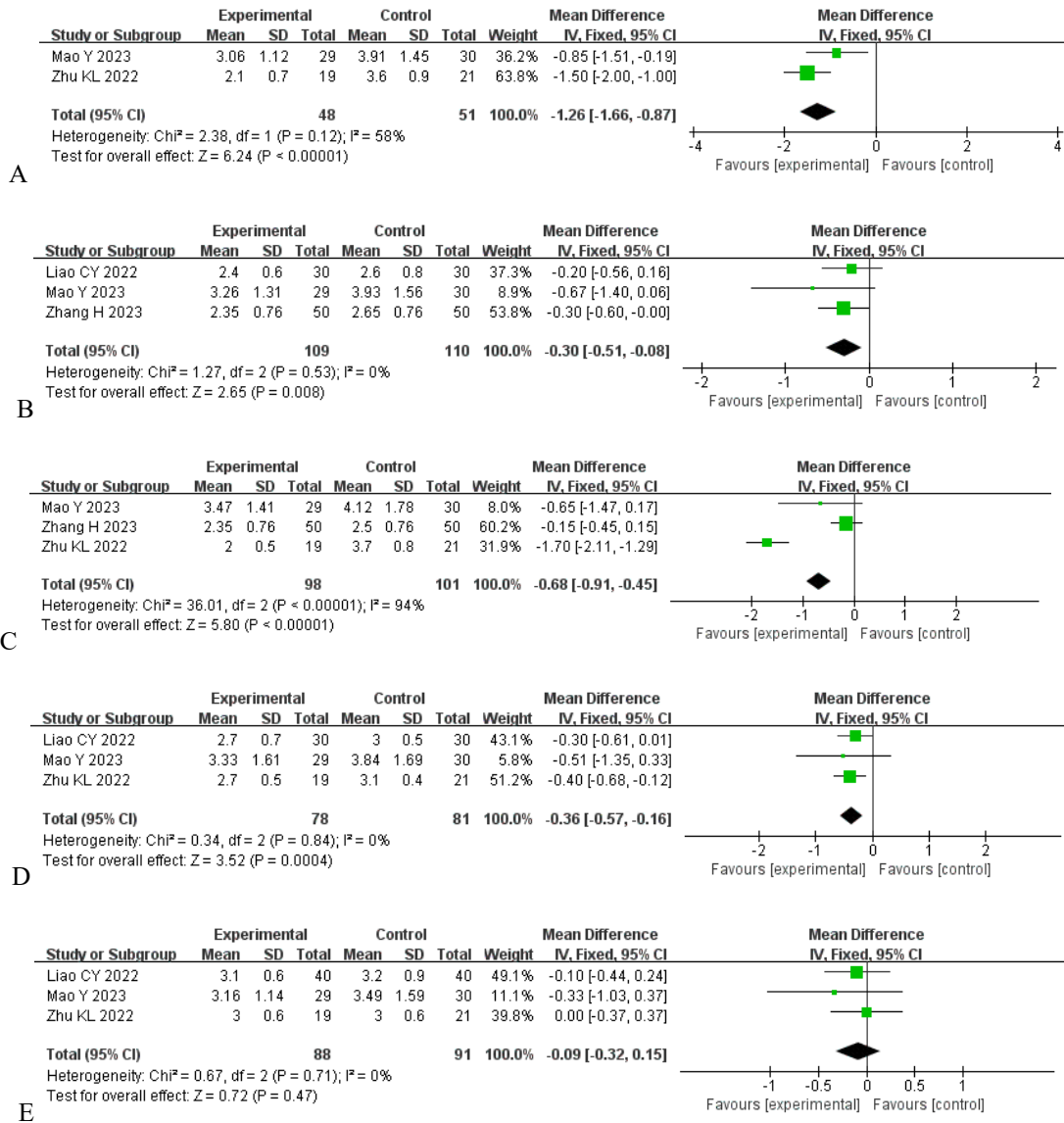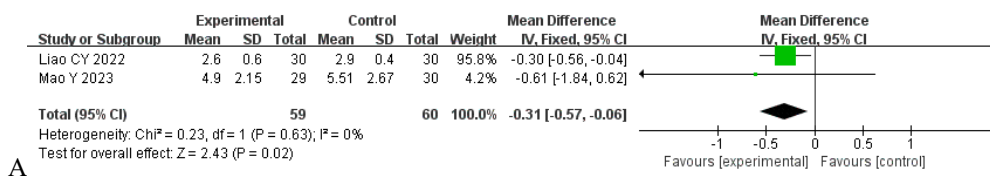*Figure 3: Resting state pain scores at different time points after surgery*

