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Original Article

Effect of quadratus lumborum block combined with butorphanol-based PCIA on postoperative analgesia and early recovery in patients undergoing colorectal cancer surgery

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Abstract: Objective: To explore the impact of quadratus lumborum block (QLB) combined with butorphanol-based patient-controlled intravenous analgesia (PCIA) on intraoperative opioid use, postoperative analgesia, and recovery indicators in patients undergoing colorectal tumor surgery. Methods: A retrospective analysis was conducted on 78 patients who underwent radical resection of colorectal tumors. Based on postoperative analgesia strategies, patients were divided into two groups: the QLB combined with butorphanol PCIA group (QB group, n = 38) and the butorphanol PCIA group (B group, n = 40). Parameters compared between groups included intraoperative sufentanil consumption, postoperative Visual Analog Scale (VAS) scores, hemodynamic and respiratory indicators, recovery time, Mini-Cognitive Evaluation Scale (MESS) scores, incidence of adverse reactions, and lower limb motor function. Results: The QB group had significantly lower total and hourly intraoperative sufentanil consumption than the B group (P = 0.014). VAS scores were significantly lower in the QB group from 30 minutes to 6 hours postoperatively (P < 0.05). Additionally, the QB group showed more stable intraoperative heart rate (HR) and mean arterial pressure (MAP), along with higher partial pressure of end-tidal carbon dioxide ($PETCO_2$) levels. Cognitive function, as measured by MESS scores at 24, 48, and 72 hours postoperatively, was significantly better in the QB group (P < 0.05). However, the B group experienced shorter times to orientation recovery, extubation, spontaneous breathing, and overall awakening. Lower limb muscle strength scores were comparable between groups, with no observed impairments in ambulation. The overall incidence of adverse reactions did not differ significantly between groups (QB group: 5.26% vs. B group: 7.5%; P > 0.05). Conclusion: QLB combined with butorphanol-based PCIA effectively enhances early postoperative analgesia and promotes hemodynamic and respiratory stability in patients undergoing colorectal tumor surgery, supporting its broader application for postoperative analgesia in this patient population.

Keywords: Quadratus lumborum block, butorphanol, PCIA, colorectal cancer, postoperative analgesia

Introduction

Colorectal cancer (CRC) ranks among the most prevalent gastrointestinal malignancies worldwide, with its incidence steadily increasing in recent years. It has emerged as a major contributor to cancer-related mortality [1, 2]. Laparoscopic radical resection has become the mainstream surgical approach for CRC, accounting for over 60% of all procedures [3]. Despite its minimally invasive nature, laparoscopic surgery is still associated with moderate to severe postoperative pain. Inadequate pain control can prolong hospital stay, increase the burden on healthcare providers, and lead to postoperative complications and decreased patient dissatisfaction [4]. Opioid analgesics remain the cornerstone of postoperative pain management. However, their adverse effects-such as nausea, vomiting, and ileus-limit their applicability, particularly within the Enhanced Recovery After Surgery (ERAS) framework [5, 6]. While epidural analgesia provides effective pain relief, its clinical use is often limited by technical challenges and the risk of hemodynamic instability [7]. In light of these limitations, regional nerve block techniques, particularly ultrasound-guided fascial plane blocks,

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have gained increasing clinical attention in recent years.

Quadratus lumborum block (QLB), a novel retroperitoneal fascial plane block, provides both visceral and somatic analgesia by targeting the ventral rami of spinal nerves from T7 to L2 and the thoracic sympathetic trunk. The local anesthetic is thought to spread along the thoracolumbar fascia to reach the celiac plexus and associated sympathetic fibers [8]. Recent studies have demonstrated the efficacy of QLB in a variety of surgical settings, including cesarean section, cystectomy, and myomectomy, with consistent and reliable analgesia over the abdominal wall [9-11]. Among its several approaches, the transmuscular quadratus lumborum block (TQLB) has shown particular promise in laparoscopic colorectal surgery by reducing postoperative pain, lowering opioid consumption, and improving the overall quality of recovery [12]. Although TQLB has gained popularity in laparoscopic colorectal procedures, its analgesic efficacy - particularly when combined with pharmacological analgesia - remains to be systematically evaluated and compared in this context.

Butorphanol, a mixed opioid receptor agonist-antagonist, exhibits strong analgesic effects with comparatively mild side effects. When administered via patient-controlled intravenous analgesia (PCIA), it has been shown to reduce the requirement for conventional opioids and to improve patient satisfaction and comfort in postoperative pain management [13, 14]. Previous studies have shown that integrating butorphanol with regional anesthesia techniques may enhance analgesic efficacy, reduce the need for rescue analgesics, and improve recovery quality. However, its effectiveness in patients with colorectal cancer remains inadequately studied.

