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Comparative Study between Ultrasound Guided Quadratus Lumborum Block versus Caudal Block for Postoperative Analgesia in Lower Abdominal Surgery in Pediatrics

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ORIGINAL ARTICLE

Comparative Study between Ultrasound Guided Quadratus Lumborum Block versus Caudal Block for Postoperative Analgesia in Lower Abdominal Surgery in Pediatrics

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Abstract

Background: ***There is growing evidence of the utilization of regional anesthesia in pediatric patients scheduled for lower abdominal surgery.***

Aim: ***To assess the effectiveness of ultrasound-guided quadratus lumborum block (QLB) with ultrasound-guided caudal block in pediatric lower abdominal surgeries.***

Patients and Methods: ***This randomized controlled study included 90 patients. Patients were randomly allocated to receive either QLB, caudal block, or general anesthesia. The primary endpoint is the cumulative opioid consumption within 24 hours following surgery. The secondary outcomes encompass pain score, time of initial analgesic request, vital signs, postoperative negative consequences, and parent satisfaction.***

Results: ***Both QLB and caudal block groups exhibited significantly lower FLACC recordings than the control group at PACU 30 minutes, 1 hour, 2 hours, and 4 hours after surgery. FLACC score was significantly reduced in the QLB, contrasted with the caudal block and control groups at 6 and 12 hours after surgery (3.6 vs. 4.2 vs. 5.1, p= 0.041) and (2.8 vs. 3.5 vs. 5.5, p= 0.025), respectively. No significant disparities were observed across the study arms regarding vomiting, hypotension, bradycardia, and urine retention.***

Conclusion: ***The current study revealed that QL block yielded superior and enduring pain relief in the first 24 hours following unilateral lower abdomen surgery in pediatric patients, contrasted with caudal block and control groups. Group QL exhibited a greater level of parental satisfaction. No serious adverse effects were reported in the study groups.***

Keywords: FLACC (Face, Legs, Arms, Cry, Consolability) score; caudal block; Quadratus Lumborum block; Pain Management

1. Introduction

There is a growing trend towards utilizing regional anesthetics in pediatric patients. It is increasingly becoming crucial to pain relief during and after surgery. Regional approaches in children are predominantly carried out under general anesthesia.[1] Caudal epidural anesthesia is a commonly employed and appreciated method of pain relief after surgery for children who are having surgery on their lower abdomen. The benefits of this encompass its efficacy and convenience for users. Nevertheless, potential adverse consequences of this treatment encompass inadvertent penetration of the dura mater, muscular paralysis of the lower extremities, and impaired bladder function. Furthermore, postoperative pain alleviation typically lasts for about 4–6 hours. The duration of pain relief is excessively brief and insufficient.[2] Remarkably, ultrasound has been demonstrated to enhance sensory and motor block while decreasing the likelihood of concerns.[3] Ultrasound-guided caudal anesthesia offers numerous benefits compared to techniques based on anatomical landmarks. While the landmark approach demonstrates a favorable success rate, the utilization of ultrasound seems to enhance the success rate of an initial puncture compared to the conventional way.[1] Considering the possible difficulties associated with caudal block, such as low blood pressure and the inability to urinate, alternative regional anesthesia approaches, such as Transversus Abdominis Plane Block (TAP) and Quadratus Lumborum Block (QLB), may be preferred.[4]

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QLB is a novel method of regional anesthesia that offers pain relief following abdominal surgery. The procedure can be conducted via a landmark strategy, such as the lumbar triangle, or with ultrasonography (US) guidance. Regional anesthesia, which is safe and effective, involves precisely placing local anesthetics near the target nerves, ensuring that neither the nerves nor any nearby tissues are harmed.[5] The Quadratus Lumborum Block (QLB) allows for the diffusion of a local anesthetic drug below the quadratus lumborum muscle into a specific triangular area called the lumbar interfascial triangle. This triangle is located adjacent to the middle layer of the thoracolumbar fascia. The QLB procedure is suggested as a more reliable strategy for accomplishing both somatic and visceral pain relief in the abdomen.[6] This study aims to assess and evaluate the effectiveness of ultrasound-guided quadratus lumborum block and ultrasound-guided caudal block in pediatric lower abdominal surgeries.

2. Patients and methods

This trial adheres to the tenets outlined in the Consolidated Standards of Reporting Trials (CONSORT) guidelines. The trial is a prospective, randomized, double-blinded, controlled trial. A cohort of 90 pediatric participants who received elective lower abdomen surgery from December 2022 to October 2023 were incorporated into the study.