3.3.2 Pain scores of two groups of patients at different postoperative time points in terms of exercise status

Two studies [12-13] compared the postoperative 6-hour motor state pain scores without significant heterogeneity ((I^2=0%, P=0.63). Using a fixed effects model, meta-analysis results showed that the experimental group had significantly lower motor state pain scores than the control group (MD=-0.31, 95% CI -0.57-0.06, P=0.02) (Figure 4-A). Two studies [12-13] compared the postoperative 24-hour motor state pain scores without significant heterogeneity ((I^2=0%, P=0.78). Using a fixed effects model, meta-analysis results showed no statistically significant difference in postoperative 24-hour motor state pain scores between the two groups of patients (MD=-0.22, 95% CI -0.63-0.20, P=0.31) (Figure 4-B). Two studies [12-13] compared the postoperative 48 hour motor state pain scores without significant heterogeneity ((I^2=0%, P=0.93). Using a fixed effects model, meta-analysis results showed no statistically significant difference in motor state pain scores between the two groups of patients (MD=-0.20, 95% CI -0.61-0.22, P=0.36) (Figure 4-C).
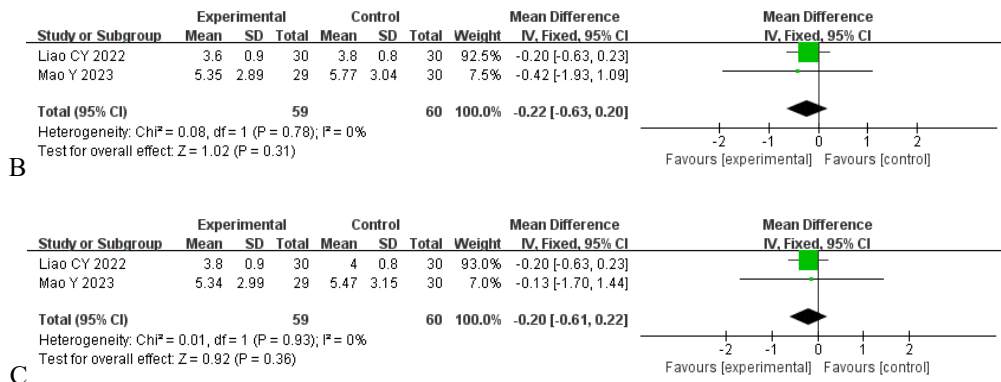
Figure 4: Postoperative pain scores at different time points during exercise

3.3.3 Intraoperative Anesthetic Dosage

Two articles [11, 13] compared the amount of sufentanil used during surgery, showing significant heterogeneity (I^2=97%, P<0.0001). Using a random effects model, meta-analysis results showed that the amount of sufentanil used during surgery in the experimental group was significantly lower than that in the control group (MD=-16.46, 95% CI -18.64-14.27, P<0.0001) (Figure 5-A). Two articles [11, 13] compared the amount of remifentanil used during surgery, with no significant heterogeneity (I^2=70%, P=0.07). Using a fixed effects model, meta-analysis results showed that the amount of remifentanil used during surgery in the experimental group was significantly lower than that in the control group (MD=-0.87, 95% CI -0.99~-0.75, P<0.0001) (Figure 5-B).
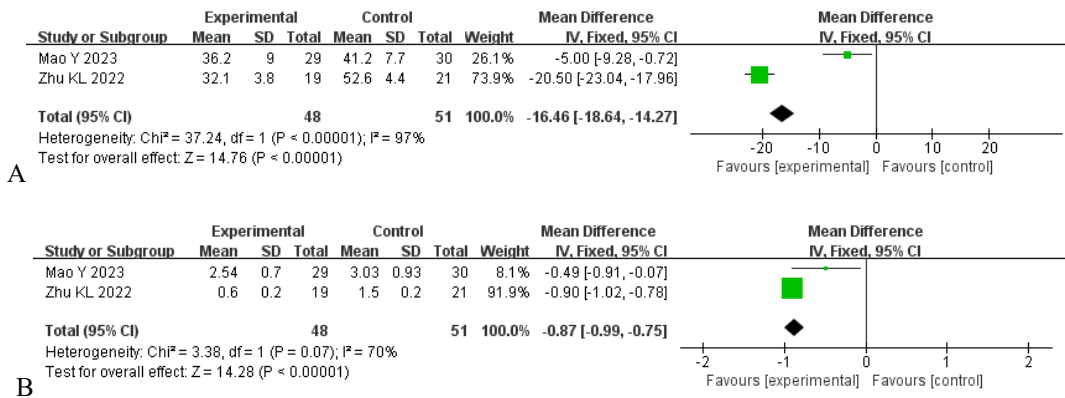

