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REVIEW

Quadratus Lumborum Block for Pain Management After Colorectal Surgery: Systematic Review and Meta-Analysis of Analgesic and Opioid-Sparing Effects

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Objective: Quadratus lumborum block (QLB) is an emerging regional anesthesia technique, and its efficacy in colorectal surgery (CRS) remains unclear. This systematic review and meta-analysis aimed to evaluate the effect of QLB on pain control, opioid consumption, and postoperative nausea and vomiting (PONV) after CRS.

Methods: Relevant articles were acquired from PubMed, Cochrane, Embase, Web of Science, and Scopus from inception to October 9, 2024. The effect of QLB on post-colorectal surgery analgesia, opioid consumption, and secondary outcomes, including time to first analgesic request (TFAR), length of hospital stay (LOS), and PONV, was assessed using mean difference (MD) or relative risk (RR) and corresponding 95% confidence interval (CI).

Results: Six studies involving 465 patients were included. QLB significantly reduced the active visual analogue scale (VAS-A) scores at 12 h (MD = −1.06; 95% CI = −1.89, −0.22; P = 0.014) and 24 h (MD = −0.81; 95% CI = −1.19, −0.43; P = 0.000) after CRS compared to sham or no block. However, QLB did not significantly decrease VAS-A at 48 h, or resting VAS (VAS-R) at 12 h, 24 h, or 48 h after surgery. Additionally, QLB had no impact on opioid consumption at 24 h and 48 h after surgery, overall postoperative opioid consumption, or opioid consumption in PACU. Likewise, QLB did not prolong TFAR, shorten LOS, or reduce the incidence of PONV.

Conclusion: QLB effectively relieves active postoperative pain following CRS. While it does not significantly reduce resting pain, opioid consumption, or complications, it has potential benefits in analgesia and recovery.

Keywords: colorectal surgery, pain, postoperative, quadratus lumborum block, regional anesthesia

Introduction

Postoperative pain management is essential for recovery after colorectal surgery (CRS). Effective pain control enhances postoperative comfort, shortens hospital stays, lowers the risk of complications, and promotes faster rehabilitation.[1,2] However, due to the multifactorial nature of postoperative pain, achieving optimal analgesia in CRS remains challenging. Although conventional opioid-based regimens are effective for pain control, their adverse effects, including impaired gastrointestinal motility, increased risk of postoperative nausea and vomiting (PONV), and postoperative ileus, are collectively referred to as opioid-induced bowel dysfunction (OIBD), which runs counter to the principles of enhanced recovery after surgery (ERAS). Within the ERAS framework, achieving optimal pain control while ensuring early mobilization and timely restoration of bowel function presents unique challenges in CRS.[3] These challenges have driven a shift toward multimodal analgesic therapy in postoperative pain management.[4] Epidural analgesia has traditionally been the most common method for postoperative pain management following abdominal surgery, as it provides effective analgesia and may reduce the incidence of cardiopulmonary complications. Nevertheless, its use in CRS has gradually declined due to potential hypotension caused by sympathetic blockade, procedure-related complications, and the

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emergence of less invasive regional analgesic techniques in the context of ERAS.[5–7] The efficacy of the recently introduced transabdominal plane block (TAPB) remains controversial. While early studies indicated that TAPB could be beneficial for postoperative pain management, more recent research suggests it is ineffective in reducing postoperative complications and does not offer significant benefits for patients postoperatively. As a result, there is an increasing demand for regional block techniques that provide more effective analgesia in clinical practice.[8,9]

Quadratus lumborum block (QLB) is a novel abdominal and trunk block technique that involves the ultrasound-guided injection of local anesthetic agents around or directly into the quadratus lumborum muscle (QLM). Four main approaches to QLB have been described: lateral QLB (QLB 1), posterior QLB (QLB 2), anterior QLB (transmuscular QLB), and intramuscular QLB.[10,11] The analgesia achieved by QLB can partly be attributed to the spread of local anesthetics along the thoracolumbar fascia (TLF) and intrathoracic fascia, which extends into the paravertebral space or travels along the visceral nerves to the celiac ganglia or sympathetic trunk, ultimately providing both somatic and visceral analgesia.[12] In contrast to TAPB, which is largely ineffective at blocking visceral pain, QLB offers both somatic pain control and effective visceral pain blockade. This advantage has led some clinicians to adopt QLB in colorectal surgery.[13]

With the growing use of ultrasound-guided QLB in clinical practice, numerous clinical studies have established its effectiveness in pain management following caesarean sections and renal surgeries. However, the efficacy and benefits of QLB in CRS remain uncertain and debated.[14] There is currently no meta-analysis assessing the impact of QLB in CRS. Therefore, this systematic review and meta-analysis evaluated the effect of QLB on postoperative analgesia and opioid consumption following CRS, providing evidence to support its clinical application.

Materials and Methods

Registration

This work was registered on PROSPERO (CRD42024602844) and conducted in accordance with the PRSIMA 2020 statement.[15]

Search Strategy

Original studies investigating the role of QLB in post-CRS analgesia and opioid consumption were collected by two researchers from PubMed, Cochrane, Embase, Web of Science, and Scopus since inception until October 9, 2024, using subject terms and broad free terms including colorectal surgery and quadratus lumborum block (Supplementary Table 1). Potentially relevant unpublished studies were also retrieved from the World Health Organization International Clinical Trials Registry Platform (www.who.int/ictrp/search/en/), Cochrane Controlled Trial Registry (https://www.cochranelibrary.com/central/) International Standard Register of Randomized Controlled Trials Number (www.isrctn.com), and http://ClinicalTrials.gov.

Eligibility Criteria

Studies were selected based on the PICO (Population, Intervention, Comparison, and Outcome) framework: (1) Population: adult patients (≥18 years) undergoing CRS under general anesthesia; (2) Exposure: QLB by injecting anesthetic agents into the QLM; (3) Comparison: placebo injection for sham block (sham block group) or general anesthesia alone (no block group); (4) Outcome: outcome measures for analgesic effect (opioid consumption, postoperative pain score or time of first opioid request) or results reflecting the quality of postoperative recovery [number of PONVs and length of hospital stay (LOS)]; (5) Study design: randomized controlled trial (RCT) or cohort study. Exclusion criteria: (1) Non-human studies, conference abstracts, letters, case reports, meta-analysis, reviews, and book chapters; (2) Published in a non-English language; (3) Inaccessible full-text; (4) Unextractable or unusable data.

Literature Screening and Data Extraction

Two researchers separately imported the initial search results into EndNote 20 to exclude duplicates, screened the titles and abstracts to identify potentially eligible articles, and reviewed their full texts against the eligibility criteria. The

references of all included studies were also reviewed to identify other eligible studies. Any disagreement that arose during the process was settled by another researcher.

Two researchers separately gathered data from the included studies into a predefined data extraction table Data extracted included authors, publication year, country, study design, age, type of surgery, sample size, QLB characteristics (approach of block, timing of block, type and dosage of local anesthesia), comparators, postoperative analytics, and results of interest, including postoperative opioid consumption, time to first analgesic request (TFAR), LOS, PONV, and postoperative pain scores. In studies presenting data in alternative formats, statistical transformation methods were applied to derive the mean and standard deviation (SD) needed for meta-analysis. Numerical data presented in graphical form were digitized and extracted using Engauge Digitizer (version 12.1, https://markummitchell.github.io/engauge-digitalizer/). Discrepancies between the two researchers were addressed by another researcher.

