

Research Article

Ultrasound-Guided Quadratus Lumborum Block Versus Local Infiltration Anesthesia for Inguinal Herniorrhaphy: A Randomized Controlled Trial

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Abstract

Background: Quadratus lumborum block (QLB) has been reported as an innovative analgesic procedure for enhanced recovery after inguinal herniorrhaphy. However, it has never been compared with local infiltration anesthesia (LIA) as the sole anesthetic technique in inguinal herniorrhaphy. This study aimed to compare the anesthetic efficacy of QLB and LIA for inguinal herniorrhaphy. **Methods:** A total of 70 patients undergoing elective inguinal herniorrhaphy were randomly assigned to receive either QLB or LIA. The primary outcome was the area under the curve (AUC) of the pain numeric rating scale (NRS) during surgery. Secondary outcomes included anesthesia efficacy, consumption of additional local anesthetics for rescue analgesia, level of intraoperative traction reaction, postoperative pain scores at rest and during movement, and adverse side effects. **Results:** The QLB group had a significantly higher AUC for intraoperative NRS scores than the LIA group (15.7 ± 3.1 vs 13.1 ± 3.6 , 95% CI for the difference: 1.23 to 4.17, $P=0.002$) and required a greater volume of rescue local anesthetics (11.0 ± 7.6 mL vs. 5.7 ± 6.4 mL, 95% CI for the difference: 1.05 to 9.55, $P=0.02$). However, the QLB group had lower scores for visceral traction reaction [median 2.0 (interquartile range, IQR 2.0 to 2.3) vs. 2.0 (IQR 2.0 to 3.0), 95% CI for the median difference: -0.82 to -0.05, $P=0.026$] and lower resting NRS pain scores at 12 h postoperatively. **Conclusions:** Both QLB and LIA can provide sufficient analgesia for inguinal herniorrhaphy without the need for conversion to other anesthetic methods. LIA is more effective in controlling intraoperative pain and reducing the consumption of rescue local anesthetics, while QLB is associated with milder peritoneal traction reaction and better postoperative analgesia at 12 h after surgery. The combination of LIA and QLB is hypothesized to be a more optimal anesthetic choice for inguinal herniorrhaphy, which requires further prospective clinical research to verify this assumption.

Keywords

Analgesia, Inguinal Herniorrhaphy, Local Infiltration Anesthesia, Quadratus Lumborum Block

1. Introduction

Inguinal hernia is a common surgical disease with a particularly high prevalence in the elderly population, and open inguinal herniorrhaphy (OIH) is the main treatment method [1,

2]. OIH can be performed under various anesthetic techniques, among which local infiltration anesthesia (LIA) is widely used

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in clinical practice for its advantages of reducing the consumption of general anesthetics and opioids, promoting the early recovery of gastrointestinal function, shortening hospital stay, and reducing the incidence of postoperative complications [3]. However, LIA often cannot adequately relax the abdominal wall muscles or effectively suppress visceral pain during hernia sac manipulation and preperitoneal space separation [4], especially in patients with giant inguinal hernias or recurrent hernias, which may affect the surgical process and patient comfort.

Quadratus lumborum block (QLB) is an innovative ultrasound-guided regional anesthesia technique that has been proven to provide effective postoperative analgesia for a variety of abdominal and orthopedic surgical procedures [5, 6]. There are four different approaches for QLB, which differ in the injection site of local anesthetics relative to the quadratus lumborum muscle. The most common approach is to inject local anesthetics between the quadratus lumborum muscle and the psoas major muscle, where the drug can spread along the thoracolumbar fascia to achieve anesthesia and analgesia of the T6-L1 dermatomes. This technique is widely applied in total hip arthroplasty, cesarean section, and nephrectomy, and it has also been extended to pediatric abdominal surgical analgesia with promising results [7]. In addition, QLB can consistently block the ilioinguinal and iliohypogastric nerves [8], which are the primary innervating nerves of the inguinal region, suggesting that QLB has the potential to provide adequate analgesia for OIH. Several case reports have confirmed the feasibility of QLB as the sole anesthetic method for inguinal hernia surgery [9-11], but there is no clinical trial that directly compares QLB with LIA as the sole anesthetic technique for OIH.

In recent years, ultrasound-guided regional nerve block has been continuously optimized, and the application of QLB in perioperative analgesia has been further expanded with the update of ultrasound equipment and block techniques [12, 13]. Relevant studies have also confirmed that the safety and efficacy of QLB in abdominal surgery have been significantly improved with the standardization of operation procedures [14]. Therefore, we conducted a prospective, single-center, randomized controlled trial to compare the anesthetic efficacy and safety of QLB and LIA for OIH, with intraoperative pain as the primary endpoint. The results of this study are expected to provide new clinical evidence for the selection of anesthetic methods for inguinal herniorrhaphy.

