Original Article

Comparison of anterior, posterior, and lateral approaches of ultrasound-guided quadratus lumborum block in an adult patient undergoing inguinal hernia surgery: A prospective randomized controlled trial

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Abstract

Background and Aims: Inguinal hernia surgeries can pose significant postoperative pain, leading to chronic pain syndromes when not managed well.

Material and Methods: Sixty American Society of Anesthesiologists (ASA) I/II adult patients scheduled to undergo unilateral inguinal hernia surgeries were enrolled in this trial. The patients were randomly allocated into three groups according to the various approaches of ultrasound-guided quadratus lumborum (QL) block: group transmuscular (TM): TM or anterior approach, group L: lateral approach, and group P: posterior approach. All the patients underwent surgery under subarachnoid blockade. A QL block was administered at the end of the surgery.

Results: A total of 19 patients in each group were analyzed. Patients in the TM group had the least 24-hour requirement of fentanyl ($P < 0.001$), with better pain scores ($P < 0.001$) and prolonged duration of analgesia. No significant difference was found in the patient satisfaction scores (PSSs) in the three approaches. None of the patients reported any adverse effects related to the block.

Conclusion: The TM approach of QL block is an effective analgesic strategy in patients undergoing unilateral hernia surgeries. It could form a part of the multimodal analgesic regimen for such patients.

Keywords: Inguinal hernia surgery, postoperative analgesia, quadratus lumborum block, ultrasound

Introduction

Inguinal hernia surgeries are associated with moderate postoperative pain, which, when inadequately treated, can lead to acute and chronic complications.[1] The Prospect trial= Procedure specific postoperative pain management group recommended the use of regional anesthesia technique (field blocks: ilioinguinal, iliohypogastric, and genitofemoral) for all patients undergoing hernia surgeries.[2] However, they did not recommend any particular block. After these recommendations, there has been the advent of various interfascial blocks, with the quadratus lumborum (QL) plane block being one among them.

A QL plane block is a posterior abdominal wall block, first described by Blanco *et al.*[3,4] The local anesthetic (LA) spreads to the paravertebral space and has been successfully used for abdominopelvic surgeries in pediatric and adult

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patients.[5-8] Various techniques of this block have been described, which lead to differential spread of LA with varied sensory and motor blockades. QL muscle is surrounded by thoracolumbar fascia, which has three layers: the anterior layer that blends to transversalis fascia laterally and the fascia of psoas major medially. The middle layer lies between QL and the erector spinae muscle. The posterior layer is posterior to the erector spinae muscle. In the anterior or transmuscular (TM) approach, the drug is deposited in between the anterior borders of QL and psoas major. In the posterior approach, the drug is deposited between the posterior surfaces of QL and thoracolumbar fascia (TLF).[6,9,10]

There have been studies comparing the techniques in cesarean surgeries, but to the best of our knowledge, there are no studies comparing the three approaches in adult hernia surgeries. We hypothesized that TM QLB would be more effective for postoperative pain relief than the lateral or posterior approach in adult hernia surgeries. We designed this study to compare the three approaches of QLB (TM, posterior, or lateral) in terms of postoperative pain scores and analgesic consumption in adults undergoing unilateral inguinal hernia surgeries. We also aimed to compare the adverse effects associated with the three approaches, that is, muscle weakness, symptoms of LA systemic toxicity, and vascular puncture.

Material and Methods

This randomized controlled trial was conducted over a period of 1.5 years in our tertiary care center.

The Institutional Ethics Committee clearance of the study was followed by its registration in the Clinical Trial Registry of India. Sixty American Society of Anesthesiologists (ASA) I/II adult patients between the age groups of 18 and 65 years, scheduled for unilateral inguinal hernia surgery, were recruited. The study was conducted in line with the principles of the Declaration of Helsinki. Exclusion criteria included patients who refused to give consent, infection at the site of needle insertion, allergy to LAs, or those on chronic analgesics. Written informed consent was obtained after explaining the patients the procedure. The patients were educated about the numerical rating scale (NRS) and the use of patient-controlled analgesia (PCA) pump a day before surgery. Patients who did not comprehend the NRS or the PCA pump were excluded from the study. The patients were randomized into three groups using computer-generated random numbers. Allocation concealment was performed using opaque, sealed envelopes, which were opened only on the day of surgery.