This retrospective study aims to investigate the effects of combining QLB with butorphanol-based PCIA on postoperative analgesia and early recovery in patients undergoing colorectal tumor resection. The findings are expected to provide clinical evidence for optimizing postoperative pain management within the framework of ERAS protocols.

Materials and methods

Clinical data

This single-center retrospective cohort study was conducted in accordance with the principles outlined in the Declaration of Helsinki. As the study posed no direct risk to patients and involved no conflicts of economic interest, the requirement for written informed consent was waived by the hospital's ethics committee. Patient data confidentiality was strictly maintained in accordance with relevant protection regulations. The study protocol was approved by the Huaihe Hospital of Henan University's ethics committee.

Clinical data were retrospectively collected for 78 patients who underwent elective laparoscopic radical resection of colorectal tumors at our hospital between January 2022 and December 2023. All clinical information was obtained from the hospital's electronic medical record system. According to the postoperative analgesia regimen, patients were assigned to one of two groups: the QB group (n = 38), which received ultrasound-guided QLB combined with butorphanol-based PCIA; and the B group (n = 40), which received butorphanol PCIA alone. All procedures were performed by the same specialized surgical and anesthetic teams to ensure consistency in operative and perioperative management. The research flowchart is shown in **Figure 1**.

Inclusion criteria were as follows: ① Age between 30 and 65 years; ② American Society of Anesthesiologists (ASA) physical status II or III; ③ Preoperative histopathological confirmation of colorectal cancer with indication for radical surgical resection; ④ Standardized surgical procedure involving a lower abdominal para-midline incision approximately 13 cm in length, resection of approximately 15 cm of intestinal segment, and systematic dissection of the mesenteric root and pericolic lymph nodes; ⑤ Administration of standardized total intravenous anesthesia. In addition, patients in the QB group received QLB. All surgeries and anesthetic procedures were performed by the same medical team.

Exclusion criteria were as follows: ① Preexisting cognitive impairment; ② Severe cardiopul-

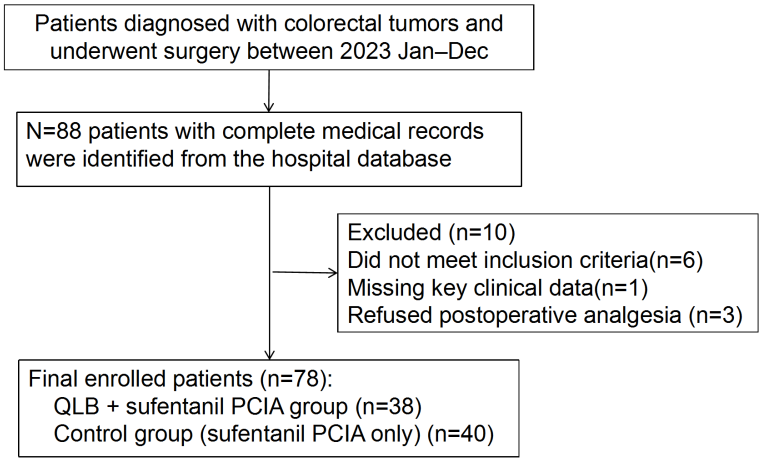

Figure 1. Flow chart of patient inclusion and exclusion. This flowchart illustrates the complete process from initial screening to final patient inclusion, detailing all exclusion criteria applied and the subsequent allocation of participants into respective study groups. PCIA, patient-controlled intravenous analgesia.

monary dysfunction; ③ Advanced hepatic or renal insufficiency (Child-Pugh class C or serum creatinine ≥ 451 μmol/L); ④ Hematologic disorders, coagulation abnormalities, or ongoing anticoagulant therapy; ⑤ Presence of distant organ metastasis; ⑥ Long-term use of analgesics prior to surgery; ⑦ History of previous abdominal surgery; ⑧ Prior radiotherapy or chemotherapy; ⑨ Emergency surgery due to complete intestinal obstruction or gastrointestinal bleeding; ⑩ Contraindications to regional nerve blocks or occurrence of related complications; ⑪ Incomplete clinical data or inability to complete follow-up.

