Original Article

Ultrasound-guided quadratus lumborum block: Posterior versus anterior approach in paediatrics undergoing laparoscopic inguinal hernia repair

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Abstract

Background and Aims: Regional anaesthesia has gained popularity in managing post-operative pain in paediatric patients. Quadratus lumborum block (QLB) is recognised as one of the peri-operative pain management techniques used during abdominal surgeries. However, no consensus about the best approach has been reached.

Material and Methods: Sixty paediatric patients with ages ranging from 1 to 6 as well as classification I and II of the American Society of Anesthesiologists, scheduled for laparoscopic inguinal hernia, were allocated to receive either a posterior approach (Group I) or an anterior approach (Group II) QLB. Twenty four-hour morphine consumption, the face, legs, activity, cry, and consolability (FLACC) score, duration of analgesia, performance time, and block-related complications were recorded.

Results: Group II showed significantly lower morphine consumption as well as a longer duration of analgesia ($P = 0.039$*, 0.020*, respectively), with an equivalent period for block performance being reported in the two groups ($P = 0.080$). At 2, 4, 6, and 12 hours post-operatively, the FLACC scores were substantially diminished in Group II compared to Group I ($P = 0.001$*, 0.012*, 0.002*, 0.028*, respectively). However, at twenty-four hours, comparable pain scores were observed between both groups ($P = 0.626$). In addition, there were no block-related complications.

Conclusions: In paediatric patients scheduled for laparoscopic inguinal hernia repair, the ultra-sound-guided anterior approach of the QLB was associated with significantly reduced post-operative morphine consumption, a lower FLACC score, and a longer analgesia duration when compared to the posterior approach.

Keywords: Analgesia, child, laparoscopy, pain, post-operative, regional anaesthesia

Introduction

Several types of research have recently focused on implementing regional blocks in conjunction with general anaesthesia during paediatric surgery to reduce the anaesthetic and analgesic requirements while still achieving adequate post-operative pain relief as well as earlier hospital discharge.[1]

Quadratus lumborum block (QLB) is an inter-fascial plane block originally proposed by Blanco,[2] in which the local anaesthetic (LA) deposition in the potential space located posterior to the abdominal wall muscles and lateral to the QL muscle has led to an efficient abdominal wall block. Subsequently, three traditional QLB variants have been proposed based on the location of LA injection relative to the QL muscle, namely, lateral, posterior, and anterior

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or trans-muscular QLB (QLB1, QLB2, and QLB3, respectively).[3] Numerous studies revealed that analgesia might be induced until reaching the T5-L1 level following QLB, with beneficial effects on both somatic and visceral pain. Moreover, a longer analgesic duration as well as an opioid-sparing impact has been verified compared to conventional blocks such as the transversus abdominis plane (TAP) block.[4]

Currently, the QLB is recognised as one of the peri-operative pain management techniques used during abdominal surgeries. Nevertheless, to the authors' knowledge, no consensus has been formed on the most effective method for performing the block.[5-7] Few publications are available in the literature comparing the three QLB techniques in the adult population.[8-11] Nonetheless, comparable research in the paediatric age range is still lacking. Therefore, this randomised study was designed to compare bilateral posterior (QLB2)'s analgesic efficacy versus bilateral anterior (QLB3) QLB techniques performed in paediatric patients scheduled for laparoscopic inguinal hernia repair.

Material and Methods

The current prospective randomized clinical trial was conducted from December 2020 to May 2022 on paediatric patients with ages ranging from 1 to 6 years as well as American Society of Anesthesiologists (ASA) classification I and II, scheduled for laparoscopic inguinal hernia. Before the initiation of the study, we obtained institutional ethical approval (Number 34077/9/20), in addition to registering in the Pan African Clinical Trial Registry (PACTR202010495971273). Participants were enrolled after the parents agreed to provide informed written consent following a thorough clarification of the procedures. Patients with known LA allergies, those whose injection sites were infected, and those who had coagulation abnormalities and cardiac, hepatic, or renal insufficiency were all excluded from the study. Additionally, subjects whose parents declined to participate in the trial were not enrolled.