Group TM: TM approach or anterior approach.

Group L: Type 1 or lateral approach.

Group P: Type 2 or posterior approach.

A standardized volume of LA: 0.4 ml/kg 0.2% ropivacaine was used for the blocks. After shifting the patient to the operation theater, standard ASA monitors were attached and baseline parameters were documented. All the surgeries were conducted in subarachnoid block. Fifteen mg of 0.5% heavy bupivacaine was administered. At the end of the surgery, an ultrasonography (USG)-guided QL block was given by experienced regional anesthesiologists with more than 7 years of experience.

Group TM (TM approach or anterior approach)

Patients were placed in the lateral decubitus position. After local sterilization, the ultrasound probe (2 to 6 MHz, low frequency, curvilinear) was covered with a sterile sheath and placed above the iliac crest. Petit's triangle was identified. The three abdominal muscles (i.e., the external oblique, internal oblique, and transverses abdominis muscles) were detected and followed posteriorly until the layers of the TLF appeared as a bright hyperechogenic line. The QL muscle appeared below the latissimus dorsi muscle. Then, a 10-cm, 22-gauge SonoPlex needle was inserted using an in-plane technique along the posterior edge of the probe in an anteromedial direction. The needle tip was placed between the two muscles (QL and psoas major muscle). After confirming the correct position of the needle using 2 ml of normal saline for hydro-dissection, 0.4 ml/kg of 2 mg/ml ropivacaine was administered. The injected LA bolus was then seen pushing the psoas major away from the QL muscle.

Group L (Lateral approach)

The patients were placed in the lateral position. The linear transducer was placed transversely in the midaxillary line between the costal margin and the iliac crest. It was moved posteriorly until the posterior aponeurosis of the transverses abdominis muscle was visible. The target was just deep to the aponeurosis but superficial to the transversalis fascia at the lateral margin of the QL muscle. The needle was inserted from either the anterior or posterior end of the transducer and advanced until the needle tip penetrated the posterior aponeurosis of the transverses abdominis muscle. LA was injected between the aponeurosis and the fascia at the lateral margin of the QL muscle.

Group P (Posterior approach)

For the posterior approach, the patient was positioned laterally and a linear transducer was similar to the lateral approach and moved posteriorly. The posterior border of QL was identified, and the needle was placed at that point. Proper placement

resulted in a spread of LA through the middle of the TLF layer and into the interfascial triangle.

After the completion of the blocks, all the patients were shifted to the postanesthesia care unit (PACU). A PCA pump was used to control postoperative pain. The pump was programmed to deliver a 20-microgram fentanyl intravenous bolus on demand, with a lockout interval of 10 min and no background infusion. All patients received regular oral paracetamol 1 g sixth hourly. Pain was assessed with NRS (0 = no pain, 10 = worst pain imaginable) at rest and at movement at 2, 4, 6, 12, and 24 hours. Parameters documented included time required for first rescue analgesia, 24-hour opioid consumption, and side effects such as quadriceps weakness, hematoma at the injection site, nausea, vomiting, and respiratory depression due to fentanyl usage. Patients and investigators involved in the collection of data were blinded to the groups assigned. All postoperative measurements were documented by the pain nurses who were unaware of the group allocation and intervention patients received.

We calculated the sample size based on a pilot study conducted on five patients undergoing hernia surgery. The mean 24-hour fentanyl requirement was 150 ± 28.28 micrograms in these patients after the lateral approach of QLB. Expecting a 20% decrease in the requirement, after the TM approach, with a power of 80% and an alpha error of 0.05, the sample size came out to be 14 in each group. To compensate for the dropout, we took a total of 20 patients in each group.

