Quadratus Lumborum Block Versus Transversus Abdominis Plane Block for Postoperative Analgesia in Abdominal Surgery: A Systematic Review and Meta-analysis

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Abstract
Background: The aim of this systematic review and meta-analysis was to compare the analgesic efficacy of the quadratus lumborum block (QLB) and transversus abdominis plane block (TAPB).

Methods: We followed the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) statement guidelines. Only trials comparing QLB with TAPB were included. The primary outcomes were visual analog scale (VAS) scores at rest and at movement during the first 48 h after surgery and postoperative analgesic requirements. Secondary outcomes included rates of side effects, such as postoperative nausea and vomiting (PONV) and dizziness, and patient satisfaction.

Results: A total of 15 controlled trials, including 1013 patients, were identified. VAS scores at rest at 0–1, 2, 4, 6, 8, 12, and 24 h and at movement at 24 and 48 h were significantly lower in patients who underwent QLB when compared with those in patients who underwent TAPB. QLB performed better in terms of postoperative analgesic requirements, with patients requiring lower levels of intravenous morphine and sufentanil over the first 24 h, fewer patients requiring rescue analgesics, and longer times to first rescue analgesic. Among patients who underwent QLB, rates of PONV and dizziness were lower and the Bruggemann comfort scale (BCS) scores were higher.

Conclusion: QLB leads to significantly better outcomes in terms of postoperative VAS scores, opioid consumption, incidence of side effects, and patient satisfaction when compared with TAPB following abdominal surgery.

Background
Postoperative pain following abdominal surgeries is an important issue that affects postoperative recovery(1). Although pain after surgeries is multifactorial, pain relief increases patient satisfaction and comfort levels, reduces perioperative inflammation, promotes rehabilitation, shortens the length of hospitalization, and decreases the cost(2). In contrast, severe pain causes mental disorders such as anxiety and depression(3). Traditionally, epidural blocks and opioid consumption were used to alleviate pain; however, adverse effects such as respiratory depression, nausea, vomiting, and itching left patients unsatisfied and restricted their use(4, 5). Therefore, multimodal analgesia and nonopioid systems were developed to enhance recovery after surgery. Recently, with the widespread use of
ultrasonography, regional nerve blocks have become an important part of multimodal analgesia regimes, which show similar analgesic efficacy with favorable rates of side effects when compared to opioids(1, 2, 6).

A range of ultrasound-guided abdominal wall blocks are administered to adults for different abdominal surgeries, such as the transversus abdominis plane (TAP), rectus sheath, pararectus + ilioinguinal/iliohypogastric, and quadratus lumborum (QL)(7). Due to its satisfactory somatic analgesia and ease of use, the TAP block (TAPB) still seems to be favored for use with abdominal surgeries. The QL block (QLB), which was first reported by Blanco, allows local anesthetic to spread to the thoracolumbar fascia, producing somatic and visceral analgesia(4, 5, 8). However, the QLB technique is more complicated than the TAPB for anesthesiologists to perform. Recently, several studies have compared the QLB with the TAP for abdominal postoperative analgesia, but conflicts remain regarding their analgesic efficacy and side effects(9, 10).

Therefore, we performed this systematic review and meta-analysis to determine the optimal nerve block for use by clinical anesthesiologists to reduce the pain connected with abdominal surgeries and decrease the side effects.

Methods
This review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement (PRISMA(11)) and the Cochrane Handbook(11) for Systematic Reviews of Interventions.

Search strategy
We conducted a search for studies on transversus abdominis plane and quadratus lumborum blocks on PubMed, Embase, the Cochrane Central Register of Controlled Trials, MEDLINE (via PubMed), and CNKI, from inception to December 15, 2019, without restrictions on language, dates, patient sex, patient age, or type of article. The search string was composed of the following terms: “transversus abdominis” OR “transverse abdominis” OR “transverse abdominis plane block” OR “transversus abdominis plane block” OR “TAP” OR “TAP block” AND “quadratus lumborum block” OR “QLB” OR “QL
block.” Relevant trials and literature were manually searched for eligibility. All titles and abstracts were recorded and examined by two authors (C.C, C.J) independently to identify eligible articles using the following inclusion and exclusion criteria.

