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Quadratus Lumborum Block versus Transversus Abdominis Plane Block for Laparoscopic Radical Resection for Rectal Cancer

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Abstract

Background: Both transversus abdominis plane block (TAPB) and quadratus lumborum block (QLB) can provide effective analgesia for abdominal surgery.

Objectives: To explore whether there are differences in the effects of TAPB and QLB on the quality of postoperative recovery in patients undergoing laparoscopic radical resection for rectal cancer.

Methods: In total, 102 patients undergoing laparoscopic radical resection for rectal cancer were randomly divided into two groups. Bilateral TAPB or QLB was performed using 0.375% ropivacaine after the induction of anesthesia. The 15-item Quality of Recovery (QoR-15) scale was used to assess the quality of recovery at 24 h postoperatively. Secondary indicators included 24-h postoperative fentanyl consumption, patient-controlled analgesia (PCA), incidence of adverse reactions, numerical rating scale (NRS) at rest and during exercise, and incidence of postoperative complications.

Results: QoR-15 scores were higher in the QLB group than in the TAPB group (115.6±11.3 vs. 99.7±14.2, P<0.05). Moreover, the 24-h sufentanil consumption was less in the QLB group than in the TAPB group (2.4±0.5 vs. 5.5±0.3 μg, P<0.05) after surgery. Time durations to first postoperative PCA compression were 152.1±28.4 and 100.3 ± 22.9 min, respectively (P<0.05). The numbers of PCA compressions within 24 h after surgery were 6.0 (2.0, 8.0) and 9.0 (3.0, 12.0) (P<0.05). There were no differences in secondary outcomes, such as adverse reactions, NRS scores at rest and exercise at 24 h postoperatively, as well as complication rates.

Conclusion: Patients undergoing laparoscopic radical resection for rectal cancer with QLB had a better quality of recovery and better analgesic effects at 24 h postoperatively, compared to TAPB.

Keywords: Analgesic effects, Quadratus lumborum block, Quality of recovery, Patients, Transverse abdominal muscle

1. Background

Enhanced recovery after surgery (ERAS) was first applied in gastrointestinal surgery to reduce the length of hospital stay, decrease the incidence of perioperative complications, and mitigate the effects of surgical stress through various interventions (1-2). In gastrointestinal surgery, ERAS combined with laparoscopic techniques could reduce the incidence of perioperative complications, shorten the length of hospital stay, and promote rapid recovery (3-4). However, the pain remains a major obstacle to recovery after surgery in patients undergoing laparoscopic colectomy (5-7). Multimodal analgesia is a component of ERAS management for abdominal surgery and can reduce the side effects of opioids (8).

Fascia iliaca compartment block has become a common modality for postoperative pain management after dissection and laparoscopic surgery (9). Among them, ultrasound-guided transversus abdominis plane block (TAPB) can reduce the consumption of opioids, alleviate postoperative pain, and shorten hospital stay in abdominal surgery (10-11). Quadratus lumborum block (QLB), an emerging fascia iliaca compartment block, has been shown to be effective in controlling both somatic and visceral pain (12-15). Studies have shown that QLB provides a wider range of blocks, better analgesia, and a longer duration of analgesia, compared to TAPB (12-13). QLB has been increasingly used for postoperative analgesia in patients undergoing abdominal surgery, with promising results (16-17).

Postoperative recovery is a complex process, of which postoperative analgesia is only one key aspect. Most studies assessing anesthesia and postoperative recovery focused on their primary outcomes including time to recovery and the incidence of adverse events. The 15-item Quality of Recovery (QoR-15) is a questionnaire that assesses postoperative recovery from the patient's perspective, providing researchers with a valid assessment of postoperative recovery (18).

2. Objectives

QoR-15 was used as an assessment tool, and the enrolled patients undergoing laparoscopic radical colon cancer surgery were regarded as the study population to explore whether QLB is more effective than TAPB in improving the quality of postoperative recovery in patients undergoing laparoscopic radical

resection for rectal cancer.