We entered the data in Microsoft Excel and analyzed the same in IBM Statistical Package for the Social Sciences (SPSS) software version 23. The normality of the data was tested using the Shapiro–Wilk test. Continuous variables were presented as mean ± standard deviation (SD) or median and interquartile range (IQR), depending on the normality of the data. The pain scores on NRS, the time required for

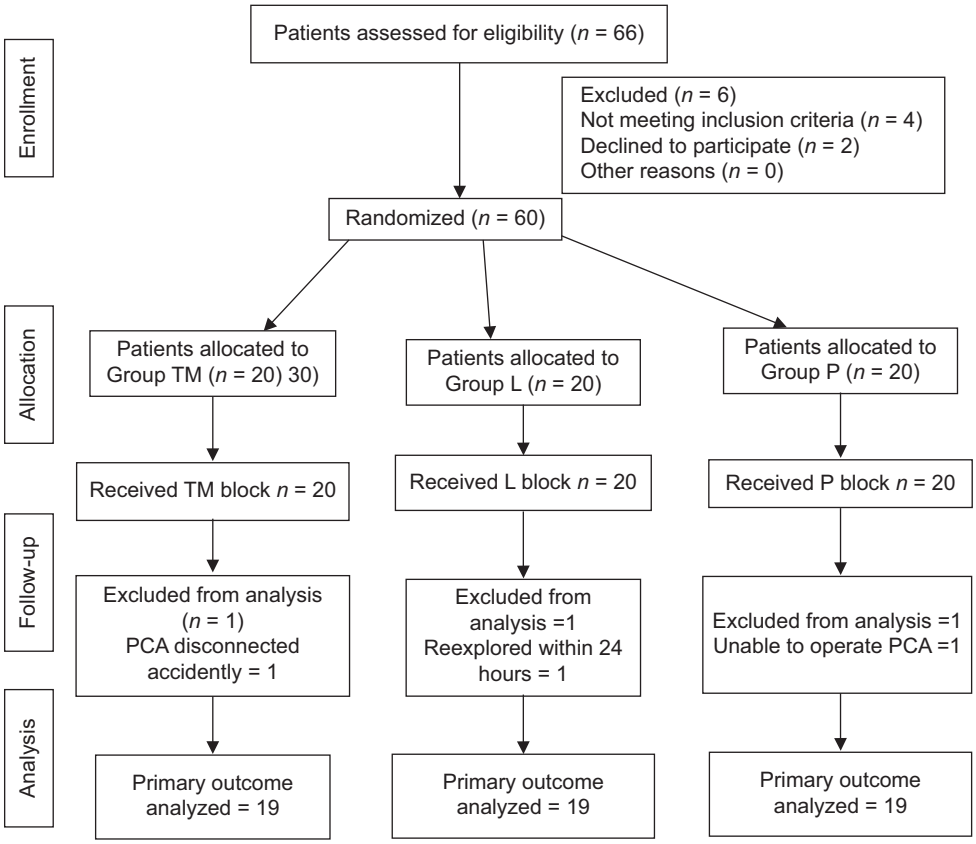

Figure 1: Flow diagram CONSORT: consolidated standards of reporting trials

Table 1: Surgical and patient characteristics

Characteristics	Group TM (*n*=19)	Group L (*n*=19)	Group P (*n*=19)	*P*
Age (years) (Mean±SD)	52.6±9.1	55.5±9.8	58.8±5.4	0.08
BMI (Kg/m^2) (Mean±SD)	24.52±1.6	25.36±2.08	25.5±1.84	0.21
Duration of surgery (mins) (Mean±SD)	81.57±20.71	81.05±17.36	78.94±17.96	0.90

Table 2: Comparison of total analgesia required, time for rescue analgesia, and patient satisfaction

Variables	Group TM (*n*=19) Median [range]	Group L (*n*=19) Median [range]	Group P (*n*=19) Median [range]	*P*
Fentanyl requirement (μg)	100 [100, 100]	180 [120, 200]	140 [120, 160]	<0.001
Time for rescue analgesia (hours)	13 [12, 14]	8 [8, 9]	10 [10, 12]	<0.001
Patient satisfaction	8 [8, 9]	8 [7, 9]	8 [7, 8]	0.150

Table 3: Comparison of NRS pain scores (*n*=57)