Anesthesia and analgesia implementation

All patients received standard preoperative monitoring. Upon entering the operating room, routine monitoring of electrocardiography, non-invasive blood pressure, and pulse oximetry was initiated, and peripheral venous access was established. For enhanced hemodynamic monitoring, radial artery catheterization was performed to enable continuous arterial pressure measurement. Anesthesia was induced using midazolam, propofol, cisatracurium, and sufentanil, followed by endotracheal intubation and initiation of mechanical ventilation. After surgical site disinfection and sterile draping, the procedure commenced. Intraoperative drug dosages were titrated based on changes in blood pressure, heart rate, and depth of anesthesia. After surgery, patients were allowed to resume spontaneous breathing and the cough reflex. They were then transferred to the recovery room for at least 15 minutes of observation and were extubated once vital signs stabilized.

Within 30 minutes postoperatively, all patients received standardized PCIA. The analgesic solution contained sufentanil citrate (0.75 μg/kg), butorphanol tartrate (150 μg/kg), and tropisetron (10 mg), diluted in 100 mL of 0.9% sodium chloride solution. The PCIA device was programmed with a basal infusion rate of 2 mL/h, a loading dose of 5 mL, a demand dose of 0.5 mL, and a lockout interval of 15 minutes. If analgesia remained inadequate, supplementary sufentanil boluses were administered as rescue analgesia.

Building upon this protocol, patients in the observation group (QB group) received an intraoperative ultrasound-guided QLB. Following anesthesia induction, patients were placed in the supine position, and the surgical site was prepared with standard aseptic techniques. A 5-10 MHz linear or convex ultrasound probe was used to locate the transverse process of the third lumbar vertebra. Under real-time ultrasound guidance, a block needle was advanced toward the anterior fascia of the quadratus lumborum muscle. Once correct needle placement and local anesthetic spread were confirmed, 20 mL of 0.375% ropivacaine hydrochloride was injected on each side, totaling 40 mL for bilateral QLB. Pre-block ultrasound image demonstrated clear visualization of the quadratus lumborum muscle and adjacent anatomical structures, with the transducer positioned at the transverse process level of the third lumbar vertebra. This served as the baseline anatomical reference for needle insertion. Under real-time ultrasound guidance, the needle was advanced to the anterior fascial plane of the quadratus lumborum muscle. Successful block confirmation was achieved upon observation of characteristic fluid dispersion within

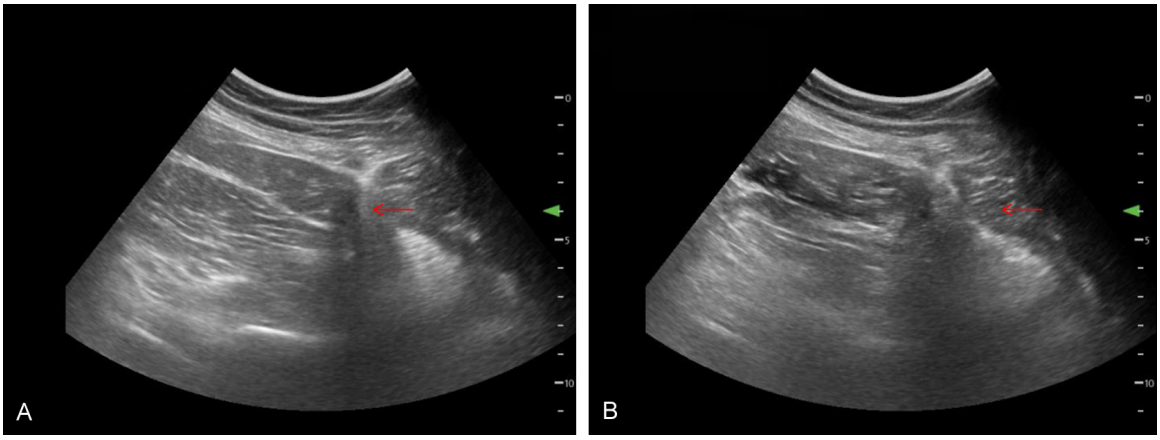

Figure 2. Images of the process of quadratus lumborum block puncture and local anesthetic injection. A. Cross-sectional ultrasound image of the quadratus lumborum muscle before block. The red arrow indicates that the probe is located at the level of the L3 transverse process, which can clearly identify the target muscle structure; B. Image of the ultrasound-guided drug injection process. The red arrow indicates that the puncture needle tip is located on the anterior fascia surface of the trapus lumborum muscle. The injection of the drug liquid forms a hypoechoic separation zone, suggesting a successful block.

the fascial plane following local anesthetic injection (see **Figure 2** for procedural details). Patients in the control group (B group) received standard postoperative analgesia with PCIA alone, without any regional nerve blockade.

Outcome measures

This study evaluated multiple intraoperative physiological stability, postoperative analgesic efficacy, cognitive function, and recovery quality. Both primary and secondary endpoints were assessed using the following measurement methods.