Participants were randomized into three comparable categories using a random number table and closed envelopes approach. Group I (the Control group) encountered general anesthesia entirely. Group II was administered QLB following the instillation of general anesthesia, analogous to the control arm. Group III, also known as the caudal block group, underwent an Ultrasound-guided caudal block procedure following the instillation of general anesthesia, analogous to the control group.

The trial encompassed participants aged 2 to 9 years, classified as ASA I or II, and established for elective unilateral lower abdominal procedures such as inguinal hernia repair, hydrocele repair, and undescended testicular surgery. The exclusion criteria included medication hypersensitivity, coagulation problems, and parental reluctance.

Procedure

Thorough assessments were performed on all participants prior to the surgical operation. Patients were requested to provide details regarding their drug consumption and past medical history, including anesthesia and any previous diseases. The primary measure of interest is the amount of pain medication consumed within 24 hours following surgery. The secondary outcome measures encompass pain score, time of initial analgesic request, vital signs, postoperative negative consequences, and patient satisfaction assessment.

The approach for administering general anesthesia involved using electrocardiography, non-invasive blood pressure measurement, and pulse oximetry to monitor all individuals in the operating room. When an intravenous cannula was not readily accessible, general anesthesia was established by administering 8% sevoflurane and 50% air in oxygen through a facemask. Subsequently, an intravenous cannula was inserted, and propofol (2–3 mg/kg) and fentanyl (1 μg/kg) were administered. After administering general anesthesia, a laryngeal mask airway was adopted. General anesthesia administration entailed using 2% sevoflurane along with a blend of 50% air and oxygen.

The method used for performing a US-guided QL block is as follows: The procedure of ultrasound-guided QLB involved situating the patient laterally and turning the side to be anesthetized upwards. A transducer with a linear array operating at a frequency range of 6–13 MHz, manufactured by FUJIFILM Sonosite, Inc. in Bothell, Washington, was employed. The transducer probe is first covered with sterile gel and positioned slightly above the iliac crest at the midaxillary line. Perform scanning in the front to locate the three muscles of the front part of the wall of the abdomen (transversus abdominis, internal oblique, and external oblique). Utilizing caudal tilting of the probe can enhance the visibility of the quadratus lumborum. Continue scanning in the posterior direction until the “Shamrock sign” image becomes visible. Place the needle (22 G, 50 mm needle) in a position where it penetrates the skin behind the ultrasound probe and moves in a direction parallel to the paraspinal muscles, to the side of the transverse process of L4, and through the quadratus lumborum. The intended site for injection was the fascial plane located between the quadratus lumborum and psoas major muscles. Administer a test dosage of 1–2 milliliters to verify the accurate positioning of the needle tip. After that, I administered bupivacaine 0.25% (0.7 ml/kg) on the same side with a maximal dosage of 2 mg/kg.

The method of performing a caudal block under the guidance of ultrasound imaging: After monitoring and administering anesthesia, the patient is situated on the left side with their hips and knees clenched. Prepare the field by applying a sterilizing solution and placing a sterile drape. A transducer with a linear array operating at a frequency range of 6-13 MHz, manufactured by FUJIFILM Sonosite, Inc. in Bothell, Washington, was utilized. The transducer probe is subsequently

wrapped in thoroughly sanitized gel. The scanning process in the transverse plane initially enables a clear view of the midline and recognition of the sacrococcygeal ligament between the two sacral cornua. The two cornua bear a resemblance to the two eyes of a frog, and as a result, they were referred to as the frog-eye sign. Subsequently, the probe was turned 90 degrees to achieve a longitudinal perspective. The needle (22 G, 50 mm) was inserted at a 20-degree angle with clear visibility of the needle tip and length. The sensation of a pop might be perceived when the needle traverses the sacrococcygeal ligament. After verifying the needle's placement in the caudal space on the screen, cautiously withdraw to verify the lack of cerebrospinal fluid or blood.

One might provide a saline bolus (0.1–0.2 mL/kg) to verify accurate placement. Subsequently, a meticulous administration of local anesthetic was performed using bupivacaine 0.25% at a dosage of 0.7 ml per kilogram of body weight, with a maximum dose of 2 mg per kilogram.