Figure 5: Intraoperative Anesthetic Dosage

3.3.4 Number of cases of rescue analgesia within 48 hours after surgery

Three studies [11-13] mentioned the number of cases of salvage analgesia after 48 hours of surgery, with no significant heterogeneity (I^2=0%, P=0.56). Using a fixed effects model, meta-analysis results showed no statistically significant difference in the number of cases of salvage analgesia after 48 hours of surgery between the two groups of patients (RR=0.20, 95% CI 0.09-0.44, P<0.0001) (Figure 6).
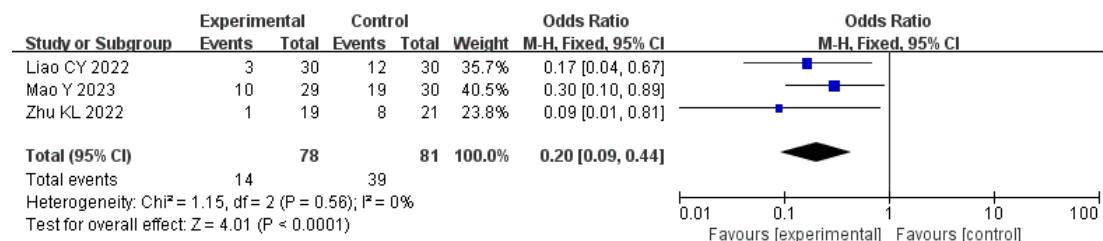

Figure 6: Number of cases of rescue analgesia 48 hours after surgery

3.3.5 Effective number of compressions with analgesic pump 48 hours after surgery

Two studies [12, 14] mentioned significant heterogeneity in the number of effective compressions of the analgesic pump at 48 hours after surgery (I^2=99%, P<0.0001). Using a random effects model, meta-analysis results showed no statistically significant difference in the number of effective compressions of

the analgesic pump between the two groups of patients at 48 hours after surgery (RR=0.15, 95% CI -0.64-0.95, P=0.70) (Figure 7).
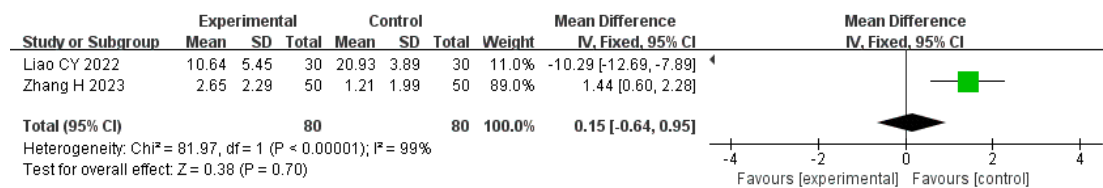

Figure 7: Effective number of compressions of the analgesic pump 48 hours after surgery