3. Methods

This prospective, randomized, and controlled study was approved by the Ethics Committee of Hubei University (study protocol number and Clinical Trial registration number: 2021-022). All patients who met the inclusion criteria were invited to participate in the trial, and those who were enrolled signed written informed consent.

The inclusion criteria were: 1) ASA class of I-III, 2) age range within 18-80 years, 3) elective laparoscopic radical resection for rectal cancer under general anesthesia, and 4) no contraindication to regional anesthesia. On the other hand, the patients who had an infection at the site of block, allergy to a local anesthetic drug, coagulation disorders, body mass index >35 kg/m^2, cognitive dysfunction, history of chronic pain, renal or hepatic failure, and history of opioid abuse were excluded from the study. Patients who met the inclusion criteria were randomized using a computer-generated random number table by 1:1 into the QLB and TAPB groups.

3.1. Anesthesia Management

Venous vascular access was established on all patients upon entering the operating room, followed by routine monitoring of the electrocardiogram, non-invasive blood pressure, and pulse oximetry. Radial artery puncture was performed under local anesthesia for continuous monitoring of arterial blood pressure. After breathing pure oxygen, induction of anesthesia was given with 1-2 μg/kg of fentanyl, 2-3 mg/kg of propofol, and 0.15 mg/kg of cis-atracurium. After intubation, mechanical ventilation was performed with 60% oxygen inhalation, an inspiratory-to-expiratory ratio of 1: 2, and a tidal volume of 6 ml/kg. The partial pressure of end-tidal carbon dioxide (PETCO2) was maintained at 34-36 mmHg. Anesthesia was maintained with propofol with a bispectral index of 40-60 and remifentanil of 0.1-1 μg/kg/min; moreover, cis-atracurium was given intermittently according to the results of muscle relaxation monitoring. The hemodynamic goal was to maintain heart rate or blood pressure within 20% of baseline.

3.2. QLB or TAPB

After the completion of tracheal intubation, QLB or TAPB was performed in both groups, and all operations were performed by anesthesiologists with more than three years of experience in ultrasound-guided nerve blocks. Using a Wisonic type ultrasound machine (Huasheng Corporation, China), a QLB type 2 approach was selected for in-plane needle entry. With 1 cm lateral to the probe as the entry point, the probe was placed between the anterior superior iliac spine and the rib margin, and after identifying the abdominal wall muscles (musculus obliquus externus abdominis, internal oblique muscle, and transverse abdominal muscle), the probe was slowly retrieved until the posterior border of the quadratus lumborum was identified, and the needle advanced to the posterior aspect of the quadratus lumborum. The needle withdrawal was free of blood and gas, and 2-5 ml of saline was injected to confirm the position of the needle tip. The needle should be again retracted without blood or gas and 20 ml of 0.375% ropivacaine (AstraZeneca AB) was injected.

Ropivacaine was selected for the block because of its rapid onset, stable hemodynamics, long postoperative analgesia time (19), low cardiotoxicity (20), and high satisfaction of patients and physicians when using ropivacaine (21).

Local anesthetic diffusion between the posterior aspect of the quadratus lumborum muscle and the thoracolumbar fascia on the ultrasound image indicates a successful block. TAPB was similarly conducted using an in-plane needle approach. After determining the position of the needle tip, 20 ml of 0.375% ropivacaine was injected, and local anesthetic diffusion in the fascial space indicates a successful block. Both QLB and TAPB were blocked bilaterally.

3.3. Postoperative Management

All patients were admitted to the Postanesthesia Care Unit (PACU), connected to a Patient Controlled Analgesia (PCA) pump with a background infusion rate of 20 μg/h and an on-demand infusion of 10 μg with a lockout time of 15 min. Continuous PCA infusion was interrupted when the patient developed severe nausea or vomiting. If the patient self-administered a bolus dose 10 min later, and the VAS score is still> 3 points, remedial analgesia is given.