2. Materials and Methods

2.1. Study Design

This was a single-center, prospective, randomized controlled clinical trial conducted at the West China Hospital of Sichuan University from February to October 2019. Patients were eligible for enrollment if they met the following criteria: (1) ASA physical status I-III; (2) aged 18 years and above; (3)

scheduled for elective primary unilateral open tension-free inguinal hernia repair; (4) able to cooperate with pain assessment and postoperative follow-up. Exclusion criteria included: (1) daily consumption of opioid analgesics before surgery; (2) allergy to local anesthetics or analgesic drugs used in the study; (3) coagulation dysfunction or use of anticoagulant drugs; (4) localized infection at the surgical site or lumbar region; (5) mental or neurological disorders with impaired cognitive function; (6) preoperative neuropathological changes in the inguinal or lumbar region; (7) history of inguinal hernia repair surgery; (8) giant inguinal hernia or incarcerated hernia requiring emergency surgery.

2.2. Study Approval and Trial Registration

This study was approved by the Ethical Committee of West China Hospital of Sichuan University (Ethical Committee no. 2018/368) in January 2019, and registered in the Chinese Clinical Trial Registry (registration no. ChiCTR1900021210, <http://www.chictr.org.cn/showproj.aspx?proj=35782>). All patients provided written informed consent before enrollment, and the study was conducted in strict accordance with the Declaration of Helsinki.

2.3. Randomization and Allocation Concealment

After obtaining written informed consent, patients were randomly assigned to the QLB group or LIA group at a 1:1 ratio using a computer-generated random sequence by an independent statistician who was not involved in the study implementation and outcome assessment. Allocation concealment was achieved using the sealed envelope method: the random assignment results were sealed in opaque envelopes, which were opened only by the anesthesiologist performing the block after the patient entered the operating room. Patients, researchers responsible for data collection, clinicians assessing block efficacy, and outcome evaluators were all blinded to the group allocation. The surgeon who performed the surgery was not blinded due to the need for layer-by-layer LIA and administration of rescue local anesthetics, but the surgeon was not involved in the outcome assessment. The non-blinded surgeon may have had potential subjective biases in the administration of rescue local anesthetics during the operation, but the influence of this bias on the primary outcome was minimized because the intraoperative NRS score was evaluated by an independent blinded outcome assessor, and the rescue medication was administered according to a unified NRS score threshold (≥ 4 points) with no discretionary adjustment by the surgeon.

2.4. Preoperative Management

On the day before surgery, the investigator explained the study protocol and the use of the NRS for pain assessment (0

= no pain, 10 = the worst pain imaginable) to the patients, and trained the patients to correctly score their pain. On the day of surgery, all patients fasted for 8 h and abstained from water for 4 h before surgery, with no premedication administered. After entering the operating room, all patients received standard anesthesia monitoring, including electrocardiography, pulse oximetry, and non-invasive blood pressure measurement (measured every 5 min). Supplemental oxygen (2-3 L/min) was administered via a facial mask, and sodium lactate Ringer's solution was intravenously infused at a rate of 5 mL/kg per hour for fluid resuscitation.

2.5. Anesthetic Procedure

All patients first received real or sham anterior QLB in the lateral decubitus position with the surgical side upward, followed by sham or real LIA in the supine position after returning to the supine position. Specifically, patients in the QLB group received ultrasound-guided anterior QLB with 30 mL of 0.33% ropivacaine on the surgical side, combined with sham LIA (1 mL of 2% lidocaine injected subcutaneously at the planned surgical incision). Patients in the LIA group received sham QLB (1 mL of 2% lidocaine injected subcutaneously at the lumbar region of the surgical side) combined with layer-by-layer LIA at the planned surgical incision with low-concentration local anesthetics.

2.5.1. QLB Protocol

Preoperative ultrasound-guided anterior QLB was performed by the same anesthesiologist with more than 5 years of experience in ultrasound-guided regional anesthesia. A sterile low-frequency convex ultrasound probe (5 MHz; Anesus ME7, Mindray, Shenzhen, China) was disinfected with iodophor and covered with a sterile probe sheath. The probe was placed laterally between the iliac crest and costal arch on the surgical side to identify the three layers of the abdominal wall muscles (external oblique, internal oblique, and transverse abdominis muscles). The probe was then slowly moved posteriorly to clearly identify the "Shamrock sign" composed of the quadratus lumborum muscle, psoas major muscle, and erector spinae muscles. After subcutaneous injection of 1 mL of 2% lidocaine for local analgesia at the needle insertion site, a 21-gauge, 100-mm needle (Uni-Plex Nanoline, Germany) was inserted into the fascial space between the quadratus lumborum muscle and psoas major muscle using the in-plane technique from the caudal to cranial direction. After the needle tip was placed in the target space, 3-5 mL of normal saline was injected for hydro-dissection to confirm the correct needle tip position (no intravascular or intraperitoneal injection). After confirmation, 30 mL of 0.33% ropivacaine was slowly injected at a rate of 5 mL/min, and the spread of the local anesthetic was observed in real time by ultrasound to ensure that the drug was evenly distributed in the target fascial space. At 20 min after the completion of QLB, sensory block efficacy was evaluated by another anesthesiologist who was blinded to

the group allocation using the pin-prick test with von Frey filaments. The sensory block range was assessed from the T8 to L2 dermatomes, and only patients with effective sensory block (pin-prick pain significantly reduced or disappeared) in the T11-L1 dermatomes were allowed to undergo surgery. Patients who did not achieve effective sensory block in the T11-L1 dermatomes received general anesthesia and were excluded from the study.