Statistical analysis

SPSS version 20 was utilized for recording data, preparation, and statistical analysis. The mean and the standard deviation were employed to analyze parametric numerical data, while the median and interquartile range (IQR) were utilized for non-parametric numerical data. Non-numerical data was analyzed using frequency and percentage. The Kruskal-Wallis test was adopted to judge the statistical significance of the disparity in a non-parametric variable among many research groups. She was performing a one-way analysis of variance (ANOVA) on continuous variables that follow a normal distribution. P-values below 0.05 were deemed statistically significant.

3. Results

Following the acquisition of ethical permission from the Al-Azhar ethical review board and personalized informed consent from parents, this randomized controlled trial successfully recruited 90 pediatric subjects who were planned to have elective lower abdomen surgery (Figure 1). No significant distinctions were found in demographic and patient parameters, including age, gender, weight, and ASA classification (p > 0.05) (Table 1).

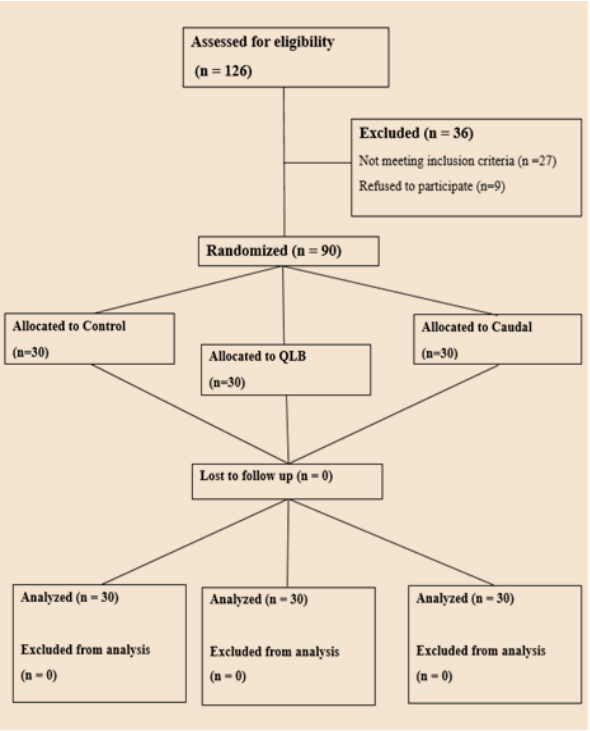

Figure 1. CONSORT flow diagram of the study process.

Table 1. Comparison of the patient characteristics between the study groups.

	CONTROL (N=30)	QLB (N=30)	CAUDAL (N=30)	TEST	P-VALUE
AGE (YEARS)				0.981	1.32
MEAN ± SD	4.2±1.3	4.5±1.5	5.3±1.2		
GENDER	N (%)	N (%)	N (%)	0.871	0.79
MALE	18 (60)	19 (63)	17 (56.7)		
FEMALE	12 (40)	11 (37)	13 (43.3)		
WEIGHT (KG)	17.9 ± 2.4	15.3 ± 2.2	17.5 ± 1.9	0.961	0.67
ASA	N (%)	N (%)	N (%)	0.614	0.41
I	22 (73.3)	23 (76.6)	21 (70.0)		
II	8 (26.7)	7 (23.4)	9 (30.0)		

Data presented as mean ± standard deviation, number and percentage

p-value >0.05, insignificant

ANOVA test

Chi-square test was used to compare the categorical values between groups.

Hemodynamic variables

The study groups showed no significant distinction in heart rate and MBP before, during, and after the operation (p > 0.05). Furthermore, when contrasting the caudal block with QL block groups to the control group, it was found that the control group had significantly higher heart rate measurements at 30 minutes during the surgery, in the post-anesthesia care unit (PACU), and at 1, 2, 4, 6, and 12 hours after the surgery (p < 0.05) (Table 2).

Table 2. Comparison between the study groups regarding heart rate.