Primary outcome measures: (1) Hemodynamic Parameters: Mean arterial pressure (MAP) and heart rate (HR) were recorded at six intraoperative time points: upon entry to the operating room (T0), 5 minutes after induction of anesthesia (T1), at skin incision (T2), 30 minutes after the start of surgery (T3), at the end of surgery (T4), and during extubation (T5). Blood pressure and HR were automatically measured and recorded by the anesthesia monitoring system to ensure data accuracy and consistency.

(2) Postoperative Pain Assessment: Pain intensity was evaluated using the Visual Analog Scale (VAS), ranging from 0 (no pain) to 10 (worst imaginable pain). VAS scores were recorded both at rest and during movement at the following postoperative time points: extubation (T5), transfer from the recovery room to the general ward (T6), and at 6 hours (T7), 12 hours (T8), 24 hours (T9), and 48 hours (T10) after surgery. Movement-evoked pain was assessed during simple limb movements.

(3) Anesthetic Drug Consumption: Cumulative intraoperative doses of anesthetic agents - including sufentanil, propofol, and remifentanil - were recorded. Drug consumption rates were standardized and expressed as dose per hour (μg/h) relative to operative duration. Data were extracted from anesthesia records.

(4) Cognitive Function Assessment: Cognitive function was evaluated using the Mini-Cognitive Assessment Instrument (Mini-Cog) or the Mini-Mental State Examination Scale (MESS) before surgery and at 24, 48, and 72 hours postoperatively. All assessments were conducted in a quiet environment by the same trained evaluator to minimize inter-rater variability and environmental bias.

Secondary outcome measures: (1) PCIA Usage: The total number of demands and effective presses on the PCIA pump within the first 48 hours postoperatively were recorded. The frequency of analgesic requests was calculated to evaluate patient analgesic requirements and compliance with PCIA.

(2) Muscle Strength Assessment: Lower limb muscle strength was evaluated 24 hours postoperatively using the Lovett scale, which ranges from 0 (no muscle contraction) to 5 (normal muscle strength with full resistance). Asse-

Table 1. General information and statistical comparison between groups

Variable	B group (n = 40)	QB group (n = 38)	x^2/t	p
Age (years)	48.3 ± 5.6	49.5 ± 5.3	0.971	0.335
Gender (male/female)	24/16	22/16	0.036	0.850
Body mass index (kg/m^2)	23.5 ± 2.7	22.8 ± 2.5	1.186	0.239
ASA physical score (I/II)	22/18	24/14	0.536	0.464
Time for quadratus lumborum block (min)	-	6.0 ± 0.7		
Operation duration (min)	147.3±39.4	153.6±41.2	0.690	0.492
Duration of anesthesia (min)	192.3±61.4	187.8±58.2	0.332	0.741
PACU stay duration (min)	59.1 ± 8.4	58.3 ± 9.1	0.404	0.688

Note: ASA, American Society of Anesthesiologists; PACU, Post-anesthetic care unit.

ssments were conducted independently by a trained evaluator blinded to group allocation.

(3) Postoperative Awakening and Recovery Quality: Time intervals to spontaneous respiration recovery, orientation return, eye-opening response, and endotracheal extubation were recorded. These parameters were uniformly documented by Post-anesthetic care unit (PACU) nurses to ensure standardized assessment of anesthetic emergence and early recovery.

(4) Adverse Event Monitoring: Common postoperative adverse events occurring within 48 hours - including nausea, vomiting, pruritus, respiratory depression, urinary retention, and dizziness - were monitored. All events were recorded in real time by clinical staff and classified according to standardized adverse event grading criteria.

Statistical analysis

Statistical analysis was conducted using SPSS 23.0 software. The measurement data were first tested for normality. Data conforming to a normal distribution were expressed as mean ± standard deviation, and the independent sample t-test was used for comparison between groups. Data that did not conform to a normal distribution were expressed as the median (quartile), and the non-parametric rank sum test is used. Counting data were expressed as the number of cases and percentages, and comparisons between groups were conducted using the χ^2 test or Fisher's exact probability method. The measurement data at multiple time points were analyzed using Repeated Measures ANOVA, and Bonferroni post hoc correction was performed when necessary. Two-sided test: A *P* value < 0.05 was considered statistically significant.

Results

Patient characteristics

There were no statistically significant differences between the two groups in baseline characteristics, including gender, age, weight, body mass index (BMI), ASA physical status classification, and duration of surgery (P > 0.05), indicating comparability before surgery (**Table 1**).

