Comparison of quadratus lumborum block and caudal block for postoperative analgesia in pediatric patients undergoing inguinal hernia repair and orchiopexy surgeries: a randomized controlled trial

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ABSTRACT

Background and objectives Caudal epidural anesthesia is a widely used popular technique for postoperative analgesia but it has potential side effects and duration of analgesia is short. Quadratus lumborum block (QLB) was found to be an effective method for postoperative analgesia in lower abdominal surgeries. In this double-blind prospective randomized trial, we aimed to compare the postoperative analgesic efficacies of QLB and the caudal block in pediatric patients undergoing inguinal hernia repair and orchiopexy surgeries under general anesthesia.

Materials and methods After approval was obtained from the ethics committee, in this prospective randomized double-blind trial, 53 patients under general anesthesia undergoing inguinal hernia repair and orchiopexy surgeries randomly received caudal block or QLB. Demographic data, postoperative analgesic requirement, Face, Legs, Activity, Cry, and Consolability (FLACC) scores at 30 min, 1, 2, 4, 6, 12 and 24 hours, parent satisfaction scores and complications were recorded.

Results The study included 52 patients, after excluding one patient because of a failed caudal block. There were no significant differences between the groups based on demographic data (p>0.05). The number of patients who required analgesics in the first 24 hours was significantly lower in QLB group (p=0.001). Postoperative 4, 6, 12 hours FLACC scores were significantly lower in the QLB group (p<0.001, p=0.001 and p<0.001, respectively). Parent satisfaction scores were higher in the QLB group (p=0.014).

Conclusion According to the results of this study, QLB can provide much more effective analgesia than caudal block without adjuvants in multimodal analgesia management of children undergoing inguinal hernia repair and orchiopexy surgeries.

Trial registration number NCT03294291.

INTRODUCTION

Caudal epidural anesthesia is a widely used and popular technique of postoperative analgesia in children undergoing lower abdominal surgery. Its advantages include effectiveness and ease of use. However, its potential side effects include accidental dural puncture, motor blockade of the lower limbs, and bladder dysfunction. Moreover, the duration of postoperative analgesia is approximately 4–6 hours. This duration of analgesia is very short and inadequate.[1] Truncal blocks with longer duration of action are preferred as an alternative to caudal block, and their use has become widespread with the introduction of ultrasound into the regional anesthesia.[2 3]

In 2007, Blanco, who defined the anterior-lateral quadratus lumborum block (QLB1) and the posterior quadratus lumborum block (QLB2), reported that QLB was an effective method for postoperative analgesia in lower abdominal surgeries.[4 5] In our previous study, we described the superiority of QLB over the transverse abdominis plane (TAP) block in pediatric patients undergoing lower abdominal surgery.[6] Although the duration of the caudal block analgesia is generally insufficient, the technique is still preferred because it is highly effective. In the literature review, we were unable to find any study that compared the postoperative analgesic efficacies of QLB with those of the caudal block during inguinal hernia repair and orchiopexy surgery. Hence, this double-blind, prospective, randomized controlled trial aimed to compare the postoperative analgesic efficacies of QLB with those of the caudal block in pediatric patients undergoing inguinal hernia repair and orchiopexy surgery under general anesthesia by considering pain scores and analgesic consumption.

MATERIALS AND METHODS

After receiving ethics approval, the study was registered at ClinicalTrials.gov. This double-blind, prospective, randomized controlled trial was conducted between December 2017 and December 2018. The trial included 53 patients between 1 and 9 years of age, who underwent unilateral inguinal hernia repair and orchiopexy surgery, with status I and II under the American Society of Anesthesiologists (ASA) physical status classification. Informed written consent was received from the parents of all study participants. Children with anatomical abnormalities, coagulation disorders, a history of allergy to local anesthetics, infection or redness at the injection site, liver, and/or kidney, and/or heart diseases and those who refused to participate in the study were excluded. Randomization was performed using a computer-generated randomization table

(http://www.random.org) method, and patients were divided into two groups: QLB and caudal block.