Quality Assessment

Two researchers used the Cochrane risk of bias tool 2.0 (RoB2.0)[16] to independently assess the potential for bias in RCTs across five domains, including bias arising from the randomization process, bias due to deviations from intended interventions, bias due to missing outcome data, bias in the measurement of the outcome, and bias in the selection of the reported results. Based on the pathway diagram, the risk of bias (RoB) for each domain was classified as "low risk", "some risk", or "high risk". The Newcastle-Ottawa Scale (NOS)[17] was employed to evaluate the RoB in cohort studies in terms of selection, comparability, and outcome. The total maximum score is nine, with seven to nine indicating high quality, four to six representing medium quality, and below four suggesting low quality. Inconsistency in findings between the two researchers was settled by another researcher.

Statistical Analysis

Data were pooled and statistically analyzed using Stata/MP 15. The Higgins I^2 index[18] and Cochran's Q test[19] were used to determine the presence of heterogeneity. When $I^2 > 50\%$ and $P < 0.05$, a random effects model (REM) was used; otherwise, a fixed effects model (FEM) was applied. Continuous variables, including opioid consumption, postoperative pain score, TFAR, and LOS, were assessed using MD and 95% CI. Where applicable, dichotomous data (eg, PONV) were analyzed using RR and 95% CI. The pooled results and corresponding 95% CIs are presented in forest plots. To explore potential sources of heterogeneity among the included studies, sensitivity analyses were conducted by sequentially omitting individual studies and assessing their impact on the pooled results. Meta-regression was performed to examine the influence of covariates on the effect size. Subgroup analyses were carried out to evaluate the consistency of treatment effects across different clinical settings.

Results

Literature Screening

Of the 715 studies initially retrieved from the databases, 154 were deleted due to duplication and 545 were removed after title and abstract screening due to ineligibility. After a thorough review of the remaining 16 articles, 10 were eliminated due to unavailable full texts, and the remaining 6[20–25] were eligible and included in this study. The search process is detailed in Figure 1.

General Study Characteristics

The six studies were published between 2018 and 2024 and carried out in 4 countries (Table 1). There were 465 patients and the sample size ranged from 56 to 148. Of these six studies, five were RCTs[20,21,23–25] and one was a retrospective cohort study.[22] The patients had a mean age of 51.9 to 68.6 years. Four studies[21,23–25] involved laparoscopic colorectal surgery, one study[20] involved laparoscopic colectomy, and one study[22] involved open colectomy. Sham block was used as a control in five studies[20,21,23–25] while no block was used in one study.[22] All six studies[20–25] utilized ropivacaine as the local anaesthetic for QLB. Morphine was used for postoperative opioid analgesia in 4 studies,[20,21,23,24] whereas sufentanil was used in the other 2 studies.[22,25]

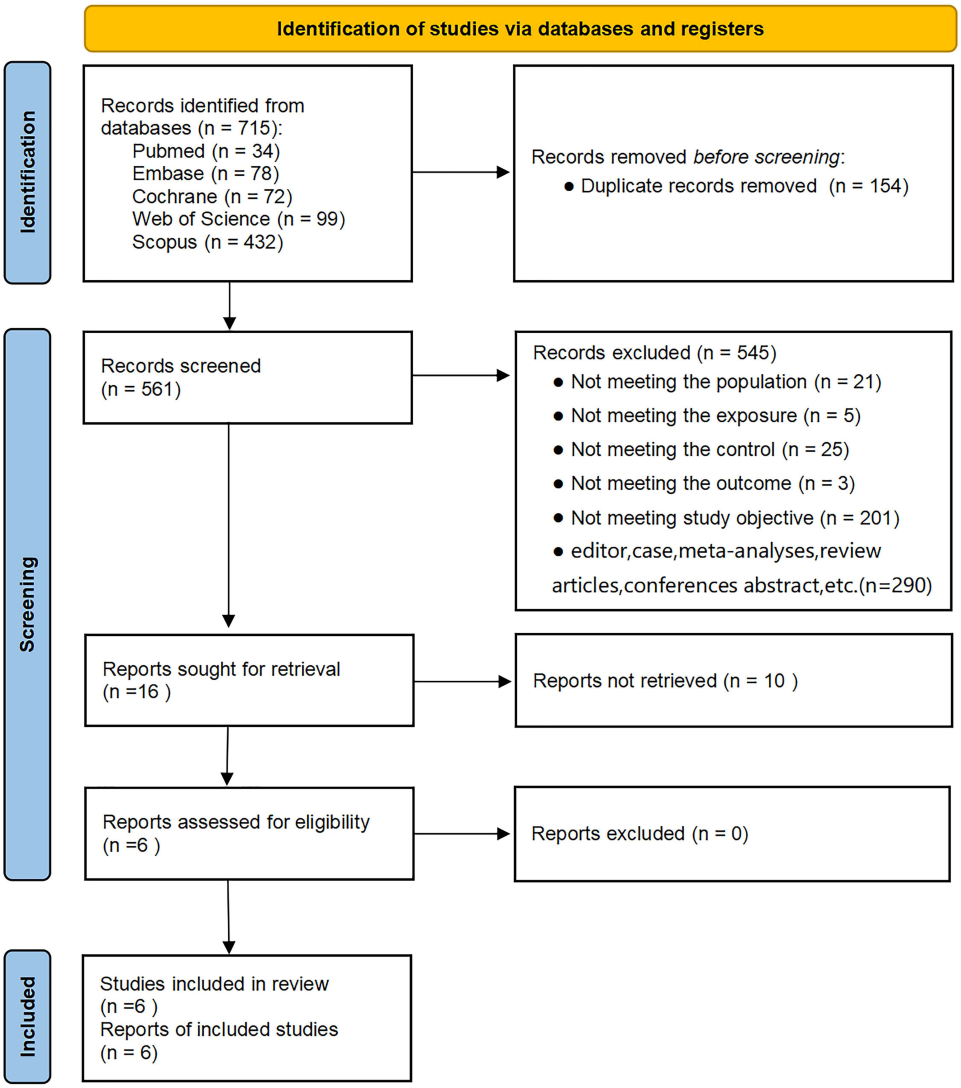

Figure 1 Flow diagram of the search process.

Quality Assessment

Quality assessment using the RoB 2.0 showed low risk for three RCTs[20,21,24] and some risk for two RCTs.[23,25] Quality assessment of the study by Wang et al[22] using the NOS yielded scores of 4 for selection, 2 for comparability, and 3 for outcome, totaling a score of 9, indicative of high methodological quality. The overall RoB and the RoB of each study are presented in Figures 2 and 3, respectively.