HR (BEAT/MINUTE)	CONTROL (N=30)	QLB* (N=30)	CAUDAL* (N=30)	TEST¶	P-VALUE
BEFORE INDUCTION	115 ±17	114 ±16	112 ±15	0.948	0.781
INTRAOPERATIVE					
15 MINUTES	107 ±11	109 ±12	110 ±14	0.485	0.987
30 MINUTES	125 ±13	110¥ ±10	105¥ ±12	0.354	0.586
AT PACU	131 ±15	104¥ ±11	102¥ ±11	0.987	0.948
POSTOPERATIVE					
1 HOUR	127 ±14	108¥ ±13	106¥ ±11	1.128	0.214
2 HOURS	121 ±14	102¥ ±13	100¥ ±11	1.531	0.214
4 HOURS	119 ±12	104¥ ±10	105¥ ±13	1.354	0.198
6 HOURS	125 ±11	107¥ ±11	111¥ ±12	1.415	0.158
12 HOURS	117 ±12	105¥ ±12	107¥ ±13	1.315	0.098
24 HOURS	112 ±13	109 ±14	113 ±14	1.236	0.848

-

Data presented as mean± standard deviation

¶ANOVA

*T test, QL vs Control; Caudal vs Control

¥Significant, p-value < 0.05

In contrast to the QL group, the caudal group showed a significantly declined MBP only during the initial 2 hours after the surgery (Table 3). Furthermore, no notable disparity was observed across the study arms regarding oxygen saturation and respiratory rate.

Table 3. Comparison between the study groups regarding mean blood pressure recordings.

MBP (MMHG)	CONTROL (N=30)	QLB* (N=30)	CAUDAL* (N=30)	TEST¶	P-VALUE
BEFORE INDUCTION	65.1±5	68.3 ±5	67.5 ±8	1.085	0.731
INTRAOPERATIVE					
15 MINUTES	78.5±6	63.5 ±4	58.4 ±7	1.696	0.823
30 MINUTES	82.6±4	65.3¥ ±5	54.8¥ ±5	1.555	0.863
AT PACU	75.3±5	62.2¥ ±6	63.4¥ ±8	1.602	1.029
POSTOPERATIVE					
1 HOUR	72.8±5	65.3¥ ±6	61.8¥ ±7	1.683	0.919
2 HOURS	77.2±4	61.5¥ ±5	58.3¥ ±6	1.437	0.357
4 HOURS	75.2±4	64.2¥ ±4	63.4 ±4	1.779	0.439
6 HOURS	71.3±3	67.3¥ ±8	66.2 ±5	1.883	0.189
12 HOURS	67.5±4	59.5 ±5	65.7 ±8	1.725	0.813
24 HOURS	67.1± 5	65.3 ±6	62.5 ±3	1.809	0.625

-Data presented as mean± standard deviation

¶ANOVA

*T test, QL vs Control; Caudal vs Control

¥Significant, p-value < 0.05

Analgesia parameters

The FLACC score was considerably reduced in the QLB group contrasted with the caudal block and control arms at 6 and 12 hours after the operation (3.6 vs. 4.2 vs. 5.1, p= 0.041) and (2.8 vs. 3.5 vs. 5.5, p= 0.025), respectively. Both the QLB and caudal block groups exhibited significantly lower FLACC recordings than the control group at PACU, 30 minutes, 1 hour, 2 hours, and 4 hours(Figure 2).

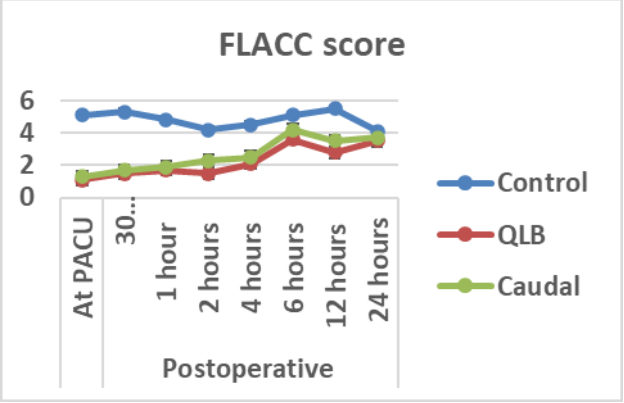

Figure 2. Comparison between the study groups regarding FLACC score.

The control group exhibited a considerably more significant amount of fentanyl consumption after surgery, in comparison to the caudal and QLB groups (504 vs. 114 vs 63 µg, p= 0.001) correspondingly (Table 4). Furthermore, there was no significant disparity observed between the groups in terms of the frequency of fentanyl 1 µg/kg administrations and the number of patients who needed further fentanyl analgesia. In addition, the QLB and caudal block groups had a significantly decreased frequency of ibuprofen doses compared to the control group (7 vs. 9 vs. 24, p < 0.05). Furthermore, the QLB group revealed a substantially longer duration until the first request for analgesic medication than the caudal

and control groups (11.6 vs. 6.5 vs. 2.3, p = 0.001).