General anesthesia procedure

All patients were preoperatively medicated with oral midazolam (0.5 mg/kg) and monitored in the operating room using electrocardiography, non-invasive blood pressure, and oximetry. If the patient did not have an intravenous cannula, general anesthesia was induced with 8% sevoflurane and 50% air in oxygen administered via a face mask. An intravenous cannula was subsequently placed, and propofol (2–3 mg/kg) and fentanyl (1 µg/kg) were administered. After general anesthesia, a ProSeal (Teleflex, Westmeath, Ireland) laryngeal mask airway was applied. General anesthesia was maintained using 2% sevoflurane and 50% air in oxygen. After the patient was placed in a lateral position and aseptic conditions with povidone-iodine were established, either QLB or caudal block was performed by the same anesthesiologist (GÖ) A standardized operation technique was implemented for all patients. Intravenous acetaminophen (15 mg/kg) was administered to all patients after surgery. Demographic information such as age, weight, operation type, and duration and complications was recorded.

QLB procedure

First, the high-frequency (10–18 MHz) ultrasound (MyLab Five, Esaote, Genova, Italy) probe was covered with a sterile sheath and placed on the anterior superior iliac crest to visualize three abdominal wall muscles three dimensionally. The internal and external oblique muscles were visualized by moving the probe posteriorly. The probe was then tilted at the junction where the fascia of these two muscles overlaid the quadratus lumborum, and the middle layer of the thoracolumbar fascia was visualized as a hyperechogenic line. Then, a 22 G, 80 mm needle (B Braun, Thermo Fisher Scientific, Waltham, MA, USA) was directed in an anterolateral to posteromedial direction using an in-plane technique. After negative aspiration, 0.5 mL saline was administered and hydrodissection was performed. Subsequently, 0.7 mL/kg of 0.25% bupivacaine was administered between the quadratus lumborum muscle and the thoracolumbar fascia.[5]

Caudal block procedure

The sacral hiatus was palpated, and the needle (Epican, B Braun Melsungen, Melsungen, Germany) was advanced into the epidural space after passing through the sacrococcygeal membrane. After a negative aspiration to confirm the absence of blood and cerebrospinal fluid, the block was performed using a 0.7 mL/kg dose of 0.25% bupivacaine without epinephrine.

Postoperative follow-up

Postoperative pain levels in all patients were assessed using the Face, Legs, Activity, Cry, and Consolability (FLACC) scale at 30 min and at 1, 2, 4, 6, 12, and 24 hours. This was performed by a second anesthetist and nurses who were blinded to the block technique used in the postanesthesia care unit and the surgical ward. In children with a FLACC score >4, 1 µg/kg fentanyl citrate was administered by intravenous, and for those with a FLACC score >2, 7 mg/kg ibuprofen was administered orally to the patients in the ward. After discharge, the parents were contacted via telephone calls, and information about pain scores and the analgesic consumption was obtained.

Parents who were blinded to the block technique evaluated their children's comfort and activity level according to the following scale: 1, unsatisfied; 2, satisfied (good); and 3,

definitely satisfied (excellent). Nausea, vomiting, hypotension, bradycardia, quadriceps muscle activity, urinary retention (in 24 hours), and other complications were managed and recorded by the blinded second anesthetist.

Sample size estimation

The primary outcome, which was the number of patients who required analgesics over a 24-hour period, was assessed using a sample size generated by G* Power 3 (Heinrich-Heine-Universitat Dusseldorf, Germany); this was based on a pilot study conducted among five patients of the caudal block group and the authors' previous study results for the QLB group. The proportion of patients who required analgesics was 0.6 and 0.12 in the caudal block and QLB groups, respectively. The sample size was calculated at a power of 95% and a significance level of 5%. Finally, 23 patients in each group and 46 patients in both groups were required to obtain statistically significant values. We designed the study to include 26 patients in each group due to the possibility of some patients not completing the study.

Statistical analyses

Statistical analyses were performed using SPSS V.21.0 (IBM) for Macintosh (Apple, Cupertino, CA, USA). Descriptive data were presented as mean and SD or median, IQR . The Hodges-Lehman estimator was used to calculate 95% CI of the median differences.[7] Categorical variables were expressed as the number of cases and percentages (n (%)). Fisher's exact test or χ^2 tests were performed for categorical data. Shapiro-Wilk and Levene tests were performed to evaluate distributions and homoscedasticity before statistical analyses. T-tests were used for normally distributed continuous variables, and the Mann-Whitney U test was used for non-parametric variables. Additionally, the effect size was calculated using the Cliff delta method.[8]