Meta-Analysis

Postoperative Opioid Consumption

24-Hour Postoperative Opioid Consumption

Five studies[20,21,23–25] involving 409 patients reported 24-hour postoperative opioid consumption. Tanggaard et al, Coppens et al, and Boulianne et al[20,21,23] reported comparable opioid consumption within 24 h after surgery between the QLB and sham block groups (P=0.93, P=0.966, and P=0.81, respectively). However, Dewinter et al[24] indicated significantly higher cumulative morphine dose within 24 hours after CRS in the QLB group compared to the sham block group. On the other hand, Wang et al[25] showed significantly lower cumulative sufentanil consumption within 0–6 hours, 6–12 hours, and 12–24 hours after CRS in the QLB group compared to the sham block group ($P < 0.05$).

Table 1 General Study Characteristics

Authors	Year	Country	Study Design	Age (mean ± SD)	Type of Surgery	Sample Size		Intervention(s)	Comparator	Approach of QLB	Timing of Block	Postoperative Analgesics
						QLB	Control					
Katrine Tanggaard et al[20]	2023	Denmark	RCT	68.6 ± 7.5	Laparoscopic or robot-assisted hemicolectomy	33	31	0.375% Ropivacaine 60 mL	Sham block (isotonic saline)	Anterior	Before induction of anesthesia	PCA morphine; oral paracetamol
S. Coppens et al[21]	2024	Belgium	RCT	62.3 ± 11.1	Laparoscopic colorectal surgery	75	73	0.375% Ropivacaine 60 mL	Sham block (0.9% normal saline)	Anterior	Before induction of anesthesia	PCA morphine; paracetamol; ketorolac; morphine; tramadol; ketamine; metamizole
Ying Wang et al[22]	2021	China	R	51.9 ± 4.8	Open radical resection of colon cancer	27	29	0.3% tropivacaine 0.4 mL/kg	No block	Anterior	Before induction of anesthesia	PCA sufentanil; sufentanil
Mélissa Boulianne et al[23]	2020	Canada	RCT	63.5 ± 16.6	Laparoscopic colonic or rectal resection	31	31	0.375% propivacaine 40 mL	Sham block	Posterior	After induction of anesthesia	Acetaminophen; xylocaine; morphine
Geertrui Dewinter et al[24]	2018	Belgium	RCT	59.2 ± 11.7	Laparoscopic colorectal surgery	50	25	0.25% ropivacaine 60 mL (weighing >55 kg) or 40 mL (weighing <55 kg) and clonidine 0.5mg/kg	Sham block (saline)	Not reported	Before induction of anesthesia	PCA morphine; acetaminophen; ketorolac
Danfeng Wang et al[25]	2021	China	RCT	59.3 ± 8.5	Laparoscopic colorectal surgery	31	29	0.33% tropivacaine 0.4 mL/kg	Sham block (0.9% normal saline)	Lateral	After induction of anesthesia	PCA sufentanil; flurbiprofen

Abbreviations: RCT, randomized controlled trial; R, retrospective cohort; QLB, quadratus lumborum block; PCA, patients controlled analgesia; SD, standard deviation.

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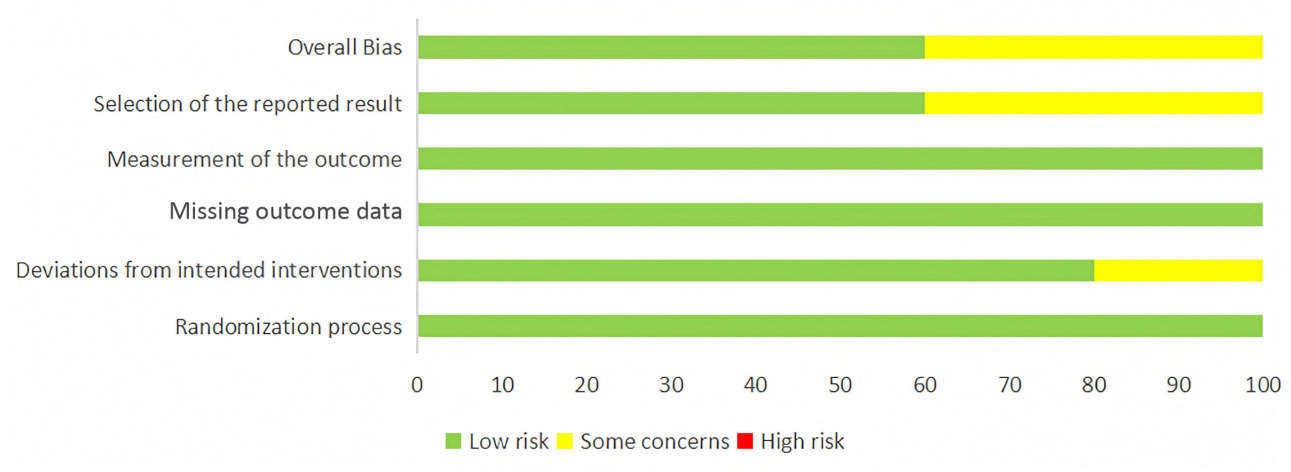

Figure 2 Overall risk of bias in RCTs.

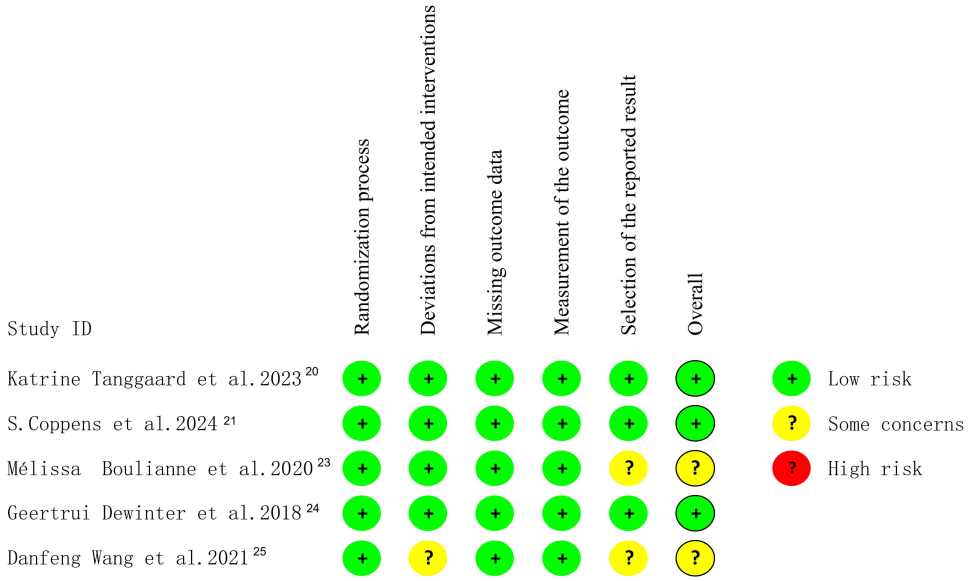

Figure 3 Risk of bias in individual RCTs.

Meta-analysis (I^2 = 81.6%, P = 0.000; REM) revealed a pooled MD of −0.07 (95% CI, −0.55 to 0.41; z = 0.29; P = 0.775) (Figure 4A), suggesting a possible decrease in 24-hour opioid consumption with QLB compared to no block/sham block. However, the difference was non-significant.