**Inclusion and exclusion criteria**

Clinical trials comparing TAP and QL blocks for postoperative analgesia after abdominal surgeries were considered eligible. Only RCTs using ultrasound-guided techniques were included. Trials with scores of less than 3 according to the Cochrane Collaboration’s tool for assessing risk of bias were classified as “high risk” and excluded from this review. Two authors separately assessed whether articles met the inclusion criteria, and discussed discrepancies to reach a consensus, as well as viewing full-text versions of the articles. We excluded case reports, review articles, letters, editorials, and cadaver studies.

**Outcomes**

Primary outcomes

1. Visual analog scale scores at rest at 0-1, 2, 4, 6, 8, 12, 24, and 48 h postoperatively, as well as the scores at movement at 24 and 48 h, were analyzed.

2. Times to first rescue analgesics after surgery were used to evaluate pain control. The longer the period to first analgesic, the better the pain management.

3. Total doses of rescue analgesics required during the first 24 h were analyzed, including morphine and/or sufentanil.

Secondary outcomes

1. Incidences of side effects such as postoperative nausea and vomiting (PONV) and dizziness were assessed.

2. Patient comfort levels were assessed based on the two trials in which they were
Data collection
Two authors (C.C, C.J) separately extracted and cross-checked the data. Data collected included types of surgery, patient ages, types of anesthesia, numbers of alternative block groups, block solution, time to start blocking, types of rescue analgesics, time to and doses of rescue analgesics, visual analog scale scores at rest and at movement at certain timepoints, side effects, and patient comfort levels.

Statistical analyses
We used Review Manager software (RevMan, version 5.2; The Nordic Cochrane Center, The Cochrane Collaboration, Copenhagen, Denmark) for all analyses and forest plots. We compared combined continuous data, such as VAS scores at rest and at movement, sufentanil consumption, and time to first rescue analgesic, using standard mean difference (SMD) as the measure of effect. Dichotomous data and categorical data were compared using a risk ratio produced by the Mantel-Haenszel model, which was used to calculate the number of patients needed to treat and the incidence of side effects. We summarized the risk ratio and mean difference with 95% CIs. Statistical heterogeneity was assessed using the $I^2$ statistic: values of 25%, 50%, and 75% indicated mild, moderate, and substantial heterogeneity, respectively. Publication bias was examined using a combination of Begg and Egger tests. Forest plots were used to graphically represent and evaluate the effects of analgesia. We performed sensitivity analyses for the primary outcomes to evaluate whether the results were robust. We were unable to divide the studies into subgroups by surgery type, because there were few studies for each surgery.

Results
Selection of trials
Through database searching and screening with preset criteria, a total of 15 trials(1, 3-6, 8-10, 12-18) reported.
were selected for inclusion in the meta-analysis. The search process is described in Figure 1.

**Basic characteristics of included studies**

The basic characteristics of the 15 included trials are summarized in Table 1. Eight were published in Chinese(3, 5, 9, 10, 14, 16-18), the others in English. A total of 511 and 502 patients were included in the QLB and TAPB groups, respectively. Trial sizes ranged from 50 to 107 patients. Patients underwent various abdominal surgeries, including Cesarean delivery, appendectomy, total abdominal hysterectomy, laparoscopic cholecystectomy, inguinal hernia repair, colorectal open surgery, laparotomy, gastrectomy, and others. Pediatric patients, from 6 months to 14 years old, participated in 2(6, 12) trials. Subcostal(1), posterior(4), and lateral(3, 5, 6, 8-10, 12-18) TAPB approaches were used.