	Group TM (*n*=19) Median [range]	Group L (*n*=19) Median [range]	Group P (*n*=19) Median [range]	*P*
NRS score (rest)				
2 h	0 [0.0, 1.0]	0 [0.0, 0.0]	0 [0.0, 0.0]	0.25
4 h	2.0 [2.0, 3.0]	3.0 [2.0, 3.0]	3.0 [2.0, 3.0]	0.01
8 h	3.0 [3.0, 3.0]	4.0 [3.0, 4.0]	4.0 [4.0, 4.0]	<0.001
12 h	3.0 [2.0, 3.0]	4.0 [3.0, 4.0]	4.0 [3.0, 4.0]	<0.001
16 h	3.0 [2.0, 3.0]	3.0 [3.0, 4.0]	3.0 [3.0, 3.0]	<0.001
24 h	2.0 [2.0, 2.0]	2.0 [2.0, 3.0]	2.0 [2.0, 3.0]	0.081
Worst NRS score	3.0 [3.0, 4.0]	5.0 [4.0, 5.0]	5.0 [4.0, 5.0]	<0.001
Median NRS score	2.5 [2.5, 3.0]	4.0 [3.5, 4.0]	3.5 [3.5, 4.0]	<0.001
Dynamic NRS				
8 h	4.0 [4.0, 4.0]	4.0 [4.0, 5.0]	4.0 [4.0, 4.0]	0.007
12 h	3.0 [3.0, 4.0]	4.0 [3.0, 4.0]	4.0 [4.0, 4.0]	0.002
16 h	2.9 [3.0, 3.0]	3.0 [3.0, 4.0]	4.0 [3.0, 4.0]	0.002
24 h	2.0 [2.0, 3.0]	3.0 [3.0, 3.0]	3.0 [3.0, 3.0]	0.001
Median NRS score	3.0 [3.0, 3.5]	3.5 [3.0, 4.0]	3.5 [3.5, 4.0]	<0.001

Table 4: Pairwise comparisons of NRS pain scores, total analgesia required, and time for rescue analgesia (*n*=57)

Pairwise comparisons	TM with L	TM with P	L with P
Fentanyl requirement (μgm) Test statistic (*P*)	-22.711 (<0.001)	-31.921 (<0.001)	9.211 (0.248)
Time for rescue analgesia (hours) Test statistic (*P*)	34.526 (<0.001)	17.105 (0.004)	-17.421 (0.003)
Worst NRS pain score Test statistic (*P*)	-20.632 (<0.001)	-15.447 (0.008)	5.184 (0.947)
Median dynamic NRS pain score Test statistic (*P*)	-18.053 (0.002)	-21.895 (<0.001)	-3.842 (1.000)

first rescue analgesia, total analgesic consumption, and patient satisfaction were presented as median (IQR) as all the data were not normally distributed. The Kruskal–Wallis test with pairwise comparisons was applied for comparisons between anterior, lateral, and posterior blocks for the pain scores, time required for first rescue analgesia, total analgesic consumption, and patient satisfaction. The significant level of all analyses was $P < 0.05$.

Results

Of the 20 patients recruited in each group, we analyzed only 19 in each of them (Consolidated Standards of Reporting Trials (CONSORT) flow diagram: Figure 1). The patients were similar in their surgical and demographic characteristics [Table 1].

A significant difference ($P < 0.001$) was observed in the fentanyl requirement between the three approaches. The requirement of analgesia was highest in the lateral approach (180 μg [120, 200]), followed by the posterior approach (140 μg [120, 160]), and was least in the TM approach (100 μg [100, 100]). On pairwise comparison, a significant difference was found between the TM and lateral approaches and the TM and posterior approaches. No difference was found between the lateral and posterior approaches. The duration of analgesia was also statistically prolonged in the TM group [Tables 2 and 3].

A significant difference ($P < 0.001$) was observed in the time required for rescue analgesia between the three approaches of the QL block. Postoperatively, the earliest requirement of analgesia was found in the lateral approach (8 hours [8, 9]), followed by the posterior approach (10 hours [10, 12]). In the TM approach, analgesia was required postoperatively after 13 hours [12, 14]. On pairwise comparison, a significant difference was found between the TM and lateral approaches, the TM and posterior approaches, and the lateral and posterior approaches [Table 4].

There were significant differences in the median NRS scores ($P < 0.001$), worst NRS scores ($P < 0.001$), and median dynamic NRS scores ($P < 0.001$) between the three approaches of the QL block. All NRS scores except for NRS scores at 2 hours and 24 hours showed significant differences between the three blocks. Dynamic NRS scores were significantly different between the three groups at all-time intervals [Table 3].