Comparison of resting and movement VAS scores at different postoperative time points

Postoperative VAS scores at rest fluctuated slightly over time in both groups; however, the QB group demonstrated significantly better analgesia during the early postoperative period. Specifically, resting VAS scores in the QB group were 1.36 ± 0.53, 1.42 ± 0.50, and 1.33 ± 0.47 at 30 minutes, 1 hour, and 6 hours postoperatively, respectively. These values were significantly lower than those in the B group (1.83 ± 0.56, 1.84 ± 0.52, and 1.74 ± 0.51, respectively; P < 0.05). No significant differences were observed between groups at 12 hours (QB: 1.93 ± 0.58 vs. B: 2.01 ± 0.60, P = 0.327) or 24 hours postoperatively (QB: 2.28 ± 0.52 vs. B: 2.37 ± 0.55, P = 0.248).

During movement, VAS scores in both groups showed an upward trend. At 6 hours postoperatively, the QB group reported significantly lower pain scores (2.22 ± 0.42) compared to the B group (2.48 ± 0.45, P = 0.040), indicating superior pain control during activity. However, no significant differences were found at 30 minutes, 1 hour, 12 hours, or 24 hours postoperatively-for example, at 1 hour postoperatively, VAS scores were 2.01 ± 0.48 in the QB group versus 2.26 ± 0.50 in the B group (P = 0.070).

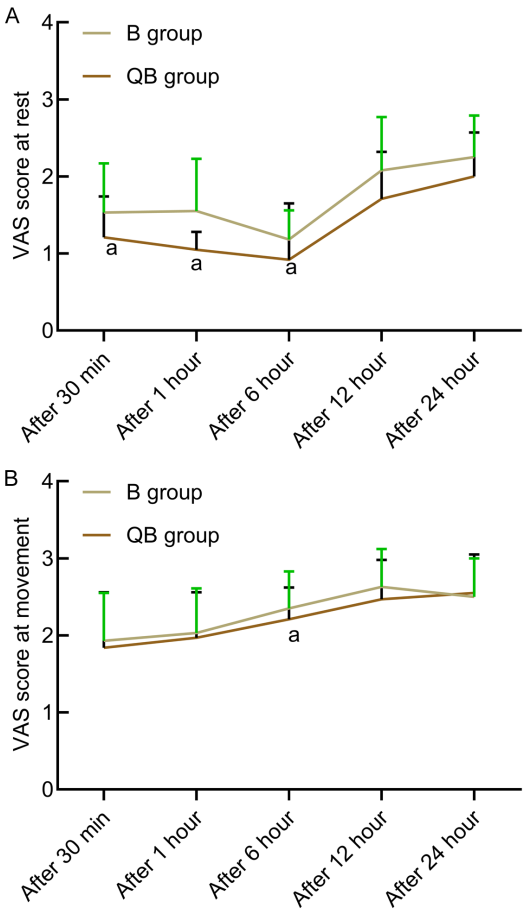

Figure 3. Comparison of VAS scores at rest and during movement at different postoperative time points. A. VAS scores at rest measured at 30 minutes, 1 hour, 6 hours, 12 hours, and 24 hours postoperatively. B. VAS scores during movement at the same postoperative time points. Data are presented as mean ± standard deviation. Compared with B group, [a]P < 0.05. VAS, Visual Analog Scale.

These findings suggest that QLB combined with butorphanol-based PCIA provides more effective analgesia in the early postoperative phase, particularly within the first 6 hours, and can significantly alleviate acute pain peaks both at rest and during movement. Detailed data are illustrated in **Figure 3**.

Comparison of intraoperative sufentanil consumption

The total intraoperative dose of sufentanil in the QB group was significantly lower than that in the B group (P < 0.001), indicating that QLB effectively reduces intraoperative analgesic requirements. Additionally, the sufentanil consumption rate per hour (μg/h) was also reduced in the QB group compared to the B group (P = 0.014), demonstrating that QLB decreases both the overall dosage and the intensity of analgesic dependence. Detailed results are shown in **Figure 4**.

Comparison of hemodynamic and respiratory parameters

HR was comparable between groups at T0 (pre-induction), with the QB group exhibiting slightly lower values. From T1 to T3, HR gradually decreased in both groups; however, the QB group consistently showed a modestly lower and more stable decline, suggesting that QLB combined with butorphanol-based PCIA contributes to better intraoperative heart rate stability.

MAP values were similar at T0 and decreased progressively over time in both groups. However, the QB group maintained higher MAP levels than the B group between T1 and T3, particularly at T1 (skin incision) and T2 (during surgery), indicating enhanced hemodynamic stability with QLB.