2.5.2. LIA Protocol

Layer-by-layer LIA was performed in the supine position by the same surgeon with more than 30 years of experience in inguinal herniorrhaphy before skin incision. The local anesthetic solution (LAs) was prepared by a nurse anesthetist before surgery, consisting of 0.25% lidocaine hydrochloride (400 mg), 0.06% ropivacaine hydrochloride (100 mg), and 0.2 mg epinephrine (1:700,000) in a total volume of 160 mL of normal saline. A total of 60 mL of the prepared LAs was administered to each patient with a 10-mL syringe and a 22-gauge needle using a stepwise infiltration method: (1) 10 mL of LAs was injected subcutaneously from the pubic tubercle to 1 cm above the midpoint of the inguinal ligament (internal inguinal ring); (2) 5 mL of LAs was injected intradermally along the planned surgical incision; (3) 6 mL of LAs was injected into the inguinal canal; (4) 4 mL of LAs was injected at the pubic tubercle; (5) 10 mL of LAs was carefully injected into the internal inguinal ring (avoiding intravascular injection by aspirating before injection); (6) after skin incision and subcutaneous fascia dissection, 10 mL of LAs was injected into the subaponeurotic space of the external oblique aponeurosis; (7) after opening the external oblique aponeurosis and mobilizing the spermatic cord, 5 mL of LAs was injected on each side of the spermatic cord structure; (8) finally, 10 mL of LAs was injected around the internal inguinal ring (for indirect hernia) or under the transverse fascia (for direct hernia). During the infiltration process, the needle was aspirated before each injection to avoid intravascular injection of local anesthetics.

2.6. Intraoperative and Postoperative Management

Intraoperative pain was assessed using the NRS at each key surgical time point, and rescue local anesthetics (2% lidocaine) were administered intravenously or locally if the patient's NRS pain score was ≥ 4 . If the NRS pain score remained above 4 after the administration of the maximum dose of rescue local anesthetics (20 mL), the anesthetic method was converted to general anesthesia, and the case was considered an anesthetic failure. Intraoperative heart rate and non-invasive blood pressure were maintained within $\pm 15\%$ of the baseline values; if there were significant fluctuations, vasoactive drugs were administered for correction according to the clinical routine. All surgical procedures were performed by the same surgeon using the Ultrapro Hernia System (Johnson & Johnson, USA) and Prolene Hernia System for mesh placement.

After the operation, the patient was transferred to the post-anesthesia care unit for observation for 2 h, and abdominal ultrasonography was performed by the same anesthesiologist to assess for potential block-related complications such as hematoma, organ injury, or local anesthetic effusion. After being transferred to the general ward, 10 mg of dezocine was intravenously administered at 6 h postoperatively as routine postoperative analgesia, and patients were encouraged to resume early ambulation and oral liquid diet. If the patient's postoperative NRS pain score was ≥ 4 and required additional analgesia, 50 mg of tramadol hydrochloride was intravenously administered as rescue analgesia.

2.7. Outcomes

The intraoperative pain scores were recorded at different time points, including skin incision (T1), opening of the external oblique aponeurosis (T2), release of the hernial sac (T3), preperitoneal space separation (T4), mesh insertion (T5), and incision closure (T6). The primary endpoint was defined as the area under the curve (AUC) of the NRS scores measured at these time points. Secondary outcomes included the following: (1) anesthesia efficacy based on the number of patients who required conversion to other anesthesia methods, (2) volume of rescue LAs for additional analgesia, (3) level of intraoperative traction reaction at T1-T6 using a four-point scale (1, no pain and discomfort, no nausea and vomiting; 2, mild discomfort and nausea, no pain and vomiting; 3, nausea, mild pain, no vomiting; 4, obvious pain, nausea, vomiting, and flatulence), (4) postoperative pain score at rest and during movement, (5) postoperative analgesics consumption, and (6) side effects.

2.8. Statistical Analysis

All calculations were conducted using the Power Analysis and Sample Size software (version 11.0; NCSS, Kaysville, Utah, USA) and data from our pilot study, in which 10 patients were randomly divided into two equal groups to receive QLB or LIA. The mean AUC for intraoperative NRS scores was 15.4 ± 2.8 for QLB and 13.3 ± 2.3 for LIA. Using a two-group *t*-test with a power of 90% and a significance level of 0.05, we concluded that a minimum sample of 31 subjects per group was required. To account for drop-outs, we aimed to recruit at least 35 in each arm.

Statistical analysis was performed using the SPSS software

package (version 25.0; IBM, Armonk, New York, USA). Normally and non-normally distributed variables were presented as mean $\pm$ standard deviation (SD) or median (interquartile range, IQR). Wilcoxon tests were used to analyze ordinal data. Differences between groups were evaluated using the independent *t* test for continuous variables and Fisher's exact test for categorical variables. The AUC of intraoperative NRS scores was calculated using the trapezoidal rule [15]. All *P* values were presented as two-tailed values, and a *P* value < 0.05 was considered statistically significant with 95% confidence intervals (CI) reported for all key continuous outcome measures.