Given that one study employed sufentanil[25] while the other four[20,21,23,24] used morphine at 24 hours after surgery, a sensitivity analysis was carried out by removing this study and the MD was re-calculated using an FEM (I^2 = 37.1%, P = 0.190). The pooled MD was 4.85 (95% CI, −0.94 to 10.64; z = 1.64; P = 0.101) (Figure 4B), demonstrating no significant difference between QLB and the sham block. Collectively, these findings indicated that the pooled data were robust and that the variation in opioid type was unlikely to be a source of heterogeneity.

Our subgroup analysis indicated that both the subgroup receiving QLB before anesthesia induction (MD, 0.17; 95% CI, −0.17 to 0.50; P = 0.324) and the subgroup receiving QLB after anesthesia induction (MD, −0.49; 95% CI, −1.74 to 0.76; P = 0.439) yielded negative results with respect to opioid consumption within 24 hours after surgery (Figure 4C). This finding suggested that QLB performed either before or after anesthesia induction did not affect the robustness of the results for 24-hour postoperative opioid consumption.

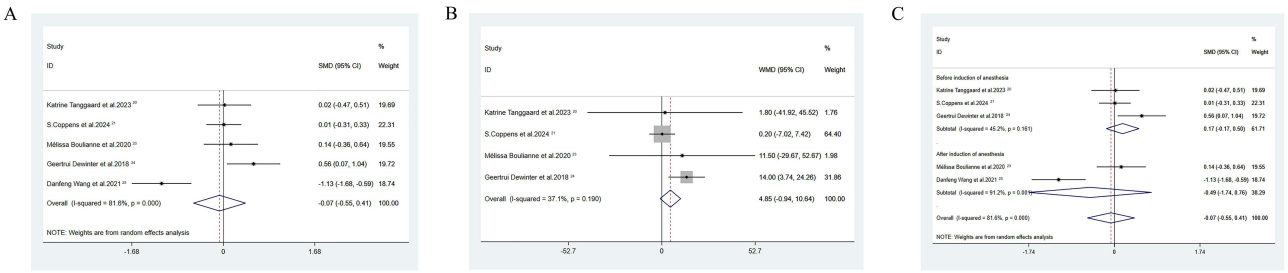

Figure 4 (**A**) Forest plot for 24-hour postoperative opioid consumption. (**B**) Sensitivity analysis of 24-hour postoperative opioid consumption after excluding the study reporting sufentanil use. (**C**) Subgroup analysis of 24-hour postoperative opioid consumption according to timing of block (before induction of anesthesia vs after induction of anesthesia).

Meta-regression analysis showed that different ultrasound-guided approaches did not significantly account for the heterogeneity in 24-hour postoperative opioid consumption (P = 0.399), indicating that the opioid-sparing effect of QLB may be consistent across different QLB approaches in this population.

48-Hour Postoperative Opioid Consumption

Three studies[22,23,25] involving 178 patients reported results for 48-hour postoperative opioid consumption. Wang et al and Wang et al[22,25] reported that the QLB group had significantly lower opioid consumption at 48 hours after CRS compared to the sham/no block group (P < 0.05). In contrast, Boulianne et al[23] showed similar 48-hour opioid consumption between the two groups (P = 0.65).

Meta-analysis (I^2 = 84.9%, P = 0.001; REM) indicated a pooled MD of −0.56 (95% CI, −1.35 to 0.22; z=1.40; P=0.161) (Figure 5A), suggesting a possible but non-significant reduction in 48-hour opioid consumption with QLB compared to no/sham block.

Of the three included studies, two[22,25] used sufentanil for postoperative analgesia, while one[23] measured oral morphine dose equivalent. After exclusion of the Boulianne et al study, meta-analysis (I^2= 55.9%, p=0.132; REM) showed that the pooled MD was −9.26 (95% CI, −14.83 to −3.69; z=3.26; P=0.001) (Figure 5B), indicating significantly lower 48-hour opioid consumption with QLB compared to no/sham block. This finding suggested that the difference in opioid type was a potential source of heterogeneity.

Given that this study included both randomized controlled trials and one retrospective cohort study, a sensitivity analysis was conducted by excluding the non-randomized study[22] to assess the robustness of the results. After excluding this study, heterogeneity was still observed (I^2 = 70.3%, p = 0.066). Although the p-value was greater than 0.05, the random-effects model was still adopted to calculate MD because I^2 exceeded 50%. The pooled MD was −0.21 (95% CI, −0.87 to 0.45; z = 0.63; P = 0.530) (Supplementary Figure 1). The direction and statistical significance of the outcome did not change (both remained nonsignificant), indicating that inclusion of the cohort study did not substantially affect the results for opioid consumption within 48 hours after surgery.

Our subgroup analysis suggested that, with respect to opioid consumption within 48 hours after surgery, the subgroup receiving QLB before anesthesia induction demonstrated a significant opioid-sparing effect (MD, −1.29; 95% CI, −1.87

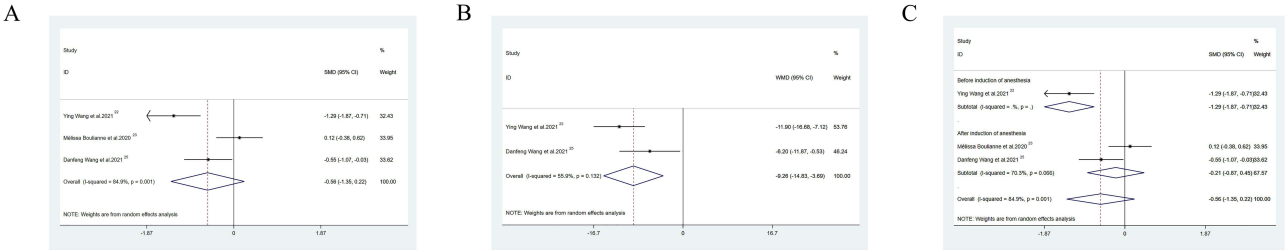

Figure 5 (**A**) Forest plot for 48-hour postoperative opioid consumption. (**B**) Sensitivity analysis of 48-hour postoperative opioid consumption after excluding the study reporting morphine use. (**C**) Subgroup analysis of 48-hour postoperative opioid consumption according to timing of block (before induction of anesthesia vs after induction of anesthesia).

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to −0.71; P = 0.000), whereas the subgroup receiving QLB after anesthesia induction showed no significant opioid-sparing effect (MD, −0.21; 95% CI, −0.87 to 0.45; P = 0.530). This finding indicated that the timing of QLB may influence the stability of the results for opioid consumption within 48 hours after surgery (Figure 5C).

Meta-regression analysis revealed that different QLB approaches did not significantly explain the heterogeneity in 48-hour postoperative opioid consumption (P = 0.654), suggesting that the opioid-sparing effect of QLB within 48 hours may be consistent across different QLB approaches in this population.

Total Postoperative Opioid Consumption

Two studies[21,23] involving 210 patients evaluated total postoperative opioid consumption. Both Coppens et al and Boulianne et al[21,23] reported no notable difference in total opioid use between QBL and sham block (P = 0.989 and P = 0.81, respectively).