**Risk of bias assessment**

The assessment of the risk of bias of the 15 RCTs is summarized in Figure 2. Three(1, 6, 16) trials provided unclear detailed descriptions of randomization. Seven(6, 9, 10, 14, 16-18) trials lacked detailed description of allocation concealment. A double-blind method was applied in 8 trials(1, 4, 6, 8, 10, 13, 15, 17). Only 1 trial(6) had no incomplete outcomes (attrition bias). All trials reported all the end points mentioned in their methods sections (reporting bias).

**Results of meta-analysis**

**Meta-analysis of at-rest visual analog scale scores**

At-rest VAS (visual analog scale) scores were assessed at 0–1 h in 4 trials(5, 13, 15, 16), at 2 h in 8 trials(3-5, 10, 13, 14, 16, 18), at 4 h in 8 trials(3-5, 9, 10, 13, 16, 18), at 6 h in 5 trials(4, 5, 13-15), at 8 h in 4 trials(3, 9, 16, 18), at 12 h in 10 trials(3-5, 9, 10, 13-16, 18), at 24 h in 10 trials(3-5, 9, 10, 13-16, 18), and at 48 h in 5 trials(3, 4, 9, 15, 18). (Table 2, Figures 3–5)

Compared with TAPB, QLB reduced at-rest VAS scores by 9 mm at 0-1 h (95% CI: -1.66, -0.13; P<0.02), by 10 mm at 2 h (95% CI: -1.23, -0.83; P<0.00001), by 13 mm at 4 h (95% CI: -1.96, -0.71;
P<0.0001), by 15 mm at 6 h (95% CI: -2.33, -0.63; P=0.0006), by 12 mm at 8 h (95% CI: -2.28, -0.14; P=0.03), by 12 mm at 12 h (95% CI: -1.74, -0.64; P<0.0001), and by 9 mm at 24 h (95% CI: -0.98, -0.76; P=0.001) postoperatively. However, there was no significant difference between QLB and TAPB groups in at-rest VAS scores at 48 h postoperatively (P=0.06). The 2 pediatric trials (6, 12) using FLACC (Face, Legs, Activity, Cry, Consolability) and POAS (Pediatric Objective Pain Scale) scores both showed that pain in the QLB group was lower compared with that in the TAPB group.

Meta-analysis of at-movement visual analog scale scores

Three trials (3, 4, 18), including a total of 190 patients, reported at-movement VAS scores at 24 h and 48 h postoperatively. At-movement VAS scores in the QLB group were lower than those in the TAPB group, both at 24 h (MD=-0.83; 95% CI: -1.15, -0.50; P<0.00001) and 48 h (MD=-3.27; 95% CI: -6.38, -0.16; P=0.04). (Table 2, Figure 6)

Meta-analysis of postoperative analgesic requirements

Intravenous morphine and sufentanil consumption over the first 24 hours postoperatively were reported by 3 trials (5, 8, 13) and 5 trials (3, 9, 15, 17, 18), respectively. Compared with the TAPB group, the QLB group consumed less morphine (MD=-2.94; 95% CI: -3.47, -2.41; P<0.00001) and sufentanil (MD=-1.50; 95% CI: -1.77, -1.23; P<0.00001) during the first postoperative day. The number of patients who required rescue analgesia was lower in the QLB group (RR=0.14; 95% CI: 0.08, 0.25; P<0.00001) (3, 4, 6, 15). Moreover, the time to first rescue analgesic was significantly longer in the QLB group than in the TAPB group (4, 5, 12, 13, 16, 18). (Table 2, Figure 7)

Meta-analysis of side effect incidences

The rate of PONV, recorded by 6 trials (9, 10, 14, 15, 17, 18), was higher in the TAPB group (RR: 0.36; 95% CI: 0.22, 0.59; P<0.00001). The rate of dizziness was also higher in the TAPB group (RR: 0.45; 95% CI: 0.26, 0.77; P=0.004) (9, 10, 17). (Table 2, Figure 8)
Meta-analysis of comfort scores

BCS (Bruggemann comfort scale) scores were reported by only 2 trials (3, 10) at 2 h, 12 h, and 24 h postoperatively. There was no significant difference between the two groups in BCS scores at 2 h (MD=0.97; 95% CI: 0.01, 1.93; P=0.05), while the QLB group showed higher BCS scores at 12 h (MD=0.48; 95% CI: 0.32, 0.63; P=0.005) and 24 h (MD=0.72; 95% CI: 0.18, 1.25; P=0.008). (Table 2, Figure 9) Two trials (15, 18) indicated that patients in the QLB group were more satisfied than those in the TAPB group.