3. Results

A total of 73 patients were initially screened, 70 of whom were enrolled in the study. One patient in the QLB group was excluded for refusing to cooperate with postoperative evaluations, and 69 patients ultimately completed all required assessments (Figure 1). The average age of patients in both groups exceeded 70 years, with more than 50% classified as ASA III (Table 1). No statistically significant differences were observed in baseline characteristics between the two groups, and intraoperative hemodynamics remained stable in both groups throughout the surgical procedure.

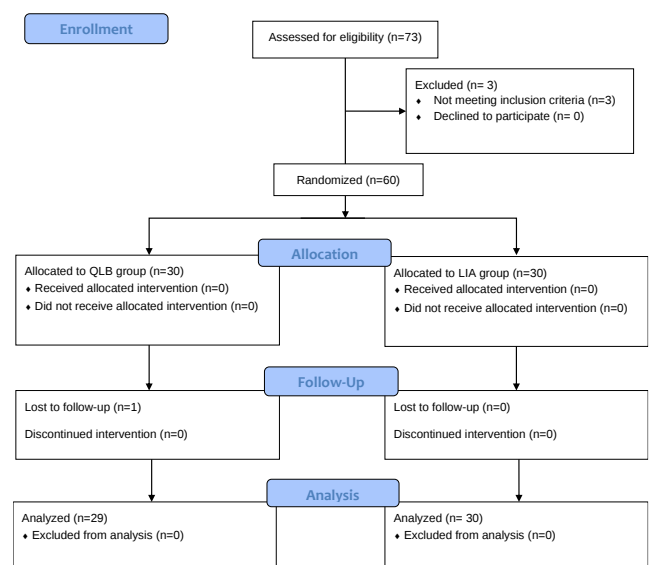


Figure 1. Study flowchart.

Table 1. Patient characteristics and surgical values.

Variable	QLB	LIA	P-value
Age (y)	71.0 $\pm$ 11.6	71.8 $\pm$ 10.5	0.781

Variable	QLB	LIA	P-value
Sex (F/M)	3/31	6/29	0.504
BMI (kg/m ²)	23.3±2.2	22.9±2.5	0.517
ASA (II/III)	16/18	18/17	0.717
Hernia type (indirect/direct)	23/11	27/8	0.377
Surgical duration (min)	28.3±7.9	27.9±7.4	0.813

Data are presented as mean ± standard deviation and counts. Abbreviations: ASA: American Society of Anesthesiologists; BMI: body mass index; LIA: local infiltration anesthesia; QLB: quadratus lumborum block.

3.1. Primary Outcome

Neither the QLB nor the LIA group required conversion to alternative anesthetic techniques. However, the intraoperative NRS AUC was significantly lower in the LIA group compared with the QLB group (13.1 ± 3.6 vs. 15.7 ± 3.1 , 95% CI: 1.23 to 4.17, $P = 0.002$, independent t test; Figure 2). Specifically, the LIA group exhibited lower NRS scores at three key time points: skin incision (T1), opening of the external oblique aponeurosis (T2), and incision closure (T6), with $P < 0.001$, $P < 0.001$, and $P = 0.025$ respectively (Table 2). No significant differences in NRS scores were found between the two groups at other time points (Table 2).

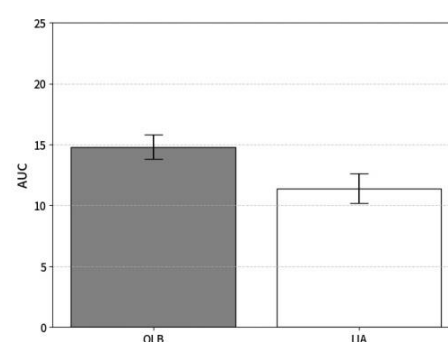


Figure 2. Bar plot of the area under the curve (AUC) for intraoperative numerical pain rating scale with 95% confidence intervals.

Table 2. Intraoperative numerical rating scale (NRS) at different time points.

Time point	QLB	LIA	P-value†
T1	3 (3, 4)	3 (2, 3)	0.002
T2	3 (3, 4)	3 (2, 3)	<0.001
T3	4 (3, 4)	3 (3, 4)	0.204
T4	3.5 (2, 4)	3 (2, 4)	0.095
T5	2.5 (2, 3)	2 (2, 3)	0.150
T6	1 (1, 2)	1 (0, 1)	0.025

Data are presented as median (interquartile range). †Wilcoxon rank-sum test used to compare medians between the groups. LIA: local infiltration anesthesia; NRS: numerical rating scale; QLB: quadratus lumborum block. T1 means the time point of skin incision, T2 means the time of opening the external oblique aponeurosis, T3 means releasing of the hernial sac, T4 means separating the preperitoneal space, T5 means inserting the mesh, T6 means sewing up the incision.