The sealed opaque envelope approach was used for randomisation, and subjects were assigned to two equal groups in a ratio of 1:1 to determine the approach, whether posterior (Group I) or anterior (Group II) QLB. With the exception of the researcher executing the blocks who did not participate in the gathering or handling of the data, all participants, the outcome assessor, and healthcare staff were unaware of the assigned intervention.

All patients were attached to standard monitoring upon entering the operating room, including pulse oximetry, non-invasive blood pressure, and electrocardiography. Induction of anaesthesia was through a face mask with 8% sevoflurane (AbbVie Inc, USA) in 100% oxygen before inserting the intravenous (IV) line as soon as the patient lost consciousness together with administration of atracurium (Hameln Pharmaceuticals Ltd., UK) 0.5 mg/kg as well as fentanyl (Sunny pharmaceutical, Egypt) 1 μg/kg. Capnography was applied after an appropriately sized endotracheal tube had been inserted and secured. Atracurium was used to maintain anaesthesia at 0.1 mg/kg increments along with 2% sevoflurane in 50% oxygen in air.

All patients had bilateral ultra-sound-guided QLB utilising a linear high-frequency ultra-sound transducer (6-12 MHz Philips, Bothell, Washington, USA) covered in sterile sheets in the lateral decubitus position following anaesthesia induction and before the start of surgery under strict aseptic precautions, and the study medication [0.3 mL/kg Bupivacaine (Sunny pharmaceutical, Egypt) 0.25%] was administered on each side. The probe was placed halfway between the iliac crest and subcostal margin in a transverse orientation to visualise the three abdominal muscles, which were then traced posteriorly until the identification of the distinctive Shamrock sign, which consists of the lumbar vertebra transverse process, erector spinae muscles, QL, and psoas major (PM) [Figure 1]. An A50 mm, 22 G needle (B. Braun Medical Inc., Bethlehem, PA) was advanced in-plane in order to deposit the LA either posterior to the QL muscle in the posterior approach group or between the psoas muscle and the QL muscle in the anterior approach group. The study medication was delivered after the injection of sterile saline (1 mL) to ensure proper needle placement [Figure 2].

Neostigmine (Egyptian International Pharmaceutical Industries Company, Egypt) 0.05 mg/kg and atropine (El

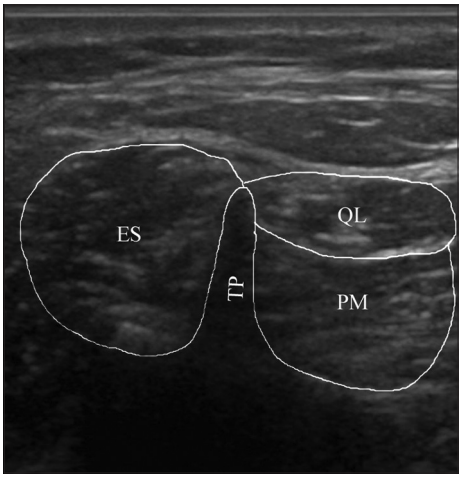

Figure 1: Shamrock sign. TP: Transverse Process, ES: Erector Spinae, QL: Quadratus Lumborum, PM: Psoas Major

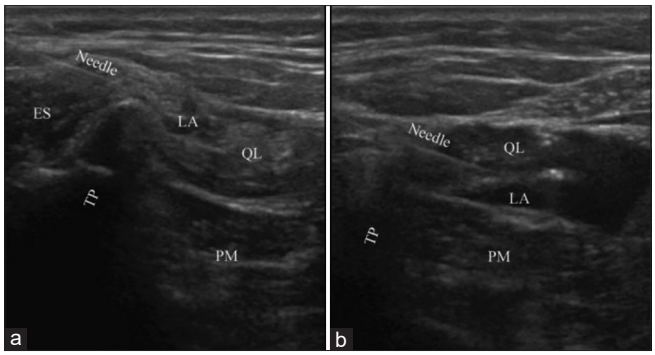

Figure 2: Ultra-sound-guided QLB. (a) Posterior approach. (b) Anterior approach. LA: Local Anaesthetic, TP: Transverse Process, ES: Erector Spinae, QL: Quadratus Lumborum, PM: Psoas Major

Nile Company Pharmaceutical, Egypt) 0.02 mg/kg were administered at the conclusion of the surgical operation to counteract the relaxant anaesthetic impact. All patients were sent to the post-anaesthesia care unit (PACU) after being extubated, in which they were subjected to routine analgesics in the form of IV paracetamol) Amriya-pharma-tech, Egypt) 15 mg/kg every 6 hours following surgery.