$PETCO_2$ levels decreased after anesthesia induction in both groups, yet the QB group consistently had higher $PETCO_2$ values from T1 to T3. This suggests more stable respiratory function, potentially reflecting reduced intraoperative stress responses due to enhanced analgesia. Detailed results are presented in **Table 2**.

Postoperative recovery

The B group demonstrated significantly faster recovery across multiple postoperative indices compared to the QB group. Specifically, orientation recovery time (28.56 ± 3.04 min vs. 30.89 ± 3.82 min, P = 0.004), extubation time (28.45 ± 1.23 min vs. 32.45 ± 2.06 min, P < 0.001), eye-opening time (19.04 ± 1.06 min vs. 23.04 ± 1.32 min, P < 0.001), and spontaneous breathing recovery time (19.96 ± 1.08 min vs. 20.81 ± 1.08 min, P = 0.0008) were all significantly shorter in the B group. These findings suggest that the analgesic regimen employed in the B group may offer advantages in terms of early postoperative recovery quality, providing valuable insights for optimizing clinical anesthesia and analgesia protocols. See **Table 3**.

Safety analysis

The overall incidence of adverse events was 5.26% in the QB group and 7.5% in the B gr-

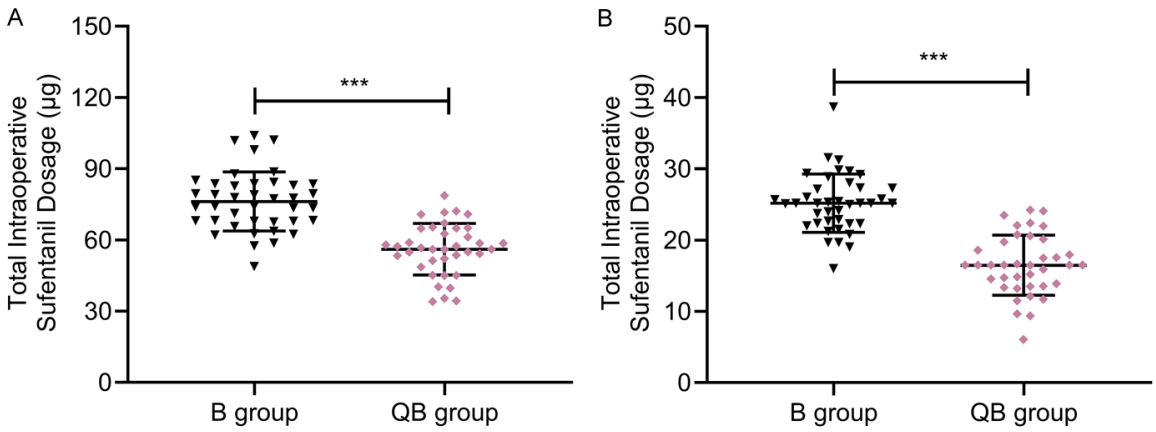

Figure 4. Comparison of sufentanil dosage between groups. A. Total intraoperative sufentanil dosage (μg) administered to patients in different groups. B. Average intraoperative sufentanil dosage (μg) in different groups of patients. ***indicates a highly statistically significant difference ($P < 0.001$). Data are expressed as mean ± standard deviation.

Table 2. Comparison of hemodynamics and respiratory parameters between groups

Parameter	B group	QB group	*t*	*P*
HR (beats per minute)			2.089	0.0401
T0	80.41 ± 5.22	78.13 ± 4.40	-1.099	0.2751
T1	75.22 ± 3.61	76.10 ± 3.46	-1.617	0.1101
T2	73.25 ± 3.07	74.38 ± 3.10	-2.431	0.0174
T3	71.52 ± 3.36	73.32 ± 3.18	-0.065	0.9480
MAP (mmHg)			-2.561	0.0124
T0	87.35 ± 5.43	87.43 ± 5.37	-1.616	0.1102
T1	84.15 ± 3.80	86.27 ± 3.51	-1.557	0.1235
T2	83.73 ± 4.64	85.32 ± 4.04	0.141	0.8880
T3	81.07 ± 3.50	82.25 ± 3.19	-1.430	0.1568
$PETCO_2$ (kPa)			-1.236	0.2202
T0	5.70 ± 0.63	5.68 ± 0.62	-2.407	0.0185
T1	5.39 ± 0.54	5.56 ± 0.51	2.089	0.0401
T2	5.24 ± 0.52	5.38 ± 0.48	-1.099	0.2751
T3	5.00 ± 0.49	5.27 ± 0.50	-1.617	0.1101

Note: HR, heart rate; MAP, mean arterial pressure; $PETCO_2$, partial pressure of end-tidal carbon dioxide.

oup, with no statistically significant difference between groups ($P > 0.05$). See **Table 4**.