3.4. Outcome Measurement

The primary outcome was the quality of recovery at 24 h postoperatively, assessed using the QoR-15 scale. Secondary indicators included time to first analgesia in the PACU, 24 h consumption of sufentanil, PCA pump use, incidence of adverse reactions to analgesic medications, numerical rating scale (NRS) at rest and during exercise, incidence of postoperative complications, postoperative exhaust time, time to first out of bed activity, number of days in the hospital, and unplanned admission to the Intensive Care Unit (ICU).

3.5. Statistical analysis

To determine the sample size, a pre-study was conducted based on the primary outcome of QoR-15 assuming α=0.05 and β=0.2, and a sample size of 98 was ultimately determined. To prevent the missed visits, 100 patients were finally included in this study.

Data were analyzed using Statistical Product and Service Solutions (SPSS) (version 23.0) (IBM Armonk, NY, USA), and continuous data were analyzed by the Kolmogorov-Smirnov test to determine the normality of the data. Measurement data that conformed to a normal distribution were analyzed using the independent samples t-test, with results expressed as Mean±SD. Nonparametric statistics were performed using the Mann-Whitney U test, and the results were expressed as median (M) (interquartile range [IQR]). Qualitative data were tested using the Chi-square test or Fisher's exact test, and results were expressed as a percentage (%). A P-value less than 0.05 was considered statistically significant.

4. Results

A total of 120 patients were enrolled in this study from January 1, 2019, to February 1, 2020. In total, 18 patients were excluded, and 102 patients were randomly assigned to one of the two groups, with one patient lost to follow-up in the QLB group, resulting in 50 patients in the QLB group and 51 patients in the TAPB group (Figure 1). The baseline data of the patients were comparable between the two groups (Table 1). During the study period, no patient developed complications, such as local anesthetic toxicity with abdominal organ injury. QoR-15 scores at 24 h postoperatively were 115.6±11.3 in the QLB group and 99.7±14.2 in the TAPB group (Figure 2, P<0.05). Time durations to first sufentanil analgesia in the PACU were 35.2±8.3 min in the QLB group and 16.5±5.1 min in the TAPB group (P<0.05), while the total postoperative sufentanil consumption rates at 24 h were 2.4±0.5 μg in the QLB group and 5.5±0.3 μg in the TAPB group (P<0.05).

First analgesic time was 152.1±28.4 min in the QLB group and 100.3±22.9 in the TAPB group (P<0.05). Patients in the QLB group had 6.0 (2.0, 8.0) presses in 24 h, compared to 9.0 (3.0, 12.0) in the TAPB group (P<0.05). The incidence of postoperative nausea, vomiting, pruritus, and drowsy urinary