Meta-analysis (I^2 = 0.0%, P = 0.975; FEM) revealed a combined MD of −0.79 (95% CI, −6.49 to 4.91; z = 0.27; P = 0.785) (Figure 6A), suggesting lower total postoperative opioid consumption with QLB compared to sham block. However, the difference was non-significant.

Opioid Consumption in PACU

Two studies[23,24] involving 137 patients assessed opioid consumption in the post-anesthesia care unit (PACU). Both studies found comparable opioid consumption in the PACU between the QLB group and the sham block group (P > 0.05).

Meta-analysis (I^2 = 0.0%, P = 0.862; FEM) indicated a pooled MD of 1.88 (95% CI, −3.09 to 6.85; z = 0.74; P = 0.459) (Figure 6B). This finding indicated a slightly higher opioid consumption in the PACU with QLB compared to the sham block, but the difference was non-significant.

TFAR

Two studies[20,24] involving 135 patients reported similar TFAR between the QLB group and the sham block group (P = 0.64 and P = 0.81, respectively).

Meta-analysis (I^2 = 0.0%, P = 0.876; FEM) of the data showed a pooled MD of 4.05 (95% CI, −2.40 to 10.50; z = 1.23; P = 0.218) (Figure 7). This suggests a slightly longer TFAR with QLB compared to the sham block, but the difference was non-significant.

LOS

Three studies[20,23,24] with 201 patients found similar LOS between the QLB group and sham block group (P = 0.26, P = 0.48, and P = 0.73, respectively).

Meta-analysis (I^2 = 17.5%, P = 0.279; FEM) indicated a pooled MD of 0.10 (95% CI, −0.18 to 0.38; z = 0.70; P = 0.485) (Figure 8A), suggesting a slightly longer LOS with QLB compared to sham. However, the difference was non-significant.

The original studies were stratified into two subgroups based on the timing of QLB: before and after anesthesia induction. The analysis showed that QLB did not significantly shorten LOS in either the pre-induction subgroup (MD,

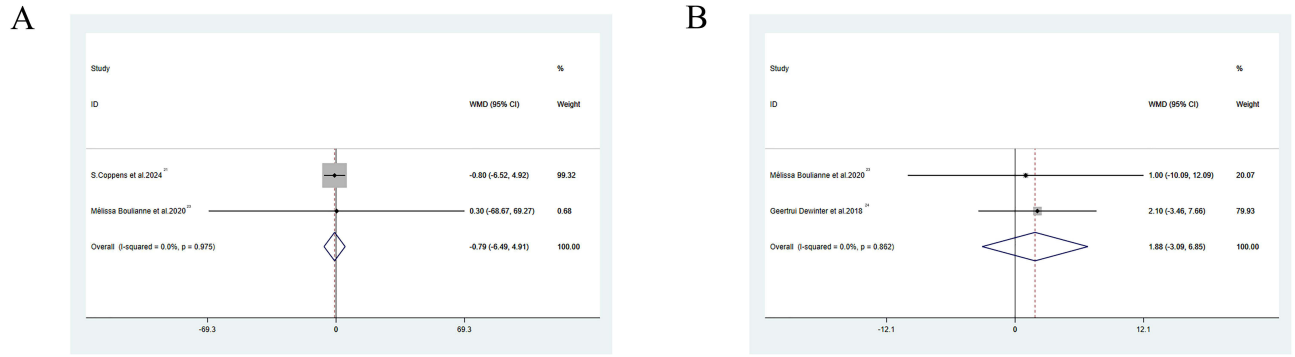

Figure 6 (**A**) Forest plot for total postoperative opioid consumption. (**B**) Forest plot for opioid consumption in the PACU.

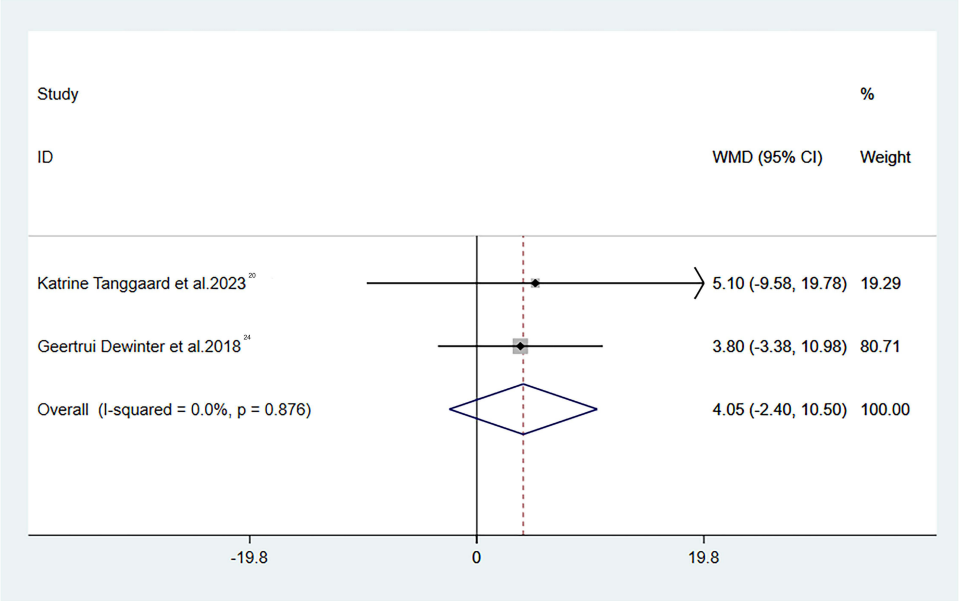

Figure 7 Forest plot for TFAR.

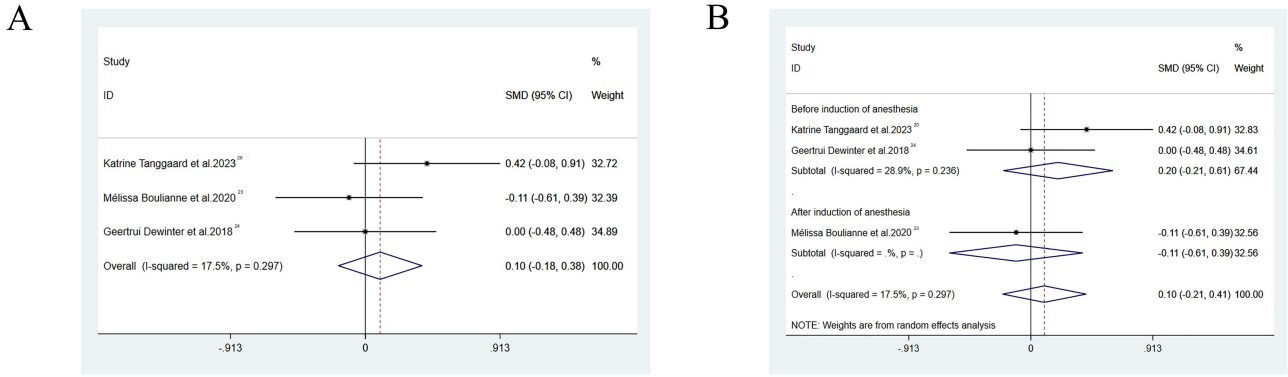

Figure 8 (**A**) Forest plot for LOS. (**B**) Subgroup analysis of LOS according to timing of block (before induction of anesthesia vs after induction of anesthesia).