3.2. Secondary Outcomes

All patients in the QLB group achieved effective sensory block in the T11-L1 region 20 minutes after block administration. The volume of additional local anesthetics (LAs) required was significantly higher in the QLB group than in the

LIA group (11.0 ± 7.6 mL vs. 5.7 ± 6.4 mL, 95% CI: 1.05 to 9.55, $P = 0.02$), with the highest demand occurring during skin incision (QLB 2.6 ± 2.1 mL vs. LIA 0.8 ± 1.4 mL, 95% CI: 1.01 to 2.59, $P < 0.001$). Furthermore, the QLB group showed a lower level of traction reaction at mesh insertion (T5) compared with the LIA group [2.0 (2.0 to 2.3) vs. 2.0 (2.0 to 3.0), 95% CI: -0.79 to -0.04, $P = 0.03$].

At 12 hours postoperatively, the resting NRS score was lower in the QLB group than in the LIA group (95% CI: -1.12 to -0.08, $P=0.014$), while no significant differences were detected at other postoperative time points or during movement (Figure 3). There were also no notable differences between the two groups in postoperative adverse events, including nausea,

vomiting, dizziness, itching, or urinary retention. No patient experienced block-related complications such as hematoma, organ injury, or anesthetic toxicity. Two patients in each group required 50 mg of tramadol hydrochloride for supplementary analgesia, and all patients were able to ambulate 6 hours after surgery and were discharged within 24 hours.

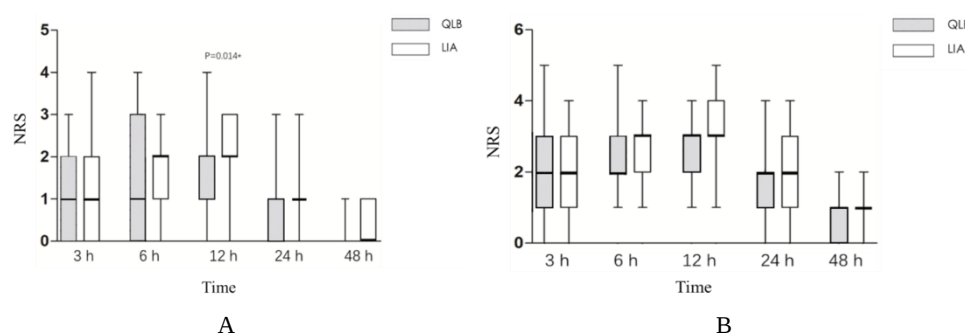


Figure 3. Postoperative pain intensity on an NRS from 0 to 10 when the patient was (A) at rest or (B) in movement.

4. Discussion

This study compared the anesthetic effectiveness of QLB and LIA in open inguinal herniorrhaphy (OIH). The results showed that both methods could provide sufficient anesthesia, eliminating the need for conversion to other anesthetic approaches and avoiding serious adverse effects or complications such as hematoma, anesthetic toxicity, or limb weakness. While LIA was more effective in controlling intraoperative pain and reducing the volume of rescue LAs, QLB was associated with less traction response and improved postoperative analgesia. Thus, the combination of LIA and QLB is hypothesized to represent a more optimal choice for inguinal herniorrhaphy, which warrants further prospective clinical investigation to validate this hypothesis.

The incision for OIH is made 1 finger-width below the internal inguinal ring but above the inguinal ligament [16]. This procedure is typically performed in the T12-L1 region, where the iliohypogastric nerve innervates the skin over the inguinal area, and the ilioinguinal nerve innervates the hernia sac, medial thigh, anterior scrotum, and labia [17]. The similar anesthetic efficacy of QLB and LIA in this study can be attributed to the effective diffusion of local anesthetics to these two nerves through different mechanisms. Cadaveric studies have demonstrated that dyes can directly spread to the L1-3 nerve roots following anterior QLB injection at the L3-4 level [18]. Since the iliohypogastric and ilioinguinal nerves originate from the L1-L2 spinal nerves [19], we hypothesize that anterior QLB blocks these nerves by facilitating the diffusion of local anesthetics into the thoracolumbar paravertebral space and the roots and branches of the lumbar nerves. In contrast, LIA directly blocks the small nerve branches in the inguinal region.

Numerous case reports have confirmed that QLB can be used as a sole anesthetic method for inguinal surgery [9-11]. A previous randomized controlled trial found that QLB is safer and more effective than general anesthesia for patients undergoing endoscopic extraperitoneal inguinal repair, as it alleviates early postoperative pain, shortens hospital stay, and reduces anesthesia-related and overall hospital costs [10]. Consistent with these findings, our study revealed that QLB combined with rescue LAs provides favorable anesthetic efficacy. Recent clinical studies have also shown that the application of QLB in elderly patients undergoing abdominal surgery can significantly reduce perioperative opioid consumption and improve postoperative recovery quality [20], which is consistent with the results of our study in elderly OIH patients.