Pain severity was evaluated using the face, legs, activity, cry, and consolability (FLACC) score at 2, 4, 6, 12, and 24 hours post-operatively. When scores were greater than or equal to 4, IV morphine (Misr pharma, Egypt) 0.05 mg/kg was given, and the overall amount of rescue analgesia needed in a 24-hour period was recorded. Furthermore, the duration of analgesia (measured from the time the block was performed until the first time rescue analgesia was required during the post-operative period) and block performance time (refers to the period elapsed between placing the ultra-sound transducer on the patient's skin till the end of injecting the LA) were both recorded. Moreover, any adverse events correlated with the blocks were noted throughout the next 24 hours.

Statistical analysis

The total amount of post-operative rescue analgesics needed was our main outcome variable. According to a prior study,[8] a trial with 25 subjects in each group was required for the study with an effect size of 1.045, a 0.05 error rate, and a 95% power performed on the G*Power statistical program (version 3.1.9.7). We targeted to include 30 subjects per group to compensate for dropouts. The statistical analysis was done utilizing the Minitab® 16 software (Minitab, Inc, LLC, State College, Pennsylvania). Verification of data normality was made utilising the Kolmogorov–Smirnov test. Comparison of numerical data with normal distribution was made between the two groups via Student's independent *t*-test for data showing normal distribution or utilising the Mann–Whitney U test, if otherwise. In addition, categorical variables were presented as patients' percentages (%) as well as numbers before analysis utilising the Fisher's exact test or Chi-square test or when appropriate. *P*-value < 0.05 was deemed significant.

Results

Thirteen patients were excluded out of the 73 patients who were determined to be eligible for this study (nine parents refused to include their children in the study, three patients had coagulation disorders, and one patient had renal impairment). Finally, 60 patients were enrolled and randomly assigned into two equal groups (30 each) [Figure 3].

Both groups' demographic features were comparable, as depicted in Table 1.

When compared to Group I, Group II displayed significantly lower morphine consumption as well as a longer duration of analgesia ($P = 0.039$*, 0.020*, respectively), with an equivalent period for block performance being reported in the two groups ($P = 0.080$) [Table 2].

Values for FLACC score were significantly diminished in Group II compared to Group I up to 12 hours after surgery ($P = 0.001$*, 0.012*, 0.002*, and 0.028*, respectively). Although statistically significant, they were not of clinical relevance. At 24 hours, comparable values were observed between both groups ($P = 0.626$) [Figure 4]. In the present study, no adverse events correlated with the block were noted.

Discussion

In this study, comparing the posterior and anterior approaches of QLB revealed a better analgesic profile with a significant reduction in the consumption of post-operative morphine, prolonged analgesia duration, and lower pain scores with no adverse events in the anterior group than in the posterior group in paediatric patients scheduled for laparoscopic inguinal hernia repair.

Many truncal blocks, such as TAP block, have been used for laparoscopic inguinal hernias with success in several studies.[12,13] In contrast, QLB is considered a relatively novel block recently utilised with proven efficacy in both adult and paediatric populations.[14-16]

The QL muscle is enclosed by the anterior as well as the middle thoracolumbar fascia, which medially connect with the PM muscle's fascia as well as laterally with transversalis fascia.[17] Numerous cadaveric investigations that examined the QL block's anatomical basis by either tissue staining on