0.20; 95% CI, −0.21 to 0.61; P = 0.328) or the post-induction subgroup (MD, −0.11; 95% CI, −0.61 to 0.39; P = 0.665) (Figure 8B). This finding suggested that the timing of the block may not affect the stability of LOS outcomes.

Meta-regression analysis indicated that differences in QLB approaches did not significantly explain the heterogeneity in LOS (P = 0.461), implying that the effect of QLB on LOS may be consistent across different QLB approaches in this population.

PONV

Four studies[20–22,25] with 328 patients showed comparable incidence of PONV between the QLB and no/sham block groups (P > 0.05).

Heterogeneity was observed in this meta-analysis (I^2 = 52.8%, P = 0.096). Despite a P > 0.05, an REM was used to calculate the RR due to I^2 exceeding 50%. The combined RR was 0.88 (95% CI, 0.55 to 1.40; z = 0.54; P = 0.586) (Figure 9A). This finding suggested that the risk of PONV in the QLB group might be numerically lower than in the sham/no-block group, but the difference was not statistically significant.

Given that this outcome included both randomized controlled trials and one retrospective cohort study, a sensitivity analysis was performed by excluding the non-randomized study[22] to assess the robustness of the results. After exclusion, heterogeneity was still observed (I^2 = 53.7%, P = 0.116). A random-effects model was applied to calculate RR because I^2

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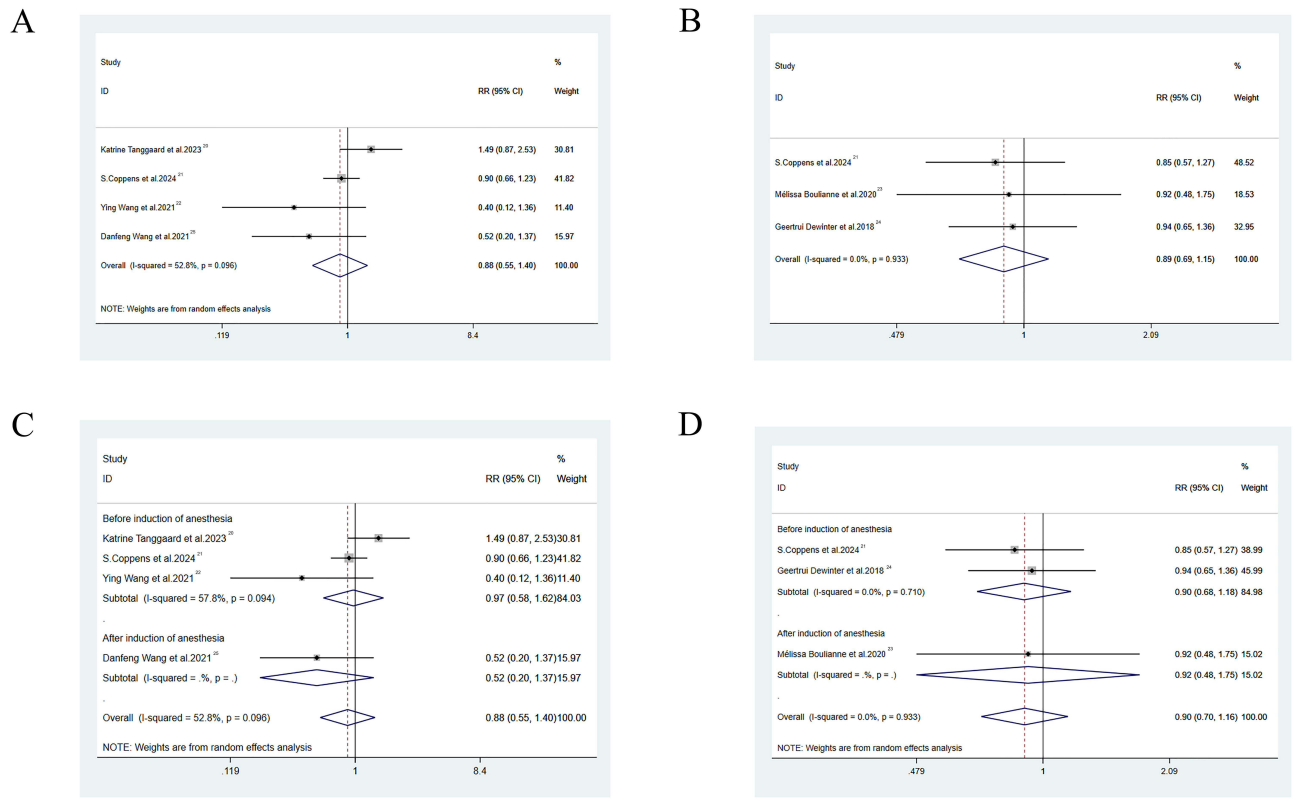

Figure 9 (**A**) Forest plot for PONV. (**B**) Forest plot for 24-hour postoperative PONV. (**C**) Subgroup analysis of PONV according to timing of block (before induction of anesthesia vs after induction of anesthesia). (**D**) Subgroup analysis of 24-hour PONV according to timing of block (before induction of anesthesia vs after induction of anesthesia).

exceeded 50%. The pooled RR was 0.98 (95% CI, 0.62 to 1.55; z = 0.10; P = 0.918) (Supplementary Figure 2), with the statistical significance of the outcome unchanged (both remained nonsignificant). This finding indicated that inclusion of the cohort study did not substantially affect the PONV results.

Three studies[21,23,24] involving 223 patients showed that the QLB group had a comparable incidence of PONV within 24 hours after CRS compared with the sham block group (P > 0.05). Meta-analysis (I^2 = 0.0%, P = 0.933; FEM) yielded an RR of 0.89 (95% CI, 0.69 to 1.15; z = 0.88; P = 0.378) (Figure 9B), indicating that the risk of 24-hour postoperative PONV did not differ significantly between the QLB and sham block groups.

The original studies were stratified into two subgroups based on the timing of QLB: before and after anesthesia induction. The risk of PONV in the QLB group did not differ significantly from the control group in either the pre-induction subgroup (RR, 0.97; 95% CI, 0.58 to 1.62; P = 0.907) or the post-induction subgroup (RR, 0.52; 95% CI, 0.20 to 1.37; P = 0.186) (Figure 9C). Similarly, the risk of 24-hour PONV in the QLB group did not differ significantly from the control group in the pre-induction subgroup (RR, 0.90; 95% CI, 0.68 to 1.18; P = 0.427) or the post-induction subgroup (RR, 0.92; 95% CI, 0.48 to 1.75; P = 0.793) (Figure 9D). This finding indicated that the timing of QLB did not affect the stability of PONV or 24-hour PONV outcomes.

Meta-regression analysis showed that differences in QLB approaches did not significantly account for the heterogeneity in PONV (P = 0.506) and 24-hour PONV (P = 0.803), suggesting that the effect of QLB on PONV may be consistent across different QLB approaches in this population.