3.3.6 Incidence of postoperative nausea and vomiting

Four studies [11-14] mentioned the incidence of postoperative nausea and vomiting without significant heterogeneity (I^2=0%, P=0.98). Using a fixed effects model, meta-analysis results showed no statistically significant difference in the incidence of postoperative nausea and vomiting between the two groups of patients (RR=0.68, 95% CI 0.30-1.52, P=0.35) (Figure 8).
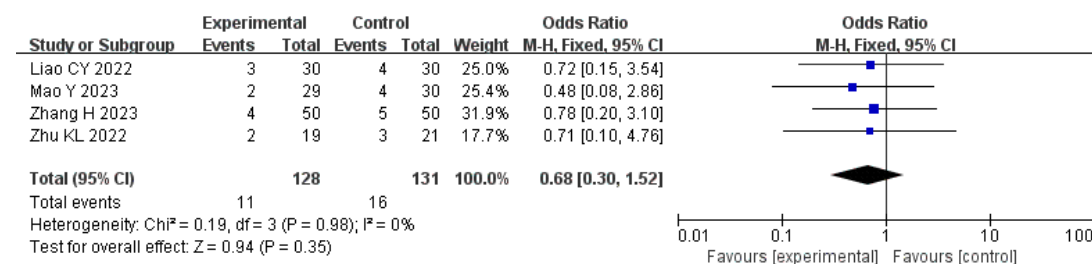

Figure 8: Incidence of postoperative nausea and vomiting

3.3.7 Hospitalization time

Three studies [12-14] mentioned hospitalization time without significant heterogeneity (I^2=63%, P=0.07). Using a fixed effects model, meta-analysis results showed that the hospitalization time of the experimental group was significantly lower than that of the control group (MD=-1.36, 95% CI -1.76-0.96, P<0.0001). (Figure 9).
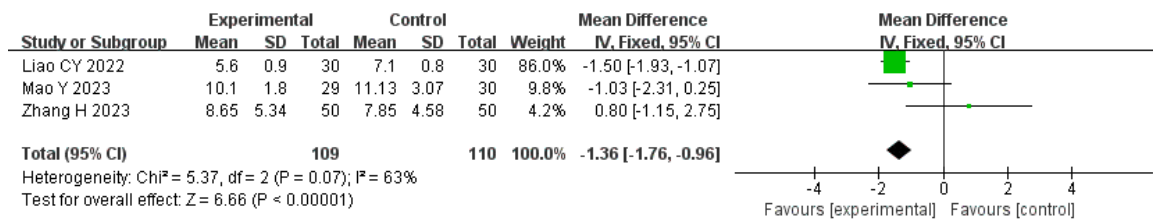

Figure 9: Hospitalization time

3.3.8 Publication bias

A funnel plot was drawn based on the resting state pain scores of two groups of patients 12 hours after surgery, and the results showed that there may be publication bias in the distribution of included studies. (Figure 10)
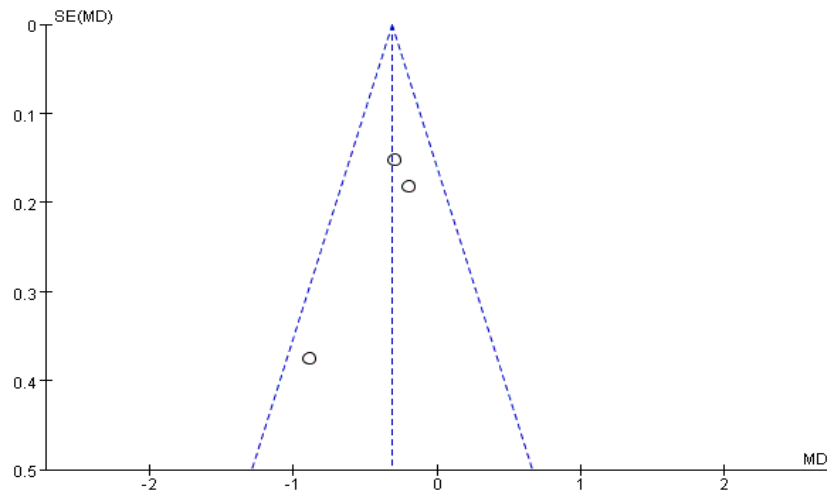
Figure 10: Funnel plot of publication bias in resting state pain scores at 12 hours post surgery