Discussion

This systematic review and meta-analysis of 15 RCTs including 1013 patients, comparing the postoperative analgesia provided by the QLB and the TAPB, demonstrated that the QLB was more effective for abdominal surgery, with a significantly increased analgesic effect, lower rescue analgesic requirements, and increased comfort of patients. The efficacy of the QLB for abdominal surgery has previously been reported. Murouchi et al. (19) reported that the QLB, compared with the TAPB, resulted in more widespread and long-lasting postoperative analgesia in laparoscopic ovarian surgery, which was a similar conclusion to that of our study. A recent meta-analysis compared the posterior TAPB technique, similar to the QLB type 1, with the lateral TAPB technique, which is widely employed. It showed that the posterior TAPB group required less morphine postoperatively (20). To the best of our knowledge, this present study is the first systematic review and meta-analysis to compare the analgesic effects of the QLB and TAPB for abdominal surgery.

We observed that VAS scores at rest at 0–1, 2, 4, 6, 8, 12, and 24 h, and at movement at 24 and 48 h, were lower in the QLB group, and postoperative analgesic consumption was also lower, compared with that of the TAPB group. The QLB covers the T7 to the L1 dermatomes (21), while the lateral and posterior TAPB affect T10–T12 and the subcostal TAPB affects T7 to T10 (22). Although the mechanism of the QLB is still unknown, the thoracolumbar fascia (TLF) is a key factor for the extensive analgesic effect of the QLB. The TLF is a complex tubular structure constructed from connective tissue, full of mechanoreceptors and a high-density network of sympathetic fibers. The local anesthetics injected in...
the QLB spread along the endothoracic fascia and TLF into the paravertebral space or in the thoracolumbar plane, contributing to somatic and visceral analgesia(21). However, the TAPB can only block visceral nerves to reduce pain in the abdominal wall and muscles. Zhou et al.(23) demonstrated that the analgesic effect of the TAPB was unsatisfactory in patients who underwent laparoscopic hysterectomy, revealing the disadvantage of the TAPB for abdominal visceral surgery, although the TAPB has been broadly applied to various abdominal surgeries(20).

In our study, the time to first rescue analgesic was significantly longer in the QLB group than in the TAPB group. The speed of local anesthetic absorption into the blood is lower in the QLB, as a result of the low perfusion of the local adipose tissue from the TLF and endothoracic fascia to the paravertebral space, leading to long-lasting analgesia(19). Therefore, the analgesic effect of the QLB is sustained for longer than that of the TAPB with the same dose of ropivacaine(19, 24).

The incidences of PONV and dizziness (side effects of opioid drug consumption) were lower in the QLB group, indicating that the QLB can be considered a safe method for abdominal surgery. However, Zhu et al.(10) discovered that Bromage scale scores, a measure of movement disorder in the lower limbs, were higher in the QLB group than in the TAPB group, indicating that the QLB may influence the myodynamia of the lower limbs. In one case, after laparoscopic gynecological surgery, it was reported that unilateral weaknesses in flexion and knee extension were experienced, lasting for approximately 18 hours after the QLB(25). Carline et al.(26) applied the QLB to 10 cadavers and reported that the L1–L3 nerve roots were mostly affected. Therefore, even though the QLB is a safe nerve block, more attention should be paid to the myodynamia of the lower limbs, to avoid patients falling out of bed.