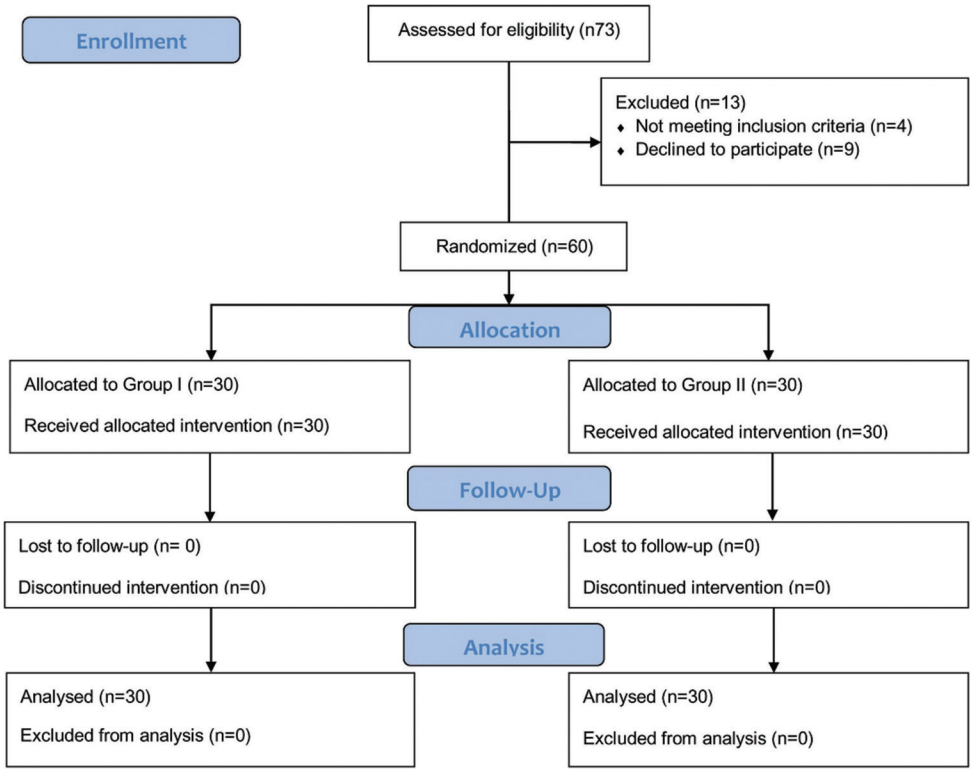

Figure 3: Consort flow diagram of participants during the course of the study

Table 1: Demographic features of both groups

Variable	Group I	Group II	*P*	CI 95%
Age (years)	3.72±1.52	3.56±1.58	0.684	(-0.637;0.964)
Gender				
M/F	27 (90%)/3 (10%)	26 (86.66%)/4 (13.33%)	0.1617	
Weight (Kg)	15.60±3.93	14.82±3.68	0.433	(-1.191;2.745)
ASA I/II	24 (80%)/6 (20%)	25 (83%)/5 (17%)	0.738	
Inguinal hernia:				
Right side	17 (56.66%)	20 (66.66%)	0.667	
Left side	8 (26.66%)	7 (23.33%)		
Bilateral	5 (16.66%)	3 (10%)		
Duration of surgery (min)	39.07±6.11	40.80±6.24	0.282	(-4.93;1.46)

Data are presented as mean±SD or patient's number (%). CI: Confidence interval. P<0.05 is significant

Table 2: Total post-operative analgesia, duration of analgesia, and performance time

Variable	Group I	Group II	*P*	CI 95%
Total Analgesic requirement (mg)	1.71±1.06	1.227±0.665	0.039*	(0.026;0.941)
Duration of analgesia (h)	13.83±5.27	16.73±4.03	0.020*	(-5.33;-0.47)
Performance time (min)	10.77±0.77	11.13±0.819	0.080	(-0.779;-0.045)

*CI: Confidence interval. P<0.05 is significant. *denotes statistically significant difference*

cadavers or radiological injectant spread assessment[18,19] revealed that QLB's analgesic efficacy was likely because of LA diffusion into the thoracic paravertebral space along the thoracolumbar fascia that surrounds the QL and endothoracic fascia as well as peripheral sympathetic field block on the basis of thoracolumbar fascia's mechanoreceptors and abundant A/C fibre nociceptors.[20-22] With different approaches (lateral, posterior, and anterior QLB) that have been proposed, it is hypothesised that the anterior QLB targets the thoracic paravertebral space's somatic nerves; the spinal nerve which runs anterior to the QL muscle, ilioinguinal, iliohypogastric, and subcostal nerves; and the L1-L3 nerve roots.[23] In contrast, the posterior block might spread into the paravertebral space or block the subcostal nerves.[7] Nevertheless, the estimated volume reaching the paravertebral space remains insufficient for the posterior approach block. Consequently,