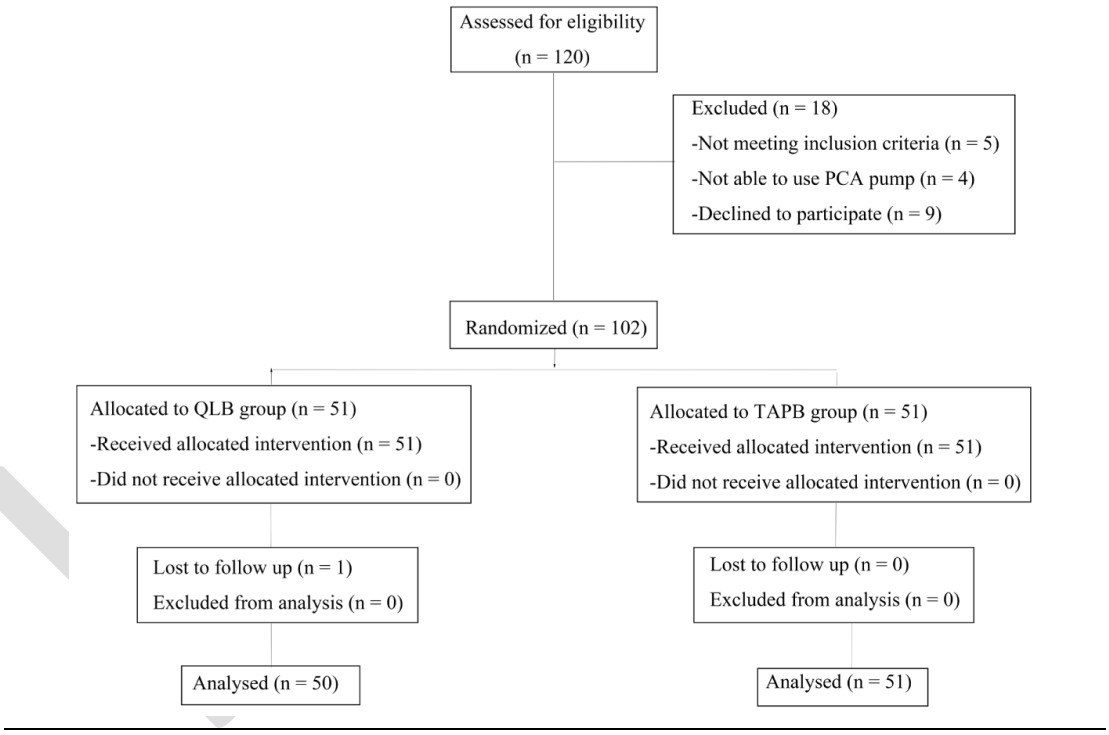

Figure 1. Trial flow diagram. TAPB, transversus abdominis plane block; ASA, American Society of Anesthesiologists.

Table 1. Patient demographic characteristics and intraoperative data

Variable	QLB group (n=50)	TAPB group (n=51)
Age (years)	67.9±6.0	68.0±6.3
Gender (Female/Male)	27/23	26/25
Body mass index (kg/cm²)	23.1±5.2	23.5±4.8
ASA physical status (I/II/III)	3/30/17	4/32/15
Duration of surgery (min)	189.5±15.6	194.1±16.2
Duration of anaesthesia (min)	212.8±19.7	220.4±18.9
Intraoperative sufentanil (μg)	21.5±1.2	20.4±1.0

Data are expressed as mean±SD or number of patients (%). QLB, quadratus lumborum block; TAPB, transversus abdominis plane block; ASA, American Society of Anesthesiologists.

Table 2. Postoperative patient data regarding analgesics and complications

Variable	QLB group (n=50)	TAPB group (n=51)	P-value
Time to first sufentanil analgesia in PACU (min)	35±8	16±5	< 0.01
Total postoperative sufentanil consumption at 24 h (μg)	2.4±0.5	5.5±0.3	0.021
PCA usage			
First analgesic time (min)	152.1±28.4	100.3±22.9	<0.01
Number of presses in 24 hours	6.0 (2.0, 8.0)	9.0 (3.0, 12.0)	0.032
Nausea	7 (14.0%)	13 (25.5%)	0.147
Vomiting	6 (12.0%)	10 (19.6%)	0.295
Pruritus	1 (2.0%)	4 (7.8%)	0.176
Drowsiness	2 (4.0%)	4 (7.8%)	0.414
Urinary retention	2 (4.0%)	1 (2.0%)	0.617

Data are expressed as mean±SD or median (IQR). QLB, quadratus lumborum block; TAPB, transversus abdominis plane block; PACU, Postanesthesia care unit; PCA, patient-controlled analgesia.

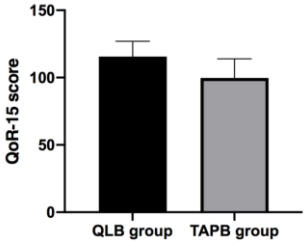

Figure 2. Primary outcomes. Data are expressed as mean±SD. QLB, quadratus lumborum block; TAPB, transversus abdominis plane block

retention did not differ between the two groups (Table 2, P>0.05). There was no difference between the two groups at rest or during exercise in terms of the NRS scores (Table 3, P>0.05). The two groups did not differ in terms of postoperative complications (Table 4, P>0.05). There were no significant differences between the two groups regarding the first time of getting out of the bed, postoperative exhaust time, unplanned admission to the ICU, and postoperative hospital stay (Table 5, P>0.05).