To date, there are 3 types of QLB, according to the needle approach and the drug injected. Our study included 10 trials that used QLB type 1 (anterolateral approach), 3 trials that used QLB type 2 (posterior approach), and 2 trials that used QLB-TM (trans-muscular approach between theQL and psoas muscles). Blanco et al.(8) suggested that QLB type 2 could be more effective and safer than the other two types due to its superficial point of injection. As the observation index was inconsistent, we were unable to divide the studies into subgroups. Further research may focus on the distinction between the different QLB types and other truncal nerve blocks.
There were several limitations to this meta-analysis. First, it should be taken into account that the included studies were heterogeneous. Studies varied in surgery, drug used for the nerve block (ropivacaine or bupivacaine), timing of the nerve block (before or after surgery), the QLB approach (type 1, type 2, or type-TM), and the TAPB approach (lateral, posterior, or subcostal). This heterogeneity may limit the clinical combinability of the results. Further studies are needed to assess the impact of these variables. Second, 3 trials failed to blind their outcome assessment, which may have led to detection bias. Third, conference abstracts and in-progress trials were excluded and only trials published in English or Chinese languages were included, which may be an additional source of clinical heterogeneity.

Conclusion
In conclusion, this study suggested that use of the QLB in abdominal surgery improves postoperative outcomes, reducing postoperative opioid consumption and promoting the satisfaction of patients.

Abbreviations
QLB
quadratus lumborum block
TAPB
transversus abdominis plane block
PRISMA
preferred reporting items for systematic review and meta-analyses
VAS
visual analog scale
PONV
postoperative nausea and vomiting
BCS
Bruggemann comfort scale
RCT
randomized controlled trial
SMD
standard mean difference
CI
confidence interval
FLACC
face, legs, activity, cry, consolability

POAS
pediatric objective pain scale

TLF
thoracolumbar fascia

QLB-TM
quadratus lumborum block trans-muscular

Declarations

1. Ethics approval and consent to participate[Not applicable.]
2. Consent for publication[Not applicable.]
3. Competing interests[The authors declare that they have no competing interests.]
4. Funding[The authors declare that they have no funding.]
5. Authors' contributions[Jc and CC searched the articles and analyzed the data regarding the QLB and TAPB. GS and CG verified the data. WY, JC and CC were the major contributors in writing the manuscript. All authors read and approved the final manuscript.]
6. Acknowledgements[Not applicable.]

Availability of data and material

We declared that materials described in the manuscript, including all relevant raw data, will be freely available to any scientist wishing to use them for non-commercial purposes, without breaching participant confidentiality.

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Tables

*Table 1 Basic characteristics of the reviewed trials. GA: general anesthesia; PCA: patient-controlled analgesia*