Although the success rate of regional anesthesia is commonly used to evaluate anesthetic efficacy, our trial went further by comparing intraoperative pain between the QLB and LIA groups, as our preliminary study found that neither group required conversion to other anesthetic methods. Our results indicated that LIA was superior to QLB in terms of intraoperative NRS AUC and the volume of rescue LAs needed. Even after achieving successful dermatomal sensory block, QLB provided less effective analgesia, particularly at superficial surgical sites such as the skin incision. This may be because QLB requires a longer time to exert its analgesic effect, with an onset time of approximately 20 minutes [21], which is why we evaluated the analgesic effect 20 minutes after QLB completion. In our hospital, some patients undergo surgery 1 hour after QLB administration due to scheduling adjustments and usually do not require additional LAs during surgery, suggesting that a longer interval after QLB may promote drug diffusion and enhance the analgesic effect. Additionally, since the hernia sac is partially innervated by the genital branch of the genitofemoral nerve, the high pain scores during skin incision

may also result from incomplete blockade of this nerve [22]. Cadaveric studies on anterior QLB have shown that only approximately 30% of genitofemoral nerves can be stained by the anesthetic [22, 23]. Based on these observations, we propose that infiltrating additional LAs at the incision site in QLB patients may achieve intraoperative pain control comparable to that of LIA.

To our knowledge, this is the first randomized controlled trial to compare the anesthetic efficacy of QLB and LIA. LIA is a common, safe clinical practice with a long history and an important role in inguinal hernia repair [24, 25]. However, it is difficult to perform in patients with giant hernias, recurrent hernias, or obesity due to scar adhesion, nerve injury at the surgical site, or limited diffusion of local anesthetics in the adipose layer [26]. Such patients may benefit more from QLB, especially when combined with small additional doses of rescue LAs. A recent retrospective study has confirmed that QLB has better applicability than LIA in obese patients undergoing abdominal hernia repair [27], which further supports our above inference. In fact, we have applied QLB as the sole anesthetic method in an elderly high-risk patient undergoing giant inguinal hernia repair, achieving satisfactory results (unpublished data). However, none of the patients enrolled in this study had giant hernias or obesity, and those with recurrent hernias were excluded. Therefore, further research is needed to determine whether QLB is superior to LIA in these specific patient populations.

Nevertheless, this study provides evidence that QLB yields better postoperative analgesia than LIA. Postoperative pain in OIH is mainly caused by surgical incision, peritoneal traction from the mesh, and intraoperative nerve injury [28, 29], which can lead to complications, delayed recovery, and patient dissatisfaction. While LIA can only provide adequate analgesia for the surgical incision, QLB can also alleviate pain from peritoneal traction. Indeed, our study found that QLB was associated with reduced peritoneal traction during hernia sac reduction. Although the difference in traction response between the two groups may not be clinically significant, it may still improve patient comfort, as QLB can inhibit visceral pain by facilitating the diffusion of local anesthetics into the paravertebral space [30]. The larger volume of LAs administered to the QLB group may also have contributed to its enhanced postoperative analgesia.

The different volumes of local anesthetics injected in the two groups merit discussion. QLB is an interfascial plane block that requires a large volume of LAs for successful blockade; 30 mL of 0.33% ropivacaine has been reported to be effective and safe [31]. In contrast, LIA relies on the diffusion of local anesthetics around target nerves, and the concentrations and volumes used in the LIA group of our study have been shown to be safe and applicable for routine clinical practice [32]. Although the quadratus lumborum muscle is located in the deep spine, it is far from major nerves and blood vessels, so the risk of visceral organ injury under ultrasound guidance is low. This explains why no such injuries were observed in the QLB

group, nor were other complications such as block-induced hypotension or limb weakness. In fact, all QLB patients were able to ambulate 6 hours after surgery. In contrast, the needle direction during LIA cannot be visualized, increasing the risk of accidental vascular puncture or local anesthetic toxicity. However, the clinician who performed LIA in our study had extensive experience with this technique in OIH and only injected LAs after adequate needle aspiration to prevent intravascular infusion.

The findings of this study should be interpreted with caution due to several limitations. First, sensory block in the surgical area was assessed preoperatively to exclude cases of unsuccessful QLB. Although both groups underwent sham procedures, QLB patients may have been aware of their treatment allocation, and surgeons could distinguish between the groups because they performed LIA and administered rescue LAs. However, the outcome evaluator was not involved in block administration and was unaware of treatment assignments, which helped reduce potential bias. Another limitation is that all blocks were performed by the same two principal investigators. While this reduced confounding in outcome analysis, it may not accurately reflect real-world clinical practice, as QLB and LIA efficacy depends on operator skill. In addition, the single-center design of this study may limit the generalizability of the results, and multi-center randomized controlled trials with larger sample sizes are needed for further verification.

5. Conclusions

In conclusion, both QLB and LIA can meet the analgesic requirements of OIH without the need for alternative anesthetic methods. QLB is associated with reduced peritoneal traction and improved postoperative analgesia at 12 h, while LIA is superior in controlling intraoperative pain and reducing rescue LA volume. It is hypothesized that the combination of QLB with LIA may provide more optimal anesthesia for OIH, and this hypothesis has not been directly tested in the present study and thus requires confirmation in subsequent well-designed clinical trials with larger, more clinically diverse samples and different rescue LA administration time points. These findings should be verified and expanded in future studies with larger, more clinically diverse samples, where rescue LAs are administered at different time points.