Comparison of perioperative cognitive function (MESS Scores)

At all postoperative time points, the QB group showed significantly higher MESS scores at 24, 48, and 72 hours compared to the B group, indicating superior cognitive recovery, greater cognitive stability, and less fluctuation in scores ($P < 0.05$). See **Figure 5**.

Postoperative lower limb muscle strength and motor function assessment

No cases of lower limb muscle weakness or impaired ambulation were observed within 24 hours postoperatively in the QB group. Muscle strength scores showed no significant differences between the QB and B groups ($P > 0.05$). See **Figure 6**.

Discussion

This retrospective study analyzed the efficacy of QLB combined with butorphanol-based PCIA for postoperative analgesia following radical colorectal cancer surgery. The results demonstrated that this analgesic regimen significantly reduced intraoperative sufentanil consumption and postoperative VAS scores, particularly within the first 6 hours after surgery. Additionally, it contributed to more stable intraoperative hemodynamics, enhanced postoperative cognitive recovery, and did not increase the incidence of adverse events.

Specifically, resting VAS scores at 30 minutes, 1 hour, and 6 hours postoperatively were significantly lower in the QB group compared to the B group. These results are consistent with

Table 3. Comparison of postoperative recovery between groups

Group	Number of cases	Orientation recovery time	Extubation time	Eye-opening time	Spontaneous breathing recovery time
B group	40	28.56 ± 3.04	28.45 ± 1.23	19.04 ± 1.06	19.96 ± 1.08
QB group	38	30.89 ± 3.82	32.45 ± 2.06	23.04 ± 1.32	20.81 ± 1.08
t		2.988	10.474	14.793	3.883
P		0.004	< 0.001	< 0.001	< 0.001

Table 4. Comparison of the total incidence of adverse reactions between groups

Group	Number of cases	Nausea and vomiting	Dizziness	Respiratory depression	Itching	Urinary retention	Total incidence of adverse reactions
B group	40	1 (2.5)	1 (2.5)	0	0	1 (2.5)	3 (7.5)
QB group	38	1 (2.63)	0	1 (2.63)	0	0	2 (5.26)
χ^2							0.152
P							0.696

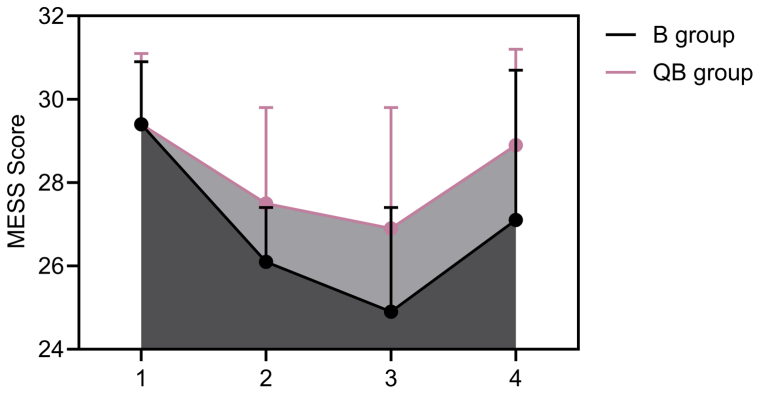

Figure 5. Comparison of MESS scores between groups. Note: Time points 1, 2, 3, and 4 correspond to preoperative, and postoperative 24, 48, and 72 hours, respectively. MESS, Mini-Cognitive Evaluation Scale.

Zhao et al., who reported in a randomized controlled trial that bilateral ultrasound-guided posterior transversus abdominis plane (TAP) block after laparoscopic colorectal cancer surgery effectively reduces numeric rating scale (NRS) pain scores both at rest and during movement, decreases opioid-related adverse effects, and improves patient satisfaction with postoperative analgesia [15]. Such findings underscore the substantial benefit of regional nerve blocks in reducing early postoperative pain and opioid requirements. Compared to the TAP block, QLB offers a broader anatomical coverage, extending analgesic effects to the retroperitoneal and paraspinal nerve regions, potentially resulting in deeper and longer-lasting pain relief [16, 17]. This expanded coverage is particularly advantageous for colorectal surgeries involving extensive manipulation of deep abdominal tissues, where QLB may offer superior analgesic support. Our study further confirmed that, when combined with butorphanol-based PCIA, QLB not only effectively reduces intraoperative sufentanil consumption and early postoperative pain scores but also stabilizes intraoperative hemodynamics and promotes postoperative cognitive recovery, without increasing the risk of adverse reactions.