Table 4. Comparison between groups regarding postoperative fentanyl consumption

	CONTROL (N=30)	QLB* (N=30)	CAUDAL* (N=30)	TEST¶	P-VALUE
FREQUENCY OF FENTANYL DOSES (1 MG/KG) N (%)					
1 DOSE	14 (46.7)	3 (10)	4 (13.3)	1.842	0.627
2 DOSES	5 (16.7)	0 (0)	1 (3.3)		
TOTAL	19 (63.4)	3 (10)¥	5 (16.7)¥	2.628	0.075
CUMULATIVE FENTANYL CONSUMPTION (MG)	504	63	114	0.931	0.001¥

Chi-square test

*T test, QL vs Control; Caudal vs Control

¥Significant, p-value < 0.05, >0.05, not significant

Concerning complications, the occurrence of nausea was notably higher in the control group compared to the QLB and caudal groups (15 versus 3 and 5, P= 0.001). Furthermore, no significant disparities were observed across the study groups regarding vomiting, hypotension, bradycardia, and urine retention. No patients in the three research groups experienced significant problems such as pneumothorax, as indicated in (Figure 3). In addition, there was no significant disparity observed between the research groups in terms of parent satisfaction score (p < 0.05) (Figure 4).

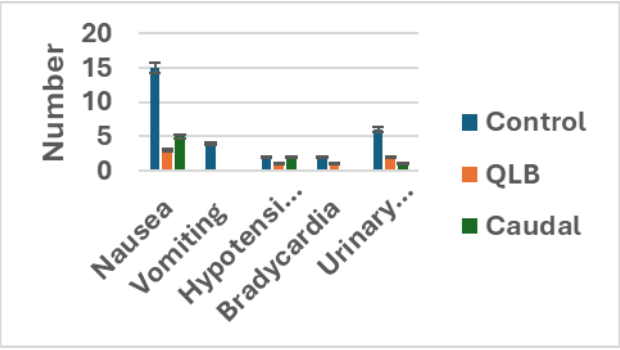

Figure 3. Comparison between the study groups regarding complications.

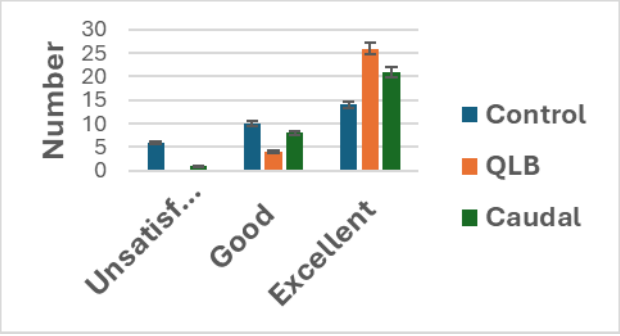

Figure 4. Comparison between the study groups regarding parent satisfaction.

4. Discussion

Various regional anesthetic techniques have been utilized to offer efficient and enduring pain relief after surgery in children patients having lower abdomen procedures, resulting in consistent satisfaction among parents.[7]

This trial revealed that QL block yielded superior and extended postoperative pain relief compared with caudal block. Additionally, group QL exhibited higher levels of satisfaction.

Ragab et al. conducted a prospective randomized controlled study on 52 pediatric patients undergoing unilateral lower abdomen surgery. The study revealed that the duration until the initial request for pain relief was much longer in the QL group compared to the control group (16.1 vs 6.7 hours).[8]

Baidya et al.[9] found that administering a single transmuscular QL block injection to juvenile patients having pyeloplasty effectively relieved postoperative pain.

In addition, Zhao et al. executed a recent meta-analysis[10] to assess the efficacy of QL block in contrast with other analgesic techniques. The study ultimately incorporated 346 pediatric patients and determined that the QL block demonstrated a significant decrease in the frequency of postoperative rescue analgesia within the initial 24-hour period.

Sato and colleagues[11] conducted a study that included 47 pediatric patients aged 1 to 17. The study revealed a significant decline in the amount of fentanyl needed for postoperative pain relief in the QL block arm, contrasted with the caudal block arm.

Furthermore, Genc Moralar et al.[12] reported that analgesia time was significantly longer in the QL1 block group (8.00 ± 5.29 hours) than in the IV opioid group (3.5 ± 2.06 hours).