| Author/year | Surgery                | Ages (years) | Anesthesia | Group(n)                  | Block solution                     | Block timing | Postoperative analgesia |
|-------------|------------------------|--------------|------------|---------------------------|------------------------------------|--------------|-------------------------|
| Blanco2016  | Caesarean Section      | 19-63        | GA         | QLB (38) Lateral TAP (38) | 0.125% bupivacaine 0.2mg/kg        | after        | PCA: morphine           |
| Han2017     | Appendectomy           | 1-7          | GA         | QLB (39) Lateral TAP (39) | 0.25% ropivacaine 20 ml            | before       | PCA: sufentanil         |
| Oksüz2017   | Low Abdominal Surgery  | 18-60        | GA         | QLB (35) Lateral TAP (35) | 0.25% ropivacaine 20 ml            | after        | iv: tramadol            |
| Kumar2018   | Lower Abdominal Surgery| 22-30        | Spina      | QLB (30) Lateral TAP (30) | 0.25% ropivacaine 20 ml            | before       | iv morphine             |
| Yousef2018  | Total Abdominal Hysterectomy | 45-60     | GA         | QLB (30) Lateral TAP (30) | 0.25% ropivacaine 20 ml            | before       | iv morphine             |
| Baytar2019  | Laparoscopic Cholecystectomy | 18-75    | GA         | QLB (54) Subcostal TAP (53) | 0.25% bupivacaine 0.3 ml/kg        | before       | PCA: tramadol           |
| Cai2019     | Caesarean Section      | 18-40        | Spina      | QLB (35) Lateral TAP (35) | 0.3% ropivacaine 20 ml             | before       | PCA: sufentanil         |
| Fu2019      | Inguinal Hernia Repair | 0.5-14       | GA         | QLB (35) Lateral TAP (35) | 0.25% of bupivacaine 0.25 ml /kg   | before       | oral: paracetamol       |
| Ipek2019    | Lower Abdominal Surgery| 65-80        | GA         | QLB (31) Lateral TAP (31) | 0.5% ropivacaine 20 ml             | before       | PCA: sufentanil         |
| Jiang2019   | Colorectal Open Surgery| 65-80        | GA         | QLB (30) Posterior TAP (30) | 0.2% ropivacaine 0.2 ml /kg        | after        | PCA: tramadol           |
| Verma2019   | Caesarean Section      | 27-78        | GA         | QLB (30) Lateral TAP (30) | 0.25% ropivacaine 20 ml            | before       | PCA: sufentanil         |
| Yang2019    | Gynecology Laparotomy Surgery | 65-74   | GA         | QLB (39) Lateral TAP (39) | 0.25% ropivacaine 20 ml            | before       | PCA: sufentanil         |
| Ye2019      | Laparoscopic Cholecystectomy | 65-74     | GA         | QLB (30) Lateral TAP (28) | 0.33% ropivacaine 20 ml            | before       | PCA: sufentanil         |
| Zhu2019     | Gastrectomy            | 65-74        | GA         | QLB (30) Lateral TAP (39) | 0.25% ropivacaine 20 ml            | before       | PCA: sufentanil         |

*Table 2 Outcomes of the reviewed trials. VAS: visual analogue scale; PONV: postoperative nausea and vomiting; BCS: Bruggemann comfort scale*
| Outcome                                      | Studies included | QLB number | TARB number | RR or Std. Mean Difference [95% CI] | P-value for statistical significance | P-value for heterogeneity | I² test for heterogeneity |
|----------------------------------------------|------------------|------------|-------------|-------------------------------------|--------------------------------------|--------------------------|--------------------------|
| Rest VAS at 0-1h                             | 4                | 125        | 126         | -0.92 [-1.76, -0.08]               | 0.03                                 | <0.00001                 | 90%                      |
| Rest VAS at 2h                               | 8                | 259        | 259         | -1.03 [-1.23, -0.83]               | <0.00001                             | <0.00001                 | 84%                      |
| Rest VAS at 4h                               | 8                | 268        | 268         | -1.33 [-1.96, -0.71]               | <0.00001                             | <0.00001                 | 99%                      |
| Rest VAS at 6h                               | 5                | 156        | 156         | -1.48 [-2.33, -0.63]               | 0.0006                               | <0.00001                 | 89%                      |
| Rest VAS at 8h                               | 4                | 134        | 133         | -1.21 [-2.28, -0.14]               | 0.02                                 | <0.00001                 | 94%                      |
| Rest VAS at 12h                              | 10               | 329        | 328         | -1.19 [-1.74, -0.64]               | <0.00001                             | <0.00001                 | 90%                      |
| Rest VAS at 24h                              | 10               | 299        | 298         | -0.87 [-0.98, -0.76]               | 0.001                                | <0.00001                 | 93%                      |
| Rest VAS at 48h                              | 5                | 165        | 164         | -0.11 [-0.23, 0.01]                | 0.06                                 | 0.99                     | 0%                       |
| Movement VAS at 24h                          | 3                | 95         | 95          | -0.83 [-1.15, -0.50]               | <0.00001                             | <0.00001                 | 96%                      |
| Movement VAS at 48h                          | 3                | 95         | 95          | -3.27 [-6.40, -0.14]               | 0.04                                 | <0.00001                 | 98%                      |
| Intravenous morphine consumption for 24h     | 3                | 103        | 103         | -2.94 [-3.47, -2.41]               | <0.00001                             | 0.18                     | 42%                      |
| Intravenous sufentanil consumption for 24h   | 5                | 165        | 165         | -1.50 [-1.77, -1.23]               | <0.00001                             | <0.00001                 | 96%                      |
| Number of patients with rescue analgesic requirement | 6             | 180        | 180         | 0.36 [0.27, 0.46]                  | <0.00001                             | 0.92                     | 0%                       |
| Time for first rescue analgesia              | 4                | 131        | 125         | 4.51 [2.10, 6.92]                  | 0.002                                | <0.00001                 | 98%                      |
| Incidence of PONV                            | 6                | 199        | 195         | 0.36 [0.22, 0.59]                  | <0.00001                             | 0.86                     | 0%                       |
| Incidence of dizziness                       | 3                | 108        | 105         | 0.45 [0.26, 0.77]                  | 0.04                                 | 0.86                     | 0%                       |
| BCS 2h                                       | 2                | 74         | 74          | 0.97 [0.01, 1.93]                  | 0.05                                 | 0.006                    | 87%                      |
| BCS 12h                                      | 2                | 74         | 74          | 0.48 [0.32, 0.63]                  | 0.005                                | 0.03                     | 78%                      |
| BCS 24h                                      | 2                | 74         | 74          | 0.72 [0.18, 1.25]                  | 0.008                                | 0.11                     | 61%                      |