4. Discussion

The causes of postoperative pain in abdominal surgery include: abdominal incision pain, visceral pain caused by surgical traction of the internal organs, and nerve damage caused by surgery [15]. Persistent postoperative pain can release a large amount of strong vasoconstrictors (such as serotonin), which not only leads to central sensitization causing persistent pain in the incision, but also exacerbates tissue ischemia, hypoxia, and necrosis, hindering the patient's postoperative recovery process [16]. Therefore, timely and effective postoperative pain management is crucial for patients undergoing abdominal surgery. According to the current perioperative multimodal analgesic strategy, regional nerve block is considered an excellent way to effectively control postoperative abdominal pain while minimizing the use of opioids [2,3]. Ultrasound guided transverse abdominis plane block (TAPB) has been developed for many years, and its technology has been gradually improved. It mainly blocks the T10 to T12 intercostal nerve anterior branch and L1 spinal nerve anterior branch running between the internal oblique and transverse abdominis muscles. It is widely used in various abdominal surgeries and can provide effective abdominal wall incision analgesia, but the effect on visceral pain is still controversial [17-18]. The subcostal approach is the main operating method. Since its inception, QLB-LSAL [19-21] has shown good analgesic effects as a new approach for blocking the lumbar quadratus muscle. Local anesthetic injected at the anterior lateral edge of the lumbar quadratus muscle above the level of the lateral arcuate ligament spreads to the head side and quickly spreads directly through the thoracolumbar fascia to the thoracic and lumbar paravertebral spaces, resulting in a shorter onset time and longer duration of pain relief; Compared to other abdominal wall fascia blocks, the advantage is that the needle passage and local anesthetic site are far away from the abdominal cavity, abdominal visceral organs, and large blood vessels, and the possibility of puncturing the artery or damaging other organs is relatively low.

From the perspective of theoretical block range and adverse reactions, QLB-LSAL is more effective than TAPB, and specific experimental data is not significant. Therefore, this study will compare and analyze the two types of blocks. The results of this meta-analysis indicate that compared with the ultrasound guided TAPB group, the ultrasound guided QLB-LSAL group significantly reduces pain scores in the early postoperative resting state (2 hours, 6 hours, 12 hours, and 24 hours) and early motor state pain scores (6 hours after surgery), Prove that the anterior block of the lateral arcuate ligament on the quadratus lumbosae muscle is indeed more effective in relieving postoperative abdominal pain; The sustained action of local anesthesia during surgery reduces the transmission of pain, resulting in a corresponding decrease in opioid analgesics in the QLB-LSAL group during surgery. The possible reason [22-23] is that compared to TAP block, QLB covers the innervation range of T7-L1 spinal nerves, and the T10-T12 range is wider than TAP block; And TAPB mainly relieves surface pain in patients, while in QLB-LSAL, local anesthetics enter the lower thoracic paravertebral region through a potential pathway, producing a "similar" effect to paravertebral blockade; While relieving incision pain, it also alleviated the patient's visceral pain, achieving better analgesic effects. In addition, compared with TAPB, the QLB-LSAL group did not show significant differences in adverse reactions such as nausea and vomiting, and pain scores during postoperative exercise, indicating that QLB-LSAL has a better analgesic effect for abdominal surgery than TAPB and does not increase the incidence of adverse reactions.

5. Result

In summary, the analysis results of this study suggest that compared with the ultrasound-guided traditional QLB approach, the ultrasound-guided QLB-LSAL group showed a significant decrease in resting state pain scores in the early postoperative period (2h, 12h, and 24h), and a significant reduction in perioperative opioid drug dosage. Therefore, ultrasound-guided QLB-LSAL combined with a patient-controlled intravenous analgesia pump significantly improves the postoperative analgesic effect on the abdomen, improves the quality of postoperative recovery, and promotes early recovery of patients.

There are several shortcomings in the evaluation of this system: (1) Some studies included in the literature have different anesthesia plans, ultrasound localization methods and imaging methods, local anesthesia drug concentrations and doses, which may increase clinical heterogeneity; (2) There are relatively few high-quality literature included in the literature; (3) The assessment of pain severity varies among different studies, which may lead to measurement bias; (4) The funnel plot suggests possible publication bias. Taking into account the aforementioned shortcomings and limited by the current number of original studies, the conclusions of this study still need to be validated through multi center, large sample, and high-quality RCTs.

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