Regarding intraoperative sufentanil consumption, this study found that the QLB group received significantly lower total doses and reduced drug usage intensity per hour compared to the butorphanol PCIA-only group. These findings suggest that QLB effectively decreases opioid requirements and supports the adoption of opioid-sparing analgesic strategies within the ERAS framework [18]. Consistent with our results, Shi et al. reported that, within a multimodal analgesia protocol, bilateral ultrasound-guided QLB via the lumbar interfascial triangle approach (LSAL) performed preoperatively significantly reduced postoperative morphine consumption and prolonged the time to first PCA request compared to conventional lateral QLB [19]. Additional studies have reported that QLB combined analgesia can reduce

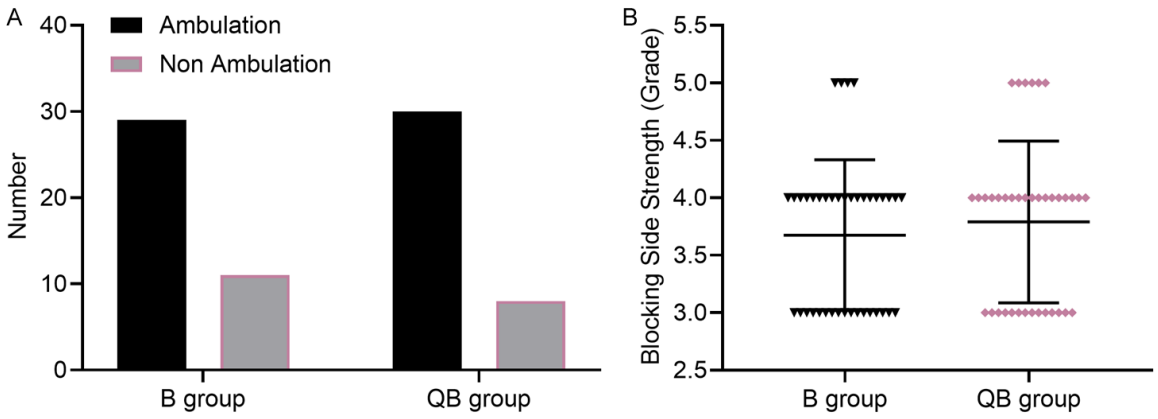

Figure 6. Evaluation of postoperative lower extremity muscle strength and motor function. A. Distribution of patients capable of ambulation versus those with impaired ambulation in each group postoperatively. B. Muscle strength grading on the blocked side of the two groups of patients. Data are expressed as the median with interquartile range.

sufentanil use by approximately 25%-40% [20, 21], thereby contributing to a lower incidence of opioid-related postoperative adverse effects.

Furthermore, the QLB group showed superior MESS scores compared to controls, suggesting that QLB may mitigate intraoperative stress responses and opioid consumption, thereby lowering the risk of postoperative delirium and cognitive impairment. This aligns with emerging evidence highlighting the neuroprotective effects of regional blocks on postoperative cognitive function. Mechanistically, QLB may facilitate cognitive recovery by attenuating intraoperative inflammatory cytokine release - such as interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF-α)-and improving postoperative oxygenation [22, 23]. Although QLB targets deep lumbar fascial planes and could theoretically induce motor nerve blockade or muscle weakness [24], our study found no significant postoperative decline in muscle strength in the QLB group. This finding supports that, when performed using standardized dosing and technique, QLB maintains a favorable safety and high procedural reliability.

The strengths of this study include: (1) the application of a consistent surgical procedure and anesthesia protocol in both groups, thereby minimizing potential confounding factors; (2) a comprehensive, multidimensional assessment encompassing analgesic efficacy, cognitive function, and hemodynamic parameters, enabling a thorough evaluation; and (3) the use of butorphanol as the baseline PCIA agent, which allowed for the demonstration of its synergistic analgesic effect when combined with QLB. However, several limitations warrant consideration. The retrospective study design inherently carries risks of selection and information bias. The relatively small sample size limited the ability to conduct detailed subgroup analyses, such as in elderly patients or those with comorbidities. Additionally, the lack of long-term postoperative follow-up precluded assessment of chronic pain and postoperative quality of life improvements. Future studies should address these limitations by adopting prospective, randomized controlled trial designs with larger cohorts. Investigations should explore optimal combinations of QLB with different PCIA drugs and examine their effects across different age groups and baseline patient conditions. Such studies will facilitate the development of more precise and individualized postoperative analgesia strategies for patients undergoing colorectal cancer surgery.

Disclosure of conflict of interest

None.

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