**Implication Statement:**
In our study, we found that QLB leads to significantly better outcomes in terms of postoperative VAS scores, opioid consumption, incidence of side effects, and patient satisfaction when compared with TAPB following abdominal surgery.

**Figures**
transverse abdominis OR transversus abdominis OR transversus abdominis plane block OR transverse abdominis plane block OR TAP OR TAP block

Quadratus lumborum block OR QLB OR QL Block

442 records
PubMed 105  EMBASE 132
Cochrane 33  Medline 61
CNKI 111

357 records after removing duplicates

337 excluded records

22 articles assessed

7 articles did not fulfill Inclusion criteria
1 not RCT
1 not for abdominal surgery
1 for chronic pain
4 high risk of bias

15 trials included

Figure 1
Flowchart summarizing retrieved, included, and excluded RCTs
Methodological quality. (A) Risk of bias summary of the randomized controlled trials, (B) Risk of bias graph of the randomized controlled trials. Green circle = low risk of bias, red circle = high risk of bias, yellow circle = unclear risk of bias.
Figure 3

Rest VAS at 0-1h, 2h, 4h. (A) Forest plot of Rest VAS at 0-1h, (B) Forest plot of Rest VAS at 2h, (C) Forest plot of Rest VAS at 4h.
Rest VAS at 6h, 8h, 12h. (A) Forest plot of Rest VAS at 6h, (B) Forest plot of Rest VAS at 8h, (C) Forest plot of Rest VAS at 12h.
Figure 5

Rest VAS at 24, 48h. (A) Forest plot of Rest VAS at 24h, (B) Forest plot of Rest VAS at 48h.

Figure 6

Movement VAS at 24, 48h. (A) Forest plot of Movement VAS at 24h, (B) Forest plot of Movement VAS at 48h.
**Figure 7**

Requirement of postoperative analgesia. (A) Forest plot of intravenous morphine consumption for postoperative 24h, (B) Forest plot of intravenous sufentanil consumption for postoperative 24h, (C) Forest plot of number of patients with rescue analgesic requirements, (D) Forest plot of time for first rescue analgesia.
Incidence of PONV and dizziness. (A) Forest plot of incidence of PONV, (B) Forest plot of incidence of dizziness, PONV: postoperative nausea and vomiting.
Postoperative BCS. (A) Forest plot of BCS at 2h, (B) Forest plot of BCS at 2h, (C) Forest plot of BCS at 2h, BCS: Bruggemann comfort scale.

Supplementary Files
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