On pairwise comparisons, there was a significant difference between the TM and lateral block and the TM and posterior approaches of the QL block for the median NRS score, worst NRS score, and median dynamic NRS scores. No significant difference was found between the lateral and posterior approaches of this block [Table 4].

No significant difference in patient satisfaction was found in the three approaches. None of the patients in any of the groups had adverse effects such as quadriceps weakness, hematoma at the injection site, nausea, vomiting, and respiratory depression due to fentanyl usage.

Discussion

This study shows that TM QLB provides more effective analgesia in patients undergoing unilateral hernia surgery in adult patients. The requirement for opioids is less with better pain scores in the postoperative period.

Inguinal hernia surgeries are associated with moderate postoperative pain, which, if inadequately treated, can lead to acute and chronic complications. QL block is an interfascial block, which provides wide analgesic distribution from T12 to L4 dermatomes. It is different from the conventional transversus abdominal plane (TAP) block in being deep to transversus abdominis aponeurosis. The mechanism of action of QLB is still unclear but has been suggested to spread along TLF and endothoracic fascia into paravertebral space. Initially, only two approaches were described: lateral and posterior approaches. Thereafter, the anterior or TM approach was described by Borglum *et al.*[10] where the LA is deposited between PM and QL muscles. The TM approach is characterized by more cephalad migration along QL and PM muscles to the PV space, leading to greater dermatomal block. This could be attributed to the same embryonic origin and the insertion of both PM and QL muscles within the thoracic cage.

In the first RCT performed to evaluate the analgesic efficacy of QLB after cesarean section, Blanco *et al.* also mentioned the unpublished contrast magnetic resonance imaging (MRI) studies conducted by them to evaluate the spread of LA after lateral and posterior approaches. The images showed that the spread of LA after the posterior approach provided a more predictable spread to the PVS. It also provided a better safety profile as QL muscle separated the needle from the visceral organs.[6]

Ahmed *et al.*[11] compared two different approaches of QL block: TM and posterior in 40 patients undergoing unilateral inguinal hernia surgery. Patients receiving TM block had a statistically significant longer duration of analgesia as compared with posterior QL block (20.1 ± 6.2 vs 12.0 ± 4.8 hours). In our study, patients in the TM group had a prolonged duration of analgesia (median 13 hours as compared to 8 and 10 hours in the other approaches). Patients in the TM group required less postoperative analgesics and had a prolonged duration of rescue analgesia. The results of our study are also supported by a cadaveric case series conducted by Elsharkawy *et al.*[12] The dye spreads more widely and rapidly into paravertebral space in the TM approach. It has also been speculated that LA in this approach spreads to the transversalis fascia and iliac fascia to affect the lumbar plexus.

There have been studies conducted earlier, which have found similar analgesic efficacy after lateral and TAP block in pediatric lower abdominal surgeries. These studies had better results with the TM approach when compared to TAP blocks in this subset of patients. This is consistent with the results found in our study.[7]

In another study conducted by Ahuja *et al.*,[13] single-shot QLB through the TM approach failed to show any benefit over no block in patients undergoing unilateral inguinal hernia surgery under SAB. This could be explained due to various other factors causing the inconsistent spread of LA such as path of least resistance, the speed of injection, and volume of injection.[14]

We did not encounter any complications associated with QLB. There are case reports that have described complications such as retroperitoneal hematoma, organ injury, and LA toxicity. Spread to the paravertebral space can cause hypotension and bradycardia. Transient quadriceps weakness has also been documented.[15]

There are a few limitations of this study. We gave all the blocks under spinal anesthesia and could not check the dermatomal level after the block, but the assessment of pain score was used as an indirect indicator of the block's efficacy. Also, we used a single-shot injection, not a continuous catheter technique, which could be more useful to prolong the duration of analgesia. Though we did not encounter any complications in our patients, it could be due to the limited sample size of the study.

Conclusion

TM QL block reduces postoperative analgesic consumption, with a longer duration of rescue analgesia and better pain scores when administered postoperatively in adult patients undergoing unilateral hernia surgeries. Further trials with a larger sample size could validate the findings of our study.

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Nil.

Conflicts of interest
There are no conflicts of interest.

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