Visual Analog Scale (VAS)

Resting Visual Analog Scale (VAS-R)

Three studies[22,23,25] measured postoperative VAS-R at 12, 24, and 48 hours. Meta-analysis (I^2 > 50.0%, P < 0.05; REM) indicated a pooled MD of −0.66 (95% CI, −1.98 to 0.65; z = 0.99; P = 0.323) at 12 h in two studies[22,25] with 116 patients (Figure 10A), −0.24 (95% CI, −1.04 to 0.57; z = 0.58; P = 0.564) at 24 h in three studies[22,23,25] with 178 patients

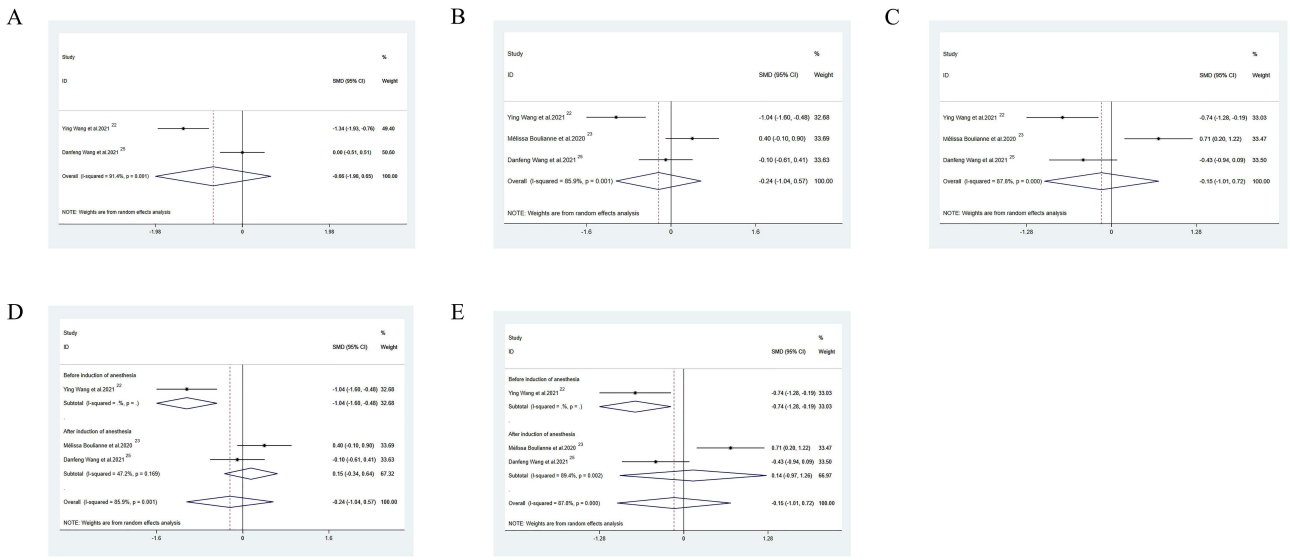

Figure 10 (**A**) Forest plot for 12-hour VAS-R. (**B**) Forest plot for 24-hour VAS-R. (**C**) Forest plot for 48-hour VAS-R. (**D**) Subgroup analysis of 24-hour VAS-R according to timing of block (before induction of anesthesia vs after induction of anesthesia). (**E**) Subgroup analysis of 48-hour VAS-R according to timing of block (before induction of anesthesia vs after induction of anesthesia).

(Figure 10B), and −0.15 (95% CI, −1.01 to 0.72; z = 0.34; P = 0.737) at 48 h in three studies[22,23,25] with 178 patients (Figure 10C). These data indicate that the VAS scores were similar across the three time points in both the QLB and sham/no block groups. Although the VAS scores were lower in the QLB group, the differences were not significant.

As both 24-hour and 48-hour postoperative VAS-R outcomes included randomized controlled trials and one retrospective cohort study, a sensitivity analysis was conducted by excluding the non-randomized study[22] to assess the robustness of the results. After exclusion, heterogeneity for 24-hour VAS-R was low (I^2 = 0.0%, P = 0.379), and a fixed-effects model was adopted to calculate MD. The pooled MD was 0.82 (95% CI, −0.35 to 1.99; z = 1.37; P = 0.171) (Supplementary Figure 3). For the 48-hour postoperative VAS-R, heterogeneity remained high (I^2 = 83.5%, P = 0.014), and a random-effects model was applied to calculate MD. The pooled MD was −0.23 (95% CI, −4.31 to 3.85; z = 0.11; P = 0.912) (Supplementary Figure 4). The statistical significance of both outcomes did not change, indicating that inclusion of the cohort study did not substantially affect the results for 24-hour and 48-hour postoperative VAS-R.

Subgroup analysis based on 24-hour and 48-hour postoperative VAS-R revealed that QLB performed before anesthesia induction significantly reduced 24-hour (MD, −1.04; 95% CI, −1.60 to −0.48; P = 0.000) and 48-hour postoperative VAS-R (MD, −0.74; 95% CI, −1.28 to −0.19; P = 0.008), whereas QLB performed after anesthesia induction did not significantly affect 24-hour (MD, 0.15; 95% CI, −0.34 to 0.64; P = 0.545) or 48-hour postoperative VAS-R (MD, 0.14; 95% CI, −0.97 to 1.26; P = 0.802) compared with the sham block group (Figure 10D and E). These results indicated that the timing of QLB may influence the stability of the results for 24-hour and 48-hour postoperative VAS-R.

Meta-regression analysis showed that different QLB approaches did not significantly explain the heterogeneity in 24-hour postoperative VAS-R (P = 0.560) or 48-hour postoperative VAS-R (P = 0.871), indicating that the effect of QLB on VAS-R may be consistent across different QLB approaches in this population.

VAS-A

Two studies[22,25] analyzed postoperative VAS-A at 12 h, 24 h, and 48 h. The pooled MD was determined using an REM for the 12 h and 48 h time points (I^2 > 50.0%, P < 0.05) and a FEM for the 24 h time point (I^2 = 0.0%, P = 0.565).

The combined MD was −1.06 (95% CI, −1.89 to −0.22; z = 2.47; P = 0.014) at 12 h in two studies[22,25] with 116 patients (Figure 11A), −0.81 (95% CI, −1.19 to −0.43; z = 4.19; P = 0.000) at 24 h in two studies[22,25] with 116 patients (Figure 11B), and −1.02 (95% CI, −2.31 to 0.28; z = 1.54; P = 0.124) at 48 h in two studies[22,25] with 116 patients (Figure 11C). These findings demonstrate that the QLB group had markedly lower VAS-A than the sham/no block group at 12 h and 24 h after CRS. Postoperative VAS-A was also decreased at 48 h in the QLB group, but the difference was non-significant.