Table 3. NRS pain scores

Variable	QLB group (n=50)	TAPB group (n=51)	P-value
NRS at rest			
0	0 (0, 1)	0 (0, 1)	0.723
1	2 (0, 2)	2 (2, 4)	0.541
6	2 (1, 3)	2 (1, 4)	0.457
12	2 (1, 3)	3 (1, 5)	0.076
24	2 (1, 4)	3 (1, 5)	0.101
NRS on movement			
0			
1	3 (1, 4)	3 (1, 5)	0.248
6	4 (2, 6)	4 (2, 7)	0.351
12	4 (2, 7)	4 (2, 7)	0.437
24	4 (2, 8)	4 (2, 8)	0.592

Data are expressed as median (IQR). QLB, quadratus lumborum block; TAPB, transversus abdominis plane block; NRS, Postanesthesia care unit.

Table 4. Incidence of postoperative complications

Variable	QLB group (n=50)	TAPB group (n=51)	P-value
Intestinal obstruction	0	1 (2.0%)	0.99
Abdominal infection	1 (2.0%)	2 (3.9%)	0.99
Arrhythmia	3 (6.0%)	3 (5.9%)	0.99
Urinary tract infection	2 (4.0%)	4 (7.8%)	0.678
Surgical incision infection	0	1 (2.0%)	0.99
Anastomotic fistula	1 (2.0%)	1 (2.0%)	0.99

Data are expressed as numbers (%). QLB, quadratus lumborum block; TAPB, transversus abdominis plane block.

Table 5. Comparison of other secondary postoperative outcomes

Variable	QLB group (n=50)	TAPB group (n=51)	P-value
First time of getting out of the bed (h)	14.2±2.1	15.0±2.9	0.486
Postoperative exhaust time (h)	20.3±3.4	21.5±4.2	0.263
Unplanned ICU admission (h)	2 (4.0%)	3 (5.9%)	0.99
Postoperative length of stay (d)	6 (4, 11)	8 (5, 11)	0.141

Data are expressed as mean±SD or number of patients (%). QLB, quadratus lumborum block; TAPB, transversus abdominis plane block; ICU, Intensive care unit.

5. Discussion

The present study compared QLB and TAPB in patients undergoing laparoscopic radical colon cancer surgery under general anesthesia, and patients receiving QLB had significantly higher

quality of recovery at 24 h postoperatively, compared to the TAPB group. Patients in the QLB group had reduced sufentanil consumption at 24 h postoperatively, longer time to first analgesic administration in the PACU, longer time to first PCA press, and fewer presses within 24 h.

Reduction of perioperative pain is the only target of postoperative recovery, and we believe that the physical and psychological recovery of patients is more meaningful than pain-free. Therefore, the QoR-15 score was used as the main outcome to assess the quality of postoperative recovery. The QoR-15 is a patient-centered and self-assessment scale for assessing the quality of postoperative recovery, with advantages, such as validity, reliability, sensitivity, clinical acceptability, and feasibility (22-23), covering five aspects of physical comfort, independence, psychological support, emotional state, and pain level; moreover, it is internationally recognized as an effective tool for assessing patients' postoperative recovery (24). Compared to the QoR-40, the QoR-15 allows for an equally extensive but more effective assessment of postoperative status (18).