RESULTS

After the exclusion of one patient because of a failed caudal block, 52 patients were included in this study (figure 1). There were no significant differences between the groups based on
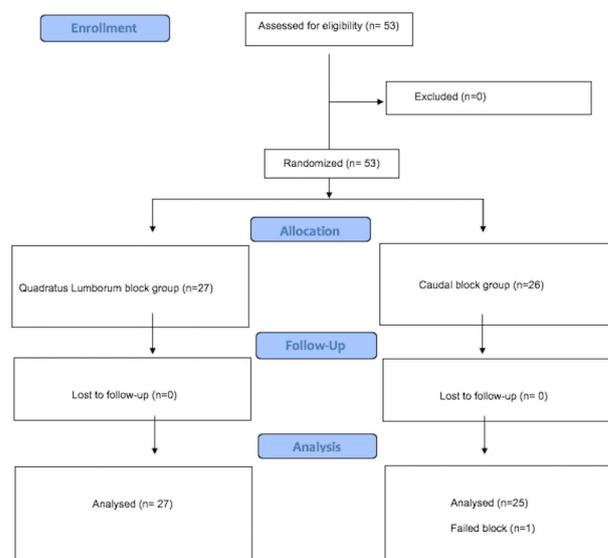

Figure 1 Consolidated Standards of Reporting Trials (CONSORT) flow chart.

Table 1 Demographic and clinical data

	Caudal group (n=25)	QLB group (n=27)	P value
Age (month)	44.36 (4.14)	47 (4.3)	0.82
Weight (kg)	17.44 (1.14)	16.8 (0.95)	0.8
Sex (M/F)	20/5	21/6	0.84
ASA classification (I/II)	23/2	21/6	0.16
Operation type (O/I)	13/12	12/15	0.63
Operation time	53.4 (4.72)	52.7 (6.29)	0.37

Data are presented as mean (SD).
Caudal group refers to caudal block group.
ASA, American Society of Anesthesiologists; I, inguinal hernia repair; O, orchiopexy; QLB, quadratus lumborum block.

Table 2 Pain scores across postoperative time points

FLACC	CG	QLB	P value	Effect size	Difference in FLACC (QLB-CG)* Median	95% CI
30 min	1 (1–1)	1 (1–1)	0.75	0.229	0	0 to 0
1 hour	1 (0–1)	0 (0–1)	0.49	0.096	0	0 to 0
2 hours	0 (0–1)	0 (0–0)	0.068	0.208	0	0 to 0
4 hours	0 (0–1)	0 (0–0)	0.001†	0.410	0	0 to 1
6 hours	1 (0–2)	0 (0–0)	<0.001†	0.680	1	1 to 2
12 hours	1 (0–1)	0 (0–0)	0.001†	0.475	1	0 to 4
24 hours	0 (0–1)	0 (0–0)	0.068	0.208	0	0 to 1

*Hodges-Lehman estimator used to calculate 95% CI of the median differences.
†P<0.05 significantly different between groups. Values are reported as median (IQR), effect size values were calculated with Cliff delta.
CG, caudal block group; FLACC, Face, Legs, Activity, Cry, and Consolability scale; QLB, quadratus lumborum block group.

demographic data such as age, sex, weight, ASA class, and operation type or duration (table 1).

The number of analgesic consumptions in the first 24 hours postoperatively was significantly lower in the QLB group (p=0.001) (figure 2). Seventeen patients used analgesics in the caudal block group; eight of them used analgesics twice, and nine patients used them once. Only two patients used analgesics in the QLB group and both used them once. The 4, 6, and 12 hours postoperative FLACC scores were lower in the QLB group (p=0.001, p<0.001, and p=0.001, respectively), while the 30 min, 1, 2, and 24 hours FLACC scores were not significantly different between the groups (p=0.75, 0.49, 0.068, and 0.068, respectively) (table 2).

Parent satisfaction scores were higher in the QLB group (p=0.014) (figure 3).

Nausea was observed in only one patient in the caudal block group. Hypotension, arrhythmia, bradycardia, vomiting, and other postoperative complications were not observed in either of the two groups.