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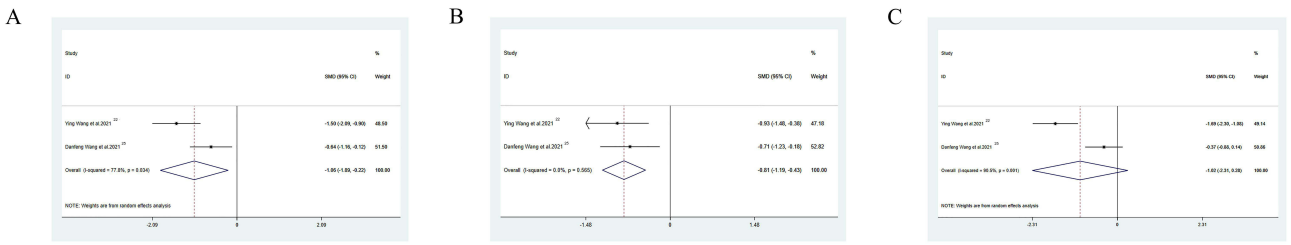

Figure 11 (**A**) Forest plot for 12-hour VAS-A. (**B**) Forest plot for 24-hour VAS-A. (**C**) Forest plot for 48-hour VAS-A.

Discussion

This represents the first systematic analysis of the role of QLB in post-CRS analgesia and opioid consumption. Our data showed that patients with QLB had significantly lower postoperative VAS-A at 12 and 24 h compared to those with sham/no block, consistent with the findings reported by Wang et al and Wang et al[22,25] Notably, this trend of reduced postoperative pain scores has also been observed in various other surgical settings, including abdominal, gynecological, and urological procedures, with QLB demonstrating effective postoperative analgesia in these contexts.[26–29] Altogether, these findings imply that QLB may offer some analgesic benefits to patients undergoing CRS, as evidenced by lower pain scores. This analgesic effect may be related to the ability of QLB to induce a widespread sensory block from T7 to L1, providing the necessary dermatome coverage for abdominal and CRS.[30,31]

In line with previous findings,[20,21,23,24] we found no significant differences in postoperative opioid consumption at 24 h and 48 h, total postoperative opioid consumption, and postoperative opioid consumption in the PACU between the QLB and sham/no block groups. There are several potential explanations for this observation. First, cadaveric studies have shown that dye from QLB can spread into the thoracic paraspinal and intercostal spaces, providing T12–L1 dermatome coverage and involving the thoracic sympathetic trunk at T4–T11.[32,33] However, the expected analgesic effect may not be achieved in clinical practice due to physiological differences between cadavers and living patients, variations in fascial pressure, and differences in the viscosity and density of dye compared to anesthetic agents.[21,34] Second, pain following colorectal surgery arises from multiple sources, including abdominal wall incisions, colorectal resection, dissection of surrounding organs and structures, and pneumoperitoneum-induced abdominal wall distension.[20] The superior mesenteric plexus innervates the ascending colon and most of the transverse colon, while the inferior mesenteric plexus innervates the distal transverse colon, the descending colon, and the sigmoid colon.[35] These pain pathways are complex, and QLB may not provide complete coverage of all affected segmental regions.

An important finding in our study was the dissociation between pain scores and opioid consumption: although QLB significantly reduced dynamic postoperative pain (VAS-A) at 12 and 24 hours, no significant reduction in opioid consumption was observed during the same period. One possible explanation for this discrepancy lies in the distinction between statistical significance and clinical relevance: while the decrease in VAS-A reached statistical significance, the minimal clinically important difference (MCID), typically around 10 mm on a 100-mm scale, may not be sufficient to translate into a significant reduction in opioid consumption.[36] In many cases, patients received standardized intravenous or oral analgesic regimens (such as scheduled administration of acetaminophen or nonsteroidal anti-inflammatory drugs).[37] These measures may have already optimized baseline analgesia, thereby limiting the additional opioid-sparing potential of QLB. Moreover, early postoperative opioid administration is often protocol-driven rather than entirely as-needed. For example, some clinicians provide fixed doses of opioids in the PACU regardless of the patient's actual pain intensity, potentially masking the opioid-sparing effect of QLB. Therefore, the lack of a significant reduction in opioid consumption does not necessarily negate the analgesic benefit indicated by the reduction in VAS scores.

Notably, although the pooled analyses did not show statistically significant reductions in opioid consumption and VAS-R, some of the original studies included in this meta-analysis reported clinically meaningful decreases in opioid consumption (Wang et al and Wang et al)[22,25] and reductions in VAS-R (Wang et al).[22] Such discrepancies may arise from multiple factors, including the timing of the block (pre- versus post-anesthesia induction, as confirmed by subgroup analysis) or differences in the type of postoperative opioid administration (as supported by sensitivity analyses). In

addition, small sample sizes in individual trials may lead to overestimation of effect sizes, whereas the larger pooled sample and conservative aggregation methods used in this meta-analysis may provide a more robust estimate of the effect. These factors underscore the heterogeneity of results across studies and highlight the need for standardized protocols in future research.

Furthermore, the pooled analyses showed no statistically significant differences between the QLB and control groups in the risk of PONV, TFAR, or LOS after surgery. Although the QLB group demonstrated numerically lower PONV incidence and a slight trend toward delayed TFAR, these changes did not reach statistical significance and should not be interpreted as evidence of clinical benefit. Therefore, current evidence is insufficient to support a clear advantage of QLB in reducing complications or improving patient comfort. This finding is corroborated by several individual studies.[20,21,23–25] This conclusion requires confirmation in additional high-quality randomized controlled trials.

Several limitations should be noted in this study. First, due to the inclusion of only six original studies, the small number of eligible studies prevented the evaluation of potential statistically significant differences in combined effect sizes across subgroups in some outcomes. Additionally, publication bias could not be evaluated using Egger's or Begg's regression tests. Therefore, the effect size may have been overestimated or underestimated. Second, the exclusion of studies not published in English may be another important limitation. Given that English is a widely used and internationally accepted scientific language, we included only studies published in English to facilitate the interpretation and comparison of results. However, this approach may exclude relevant non-English studies and introduce linguistic bias. Finally, the included studies exhibited a certain degree of clinical heterogeneity, and our sensitivity analyses confirmed that the type of opioid used was an important source of this heterogeneity. Differences in opioid type limit the direct comparability of opioid consumption across studies. Although conversion to morphine milligram equivalents (MME) would be ideal, the lack of standardized conversion rates for sufentanil may introduce substantial uncertainty. Future studies should provide opioid consumption data converted to MME to allow for more reliable meta-analyses.

Conclusion

QLB significantly reduced postoperative VAS-A scores at 12 h and 24 h compared to no block or sham block. QLB did not demonstrate statistically significant effects in reducing postoperative opioid consumption, decreasing postoperative VAS-R, prolonging TFAR, shortening LOS, and lowering the risk of PONV. QLB may serve as a beneficial adjunct in multimodal analgesia for CRS by reducing pain during early postoperative mobilization. However, given the absence of an opioid-sparing effect and the methodological limitations of existing studies, current evidence does not support the routine use of QLB. Additional original studies, particularly high-quality RCTs, are needed to evaluate the analgesic effects of QLB. These studies could provide valuable insights to support the development of guidelines for perioperative pain management in CRS.

Data Sharing Statement

The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

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Disclosure

The authors declare that they have no competing interests.

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