TAPB has been demonstrated as an effective treatment in laparoscopic surgery to reduce postoperative pain, decrease opioid consumption, improve QoR-40 scores, and promote rapid postoperative recovery (25). TAPB can provide effective somatic analgesia but is less effective in suppressing visceral pain (26). QLB was effective in relieving pain after gynecologic laparoscopic surgery and cesarean delivery (27), and it has also proven effective in gastrointestinal and renal surgery (26). It has been noted that TAPB blocks skin sensation from T_{10} to T_{12}, whereas QLB blocks T_7 to T_{12}, which may be partly related to the diffusion of local anesthetic into the paravertebral space or thoracolumbar plane (containing mechanoreceptors and a dense network of sympathetic fibers), and this extensive diffusion significantly inhibits the somatic and visceral pain (12). Another trial investigated the relationship between the concentration of local anesthetic and the analgesic effect of QLB and TAPB. The results showed that local anesthetic concentrations were higher at TAPB than at QLB; however, the analgesic effect was better at QLB than at TAPB, possibly in part because the drug entered the paravertebral space filled with adipose tissue from the fascial space, resulting in lower perfusion and slower absorption of local anesthetic (12). One study, by comparing with the Sham group, noted that QLB significantly reduced perioperative opioid consumption in patients undergoing laparoscopic colorectal surgery, reduced postoperative pain, shortened time to first out of bed activity, improved QoR-15 scores, and promoted postoperative recovery (28). However, no study has been conducted to compare the difference between QLB and TAPB on postoperative recovery in patients undergoing laparoscopic radical colon cancer surgery using QoR-15 as the primary outcome. This study showed that patients in the QLB group had higher QoR-15 scores at 24 h postoperatively, compared to those in the TAPB group, suggesting that QLB promoted postoperative recovery.

A study by Marcin Kolacz et al. (29) compared QLB with TAPB in renal transplantation and found that unilateral QLB was superior to unilateral TAPB in terms of postoperative analgesia and fentanyl consumption; however, there was no difference in postoperative NRS scores either at rest or during exercise. Similar to the results of this study, the present study showed that patients in the QLB group had significantly less sufentanil consumption than the TAPB group at 24 h postoperatively. All patients were admitted to the PACU for transition postoperatively, and analgesic interventions were performed when patients had an NRS >3 scores; in addition, the patients receiving QLB had a significantly longer time to first analgesia administration than TAPB, and patients in the QLB group had a significantly longer first analgesic time, as well as fewer presses over 24 h, indicating the advantage of QLB in terms of analgesic efficacy. The results of a randomized study of laparoscopic gynecologic surgery showed that QLB reduced postoperative pain in patients at rest and during exercise, compared to controls (30). However, in our study, there was no difference in the NRS scores at rest and exercise at 0 h, 1 h, 6 h, 12 h, and 24 h after surgery. The reason may be that PCA was used as the analgesic modality which allows self-administrated analgesia according to their condition. This multifaceted analgesic plan ensures that the quality of postoperative recovery is not affected by pain, which is why we did not choose postoperative pain as the primary outcome.

Although there was a difference between the two groups in sufentanil consumption, opioid-related adverse effects did not differ between the two groups either. This result is consistent with that reported by Yuki Aoyama, who also did not find a difference between QLB and TAPB in reducing opioid-induced nausea and vomiting in gynecologic laparoscopic surgery (31). We observed no difference in postoperative complications, such as intestinal obstruction, abdominal infection, cardiac arrhythmia, urinary tract infection, incision infection, and anastomotic fistula between the two groups. In addition to the small sample size, another reason may be that our hospital has developed an accelerated recovery process that is humane, refined, and precise in both surgical operations, anesthesia management, and postoperative care. It is worth noting that the postoperative hospital stay of the QLB group was reduced by two days. However, this difference was not significant since the sample size was too small, suggesting the advantages of QLB, which needs to be confirmed by further studies.

This study has the following limitations: first, for

ethical reasons, we did not subject patients to sham surgery or a blank control group. However, both TAPB and QLB have emerged as effective analgesic modalities for abdominal surgery. Second, we only studied Chinese patients, and further research is needed to determine whether there are ethnic differences. Third, TAPB or QLB was performed while the patient was unconscious following anesthesia induction, and the effective block area could not be determined by skin sensation; however, this is consistent with clinical practice, where blocks are usually administered in the absence of pain after anesthesia induction. Patients in the QLB group had reduced sufentanil consumption 24 h postoperatively, indirectly indicating the effectiveness of the block.

This prospective, single-center, and randomized controlled study demonstrated that QLB provided a better analgesic option for patients undergoing radical laparotomy for colon cancer, prolonged the time to first analgesic administration, reduced the consumption of postoperative opioids, and strongly contributed to a faster postoperative recovery for patients.

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Footnotes

Conflicts of Interest: None
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