DISCUSSION
To our knowledge, the present investigation was the first double-blind, randomized, prospective study to compare between QLB and caudal block for postoperative pain relief in pediatric patients undergoing inguinal hernia repair and orchiopexy surgeries. The results demonstrated that QLB was more effective and provided more long-lasting analgesia compared with the caudal block. Sato compared the caudal block with bilateral QLB in children who underwent urethral implantation surgery, and total analgesic use was found to be lower in the QLB group in the first 24 hour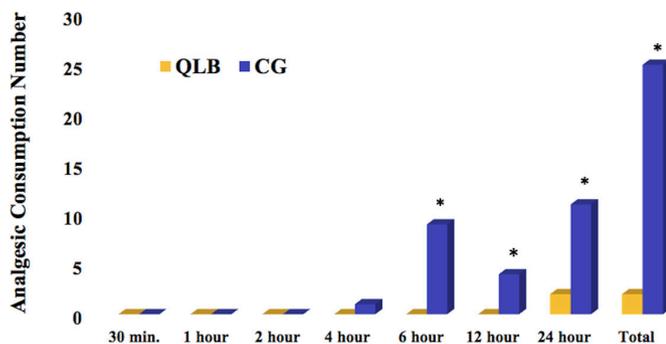s. In that study, 0.03 mg/kg morphine in 1.0 mL/ kg of 0.2% ropivacaine was used in the caudal block group, and 0.5 mL/kg of 0.2% ropivacaine was used per side in the QLB group.[9]

Caudal block is a commonly used technique in pediatric patients undergoing lower abdominal surgery, but it has a short duration of action. In some clinics, adjuvant drugs, such as opioids, ketamine, and alpha-2 agonists (clonidine, dexmedetomidine), are added to the local anesthetics administered to the epidural space to prolong the block's duration of action.[10] Studies have shown that added adjuvants improve the duration of analgesia. Saadawy et al reported that the duration of analgesia was 6.2±2.8 hours in patients who underwent caudal block and were administered 1 mg/kg of 0.25% bupivacaine, while it was 18.5±2.8 hours in patients who underwent caudal block and were administered 1 mg/kg bupivacaine added to 1 µg dexmetodomine.[11] In another study, Baduni et al compared 1 mg/kg of 0.25% bupivacaine to clonidine added to the same dose of local anesthetic; he reported that the duration of analgesia was 295.00±41.78 min in the bupivacaine group and 724.80±60.29 min in the bupivacaine+clonidine group.[12] Sanwatsarkar et al also performed caudal block with 0.75 mL/kg of 0.25% bupivacaine and added 50 µg/kg morphine for patients who underwent lower abdominal and urogenital surgeries; the duration of analgesia was 13.36±2.47 hours.[13] Although the use of adjuvants increases the duration of analgesia, it may cause

Figure 2 Analgesic consumption number across by time point. *P<0.05 significantly different between QLB and caudal groups. CG, caudal block group (bar with yellow color); QLB, quadratus lumborum block group (bar with purple color).
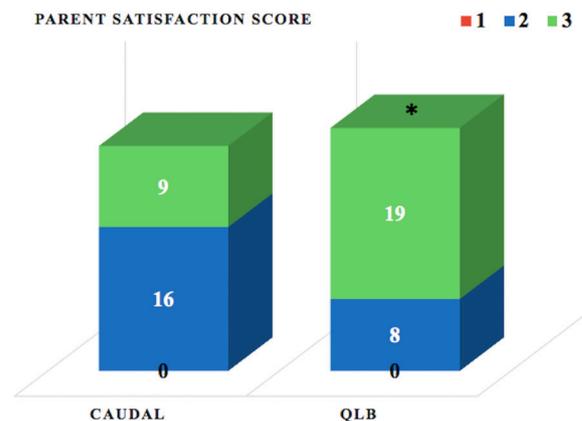

Figure 3 Parent satisfaction score: 1, unsatisfied; 2, satisfied; 3, definitely satisfied. *P<0.05 significantly different between QLB and caudal groups. CAUDAL, caudal block group; QLB, quadratus lumborum block group.

various side effects. It has been shown that the use of opioids may cause hypotension, respiratory depression, pruritus, nausea, and vomiting; additionally, intrathecal administration of ketamine may cause neural apoptosis in animal studies.[14 15] Although several studies have reported that clonidine and dexmetodomine can be used safely at low doses, intrathecal or epidural administration of these agents is not permitted by health authorities in Turkey.[16] Different volumes and doses of local anesthetics are used in caudal blocks. In a study comparing the caudal block administration doses of 1 and 1.5 mL/kg, it was reported that the diameter of the optic nerve sheath increased at a dose of 1.5 mL/kg, which is regarded as a sign of a significant increase in the intracranial pressure.[17] In our study, caudal block was performed with 0.7 mL/kg bupivacaine, and no adjuvant agent, including epinephrine, was added. The first analgesic use occurred at 4–15 hours in 17 patients who required analgesia in the caudal block group; of them, eight patients used analgesics for a second time. The duration of action of the caudal block in studies using 0.7 mL/kg bupivacaine was consistent with our findings.[18 19]