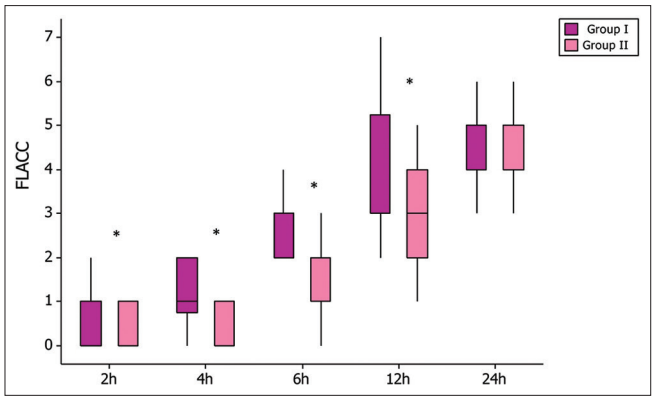

Figure 4: FLACC score for assessment of pain. *Denotes statistically significant difference ($P < 0.05$)

the diffusion into the thoracolumbar plane was regarded as an additional synergistic pathway for achieving an analgesic impact.[5] Lateral QLB is linked to injectate diffusion to the subcutaneous tissue as well as the transversus abdominis muscle plane.[24] However, when compared to posterior QLB using a magnetic resonance imaging (MRI) study, a more predictable spread of the LA was noted with the posterior approach,[7] hindering it more favorable to be employed in our study to be compared with the anterior technique.

There is a paucity of data in the literature describing the utilisation of QLB in children for post-operative analgesia in various types of procedures.[25-28] Although various studies have been conducted to compare different approaches to QL[9,10] or to detect the efficacy of their combination,[29] none of the studies mentioned the same in paediatric patients, and there have been no comparisons between various QL techniques in paediatric cases. As far as we know, there are no randomized studies to evaluate the effectiveness of the posterior approach versus the anterior approach quadratus lumborum in paediatrics. However, other studies compared the same two approaches in adults in different procedures.[8,11,30]

In this study, a significant reduction in post-operative morphine consumption, lower pain scores, and a more extended analgesia duration were observed in the anterior approach cases compared to the posterior approach. These findings are consistent with other research studies that compared the trans-muscular versus the posterior approach for relieving pain relief following open inguinal hernia repair as well as the caesarean section in the adult age group.[8,11]

The block performance time was found to be comparable between the two groups in our study, which was in accordance with the results obtained by Ahmed *et al*.,[8] who found no difference in block performance time between the two groups. In contrast, Koksal *et al*.[11] demonstrated that a shorter time for block performance was recorded in the posterior approach compared to the anterior approach group in patients who underwent elective caesarean section, which was attributed to the deeper anatomy of the anterior approach than the other one. However, our paediatric patients are smaller in size, and ultrasonic anatomy is easily identified compared to adults, which might explain why we found no difference in block performance time in the present study.

No block-related complications were detected in both groups, especially weakness in the muscles of the quadriceps, iliacus, and the psoas, because of spread to lumbar plexus as injection sites were identified carefully by ultra-sound before injection.

One of the limitations identified in the present study was that the sensory levels were not evaluated immediately following QLB because the block was carried out following general anaesthesia induction. Another limitation was the absence of a sham or control group.

Conclusions

The results of this study revealed that the anterior approach for QLB was more effective in controlling pain and decreasing post-operative analgesic requirements with a statistically significant lower FLACC score, less post-operative consumption of morphine, and a more extended analgesia duration observed in the anterior approach group than in the posterior group. Nevertheless, block performance time was comparable between the two groups.

Data availability statement

To researchers who provide a methodologically sound proposal. (accepted or can be replaced by the word "request").

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Nil.

Conflicts of interest

There are no conflicts of interest.

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