Abbreviations

QLB	Quadratus Lumborum Block
LIA	Local Infiltration Anesthesia
AUC	Area Under the Curve
NRS	Numeric Rating Scale
OIH	Open Inguinal Herniorrhaphy
ASA	American Society of Anesthesiologists
BMI	Body Mass Index

LAs	Local Anesthetic Solutions
SD	Standard Deviation
IQR	Interquartile Range
CI	Confidence Interval

Author Contributions

Yong Liu: Conceptualization, Data curation, Formal Analysis, Writing – original draft, Writing – review & editing

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Data Availability Statement

The data is available from the corresponding author upon reasonable request.

Conflicts of Interest

The author declares no conflicts of interest.

References

- [1] International guidelines for groin hernia management. *Hernia*. 2018; 22(1): 1-165. <https://doi.org/10.1007/s10029-017-1664-1>
- [2] de Goede B, Timmermans L, van Kempen BJ, van Rooij FJ, Kazemier G, Lange JF. Risk factors for inguinal hernia in middle-aged and elderly men: results from the Rotterdam Study. *Surgery*. 2015; 157(3): 540-546. <https://doi.org/10.1016/j.surg.2014.10.011>
- [3] Kulacoglu H, Alptekin A. Current options in local anesthesia for groin hernia repairs. *Acta Chir Iugosl*. 2011; 58(3): 25-35. <https://doi.org/10.2298/ACI1103025K>
- [4] Monestiroli UM, Bondurri A, Gandini F, Lenna G, Vellini S, Danelli P. Giant inguinoscrotal hernia. *Tech Coloproctol*. 2007; 11(3): 283-284. <https://doi.org/10.1007/s10151-007-0418-9>
- [5] Ueshima H, Otake H, Lin JA. Ultrasound-guided quadratus lumborum block: an updated review of anatomy and techniques. *Biomed Res Int*. 2017; 2752876. <https://doi.org/10.1155/2017/2752876>
- [6] Elsharkawy H, El-Boghdadly K, Barrington M. Quadratus lumborum block: anatomical concepts, mechanisms, and techniques. *Anesthesiology*. 2019; 130(2): 322-335. <https://doi.org/10.1097/ALN.0000000000002576>
- [7] Chakraborty A, Goswami J, Patro V. Ultrasound-guided continuous quadratus lumborum block for postoperative analgesia in a pediatric patient. *A & A Case Rep*. 2015; 4(3): 34-36. <https://doi.org/10.1213/ANE.0000000000000715>
- [8] Eichenberger U, Greher M, Kirchmair L, Curatolo M, Moriggl B. Ultrasound-guided blocks of the ilioinguinal and iliohypogastric nerve: accuracy of a selective new technique confirmed by anatomical dissection. *Br J Anaesth*. 2006; 97(2): 238-243. <https://doi.org/10.1093/bja/ael165>
- [9] La Colla L, La Colla MDL, Schroeder R, Schroeder RMD. Quadratus lumborum block as sole, homeostatic preserving anesthetic for a patient with multiple system atrophy undergoing open inguinal hernia repair: a case report. *Case Rep Anesthesiol*. 2018; 2018: 7161860. <https://doi.org/10.1155/2018/7161860>
- [10] Favaro ML, Gabor S, Souza DBF, Araújo AA, Milani ALC, Ribeiro Junior MAF. Quadratus lumborum block as a single anesthetic method for laparoscopic totally extraperitoneal (Tep) inguinal hernia repair: a randomized clinical trial. *Sci Rep*. 2020; 10(1): 8526. <https://doi.org/10.1038/s41598-020-65504-8>
- [11] Balogh J, Chen A, Marri T, De Haan JB, Guzman-Reyes S. Quadratus lumborum 2 block as the sole anesthetic technique for open hernia repair in multimorbid patients. *Cureus*. 2020; 12(8): e9697. <https://doi.org/10.7759/cureus.9697>
- [12] Li X, Wang H, Zhang L. Efficacy of ultrasound-guided quadratus lumborum block in perioperative analgesia for abdominal surgery: A meta-analysis. *J Clin Anesth*. 2022; 78: 110698. <https://doi.org/10.1016/j.jclinane.2022.110698>
- [13] Zhang Y, Liu S, Chen J. Standardization of ultrasound-guided quadratus lumborum block and its clinical application value. *Anesth Analg*. 2023; 137(2): 412-418. <https://doi.org/10.1213/ANE.0000000000005892>
- [14] Wang L, Zhao Y, Sun W. Safety and efficacy of different QLB approaches in abdominal surgical analgesia: A randomized controlled trial. *Reg Anesth Pain Med*. 2023; 48(5): 389-395. <https://doi.org/10.1097/AAP.0000000000001987>
- [15] Matthews JN, Altman DG, Campbell MJ, Royston P. Analysis of serial measurements in medical research. *BMJ*. 1990; 300(6719): 230-235. <https://doi.org/10.1136/bmj.300.6719.230>
- [16] Edwards CJ, Weller RS, Turner JD, Dobson SW, Jaffe JD, Reynolds JW. Ilioinguinal/Iliohypogastric versus quadratus lumborum nerve blockade for elective open inguinal herniorrhaphy: a prospective, randomized, double-blinded, equivalence trial. *Reg Anesth Pain Med*. 2020; 45(12): 970-974. <https://doi.org/10.1097/AAP.0000000000001664>
- [17] Bhatia N, Sen IM, Mandal B, Batra A. Postoperative analgesic efficacy of ultrasound-guided ilioinguinal-iliohypogastric nerve block compared with medial transverse abdominis plane block in inguinal hernia repair: a prospective, randomised trial. *Anaesth Crit Care Pain Med*. 2019; 38(1): 41-45. <https://doi.org/10.1016/j.accpm.2018.09.004>
- [18] Carline L, McLeod GA, Lamb C. A cadaver study comparing spread of dye and nerve involvement after three different quadratus lumborum blocks. *Br J Anaesth*. 2016; 117(3): 387-394. <https://doi.org/10.1093/bja/aew216>