Due to the potential complications of caudal block, such as hypotension and urinary retention, other regional anesthesia techniques such as intradural injection, total spinal block, intravascular, subcutaneous, intraosseous, presacral, or intravascular injection and truncal blocks such as ilioinguinal, TAP, and QLB blocks have been explored.[20 21] Due to the use of these blocks under ultrasound guidance, their use in pediatric patients has increased. There are very few randomized controlled trials in the literature that have investigated the use of ultrasound-guided QLB in children.[9 21] In our previous study, we performed QLB using 0.5 mL/kg of 0.2% bupivacaine, and only three patients required analgesia within 24 hours, and the earliest time for the analgesic requirement was at 17 hours.[6] In this study, we used caudal anesthesia and 0.7 mL/kg of 0.25% bupivacaine in the QLB group and found that only two children in the QLB group used additional analgesia within 24 hours; the time to first analgesic use was 16 hours for one child and 19 hours for the other.

QLB includes the QLB1 and QLB2, transmuscular quadratus lumborum, and intramuscular quadratus lumborum block (IMQL) approach.[5 6 22 23] Hussein compared transmuscular quadratus lumborum block and IMQL in lower abdominal surgeries and reported that transmuscular quadratus lumborum block was more effective.[24] In our clinic, we used the QLB2 block because it is both safe and effective. Blanco published a study reporting that QLB2 was superior to TAP block in the pain management of patients who underwent cesarean section; he also indicated that paravertebral spread could explain the effect of QLB2.[25] We were unable to find any studies in the literature comparing a QLB approach with the caudal block applied in inguinal hernia repair or orchiopexy surgery. When we reviewed studies comparing caudal block with other truncal blocks, some reported that the duration of action of the TAP block was longer than that of the caudal block in pediatric patients who underwent lower abdominal surgery. Alsadek et al reported that the TAP block was superior in terms of analgesic consumption and pain scores between 6 and 12 hours, and Bryskin et al reported that it was superior in the entire 24 hours.[26 27] In our study, FLACC scores in the QLB group were lower than those in the caudal block group at 4, 6, and 12 hours, whereas there was no difference at 1, 2, and 24 hours.

A total of 18 950 caudal blocks were reviewed from the database of the Pediatric Regional Anesthesia Network. The complication rates of caudal block were as follows: block failure, 1%; blood aspiration, 0.6%; dural puncture, 0.08%; cardiac arrest, 0.005%; seizure, 0.005%; and sacral pain, 0.005%. The review reported that the mean dose of local anesthetics used was 1.4 mg/kg (95% CI 0.78 to 2.51) when calculated as a bupivacaine equivalent. The authors stated that the complications indicated in the study were generally related to local anesthetic toxicity.[28] Additionally, Suresh et al reported that a 1 mg/kg dose of 0.25% bupivacaine did not cause urinary retention and could be used as a safe dose.[16] In this study, we performed caudal block using 1.75 mg/kg (0.25% (0.7 mL/kg)) of bupivacaine. No complications were recorded, except for one failed block, which was excluded from the study.

There are a limited number of cases in the literature addressing complications associated with QLB. Clinicians should be aware that complications, such as retroperitoneal hematoma, organ injury, and local anesthetic toxicity, could occur. Local anesthetic can spread to the paravertebral area; hence, we should be careful about complications such as bradycardia and hypotension.[29] A case in the literature reported the femoral block-induced quadriceps muscle weakness that disappeared after 18 hours.[30] However, transient quadriceps muscle weakness or motor blocks were not observed in the QLB group.

Our study had some limitations. First, we did not confirm the distribution of the local anesthetic using ultrasound in real time or after the block was performed in the caudal block group. Second, we did not perform a dermatomal-level check before or after the surgery in both groups because the study was performed in pediatric patients and the blocks were administered under general anesthesia. We believe that more patient series are needed to compare complications between QLB and caudal groups.

In conclusion, QLB can provide significantly more effective and longer lasting analgesia than caudal block without adjuvants in the multimodal analgesia management of children undergoing inguinal hernia repair and orchiopexy surgeries.

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