- [19] van Schoor AN, Boon JM, Bosenberg AT, Abrahams PH, Meiring JH. Anatomical considerations of the pediatric ilioinguinal/iliohypogastric nerve block. *Paediatr Anaesth*. 2005; 15(5): 371-377. <https://doi.org/10.1111/j.1460-9592.2005.01519.x>
- [20] Chen Y, Li M, Han X. Effect of QLB on perioperative opioid consumption in elderly patients undergoing abdominal hernia repair. *Geriatr Gerontol Int*. 2024; 24(1): 68-72. <https://doi.org/10.1111/ggi.14389>
- [21] Johnston DF, Sondekoppam RV. Continuous quadratus lumborum block analgesia for total hip arthroplasty revision. *J Clin Anesth*. 2016; 35: 235-237. <https://doi.org/10.1016/j.jclinane.2016.05.014>
- [22] Dam M, Moriggl B, Hansen CK, Hoermann R, Bendtsen TF, Borglum J. The pathway of injectate spread with the transmuscular quadratus lumborum block: a cadaver study. *Anesth Analg*. 2017; 125(1): 303-312. <https://doi.org/10.1213/ANE.0000000000001656>
- [23] Adhikary SD, El-Boghdadly K, Nasrallah Z, Sarwani N, Nixon AM, Chin KJ. A radiologic and anatomic assessment of injectate spread following transmuscular quadratus lumborum block in cadavers. *Anesthesia*. 2017; 72(1): 73-79. <https://doi.org/10.1111/anae.13547>
- [24] Nordin P, Zetterstrom H, Gunnarsson U, Nilsson E. Local, regional, or general anaesthesia in groin hernia repair: Multicentre randomised trial. *Lancet*. 2003; 362(9387): 853-858. [https://doi.org/10.1016/S0140-6736\(03\)14193-9](https://doi.org/10.1016/S0140-6736(03)14193-9)
- [25] Amid PK, Shulman AG, Lichtenstein IL. Local anesthesia for inguinal hernia repair step by step procedure. *Ann Surg*. 1994; 220(6): 735-737. <https://doi.org/10.1097/00006558-199412000-00009>
- [26] Reid TD, Sanjay P, Woodward A. Local anesthetic hernia repair in overweight and obese patients. *World J Surg*. 2009; 33(1): 138-141. <https://doi.org/10.1007/s00268-008-9801-6>
- [27] Zhao J, Zhang H, Liu P. Retrospective comparison of QLB and LIA in obese patients undergoing open inguinal herniorrhaphy. *Hernia*. 2024; 28(3): 1245-1251. <https://doi.org/10.1007/s10029-024-02987-x>
- [28] Andresen K, Rosenberg J. Management of chronic pain after hernia repair. *J Pain Res*. 2018; 11: 675-681. <https://doi.org/10.2147/JPR.S158762>
- [29] Johnner A, Faulds J, Wiseman SM. Planned ilioinguinal nerve excision for prevention of chronic pain after inguinal hernia repair: a meta-analysis. *Surgery*. 2011; 150(3): 534-541. <https://doi.org/10.1016/j.surg.2011.05.020>
- [30] Blanco R, Ansari T, Girgis E. Quadratus lumborum block for postoperative pain after caesarean section: A randomised controlled trial. *Eur J Anesth*. 2015; 32(11): 812-818. <https://doi.org/10.1097/EJA.0000000000000434>
- [31] Hu J, Wang Q, Zeng Y, Xu M, Gong J, Yang J. The impact of ultrasound-guided transmuscular quadratus lumborum block combined with local infiltration analgesia for arthroplasty on postoperative pain relief. *J Clin Anesth*. 2021; 73: 110372. <https://doi.org/10.1016/j.jclinane.2021.110372>
- [32] Song Y, Han B, Lei W, Kou Y, Liu Y, Gong Y. Low concentrations of lidocaine for inguinal hernia repair under local infiltration anaesthesia. *J Int Med Res*. 2013; 41(2): 371-377. <https://doi.org/10.1177/0300060512472506>

Biography



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Research Field

Liu Yong: research field nerve block, research field local anesthetic toxicity, research field perioperative neurocognitive disorders, research field perioperative lung protection strategies, and research field clinical anesthesiology.