On the contrary, Ipek et al.[13] revealed that the duration of effect in the QL1 group was 2.17 ± 1.94 hours, but it was 5.08 ± 5.71 hours in the caudal group. Although both groups used the same concentration of local anesthetic (0.25% bupivacaine, 0.5 mL/kg) in the QL block, their findings contradicted ours. The variation in the QL block technique could explain this disagreement since Ipek et al. employed a lateral QL block, whereas we utilized a posterior QL block. Furthermore, this inconsistency could be clarified by considering the implementation of multimodal analgesia, specifically the delivery of ibuprofen at a dosage of 7 mg/kg after the surgery. Indeed, Ipek et al.[13] administered a dosage of 1 µcg/kg fentanyl during the induction

phase, but they did not administer intravenous non-steroidal analgesic.

Furthermore, the present findings are incongruous with the study conducted by Samerchua et al.[14] which documented the timing of the initial administration of oral acetaminophen following ilioinguinal herniotomy in a group of 40 pediatric patients was slightly longer in the QL block group compared to the ilioinguinal/iliohypogastric group (8.4 ± 4.1 and 4.8 ± 2.2, respectively), but this difference was not statistically significant. The negligible outcome could be due to the limited sample size or the possibility that children were administered oral acetaminophen doses 1 or 2 hours before pain score recording.

The QL block's impact is believed to result from the cranial dissemination of local anesthetic into the thoracic paravertebral space (TPVS).[15] Carney et al. confirmed the dissemination of this phenomenon by detecting the presence of a local anesthetic combined with a contrast agent in TPVS following the administration of QL block.[16]

The epidural area is characterized by its significant vascularity, which accelerates the absorption of local anesthetics. This accounts for the reduced duration and less effective pain relief the caudal block provides. This was illustrated in a relatively recent meta-analysis conducted in hypospadias surgery, which compared caudal anesthesia with other peripheral nerve blocks. The analysis found that caudal anesthesia had a notably shorter duration of pain relief, higher pain scores for up to 24 hours, and increased consumption of pain relief medication.[17]

Concerning hemodynamics, this study found that no significant distinction was observed between the QL and caudal block groups. Furthermore, patients in the QL group exhibited significantly reduced deviation from the initial state at 30 minutes during the operation, in the PACU, and at 1, 2, 4, and 6 hours after the operation when contrasted with the control group (p-value < 0.05). Unlike the QL group, the difference in the caudal group was significant only in the first two postoperative hours.

Ragab and colleagues demonstrated no significant difference in hemodynamic stability between the two arms, except at 30 minutes, as the control group had considerably higher systolic blood pressure (SBP) without any clinical significance. This lack of significant distinction was observed for 45 minutes regarding SBP, diastolic blood pressure (DBP), and heart rate (HR).[8]

In addition, this study did not document any negative consequences caused by the local anesthetic, such as irregular heart rhythm, seizures, low blood pressure, or allergic reactions, either during or after the operation. Furthermore, the control group had a considerably higher incidence of nausea compared to the QLB and caudal groups (15 versus 3 and 5, P= 0.001). No notable disparities were observed among the study groups regarding vomiting, hypotension, bradycardia, and urine retention. Significantly, none of the patients in the three research groups experienced significant problems such as pneumothorax.

The disparity in nausea experienced by the research groups can be related to the variation in fentanyl use. The study found that the control group had a considerably higher amount of fentanyl consumed after surgery compared to the caudal and QLB groups (504 vs. 114 vs. 63 µg, p= 0.001), respectively.

These findings align with those of Sato and his colleagues.[11] During the 48-hour postoperative study period, no disparity in vomiting occurrence was observed across the groups. There were no further complications, such as systemic toxicity from local anesthesia.

Alansary and his colleagues[18] had comparable findings. The researchers documented a small number of minor cases of postoperative nausea and vomiting (PONV) in both groups of patients, and there was no statistically significant variation between the two groups. Furthermore, applying localized blocks did not lead to hematoma, damage to underlying tissues, local anesthetics toxicity, or hemodynamic instability.

According to Blanco et al.,[5] patients who underwent a cesarean delivery and received a QL2 block did not experience any complications related to needle insertion. This is because the QL2 block is performed on a superficial muscle called the QL muscle, which acts as a barrier between the needle tip and the peritoneum. As a result, the risk of injecting into the peritoneal cavity and causing bowel injury is minimized, making the procedure safe. Furthermore, a few negative occurrences can be attributed to the comparatively limited number of participants and the utilization of ultrasound guidance for direct needle visibility during insertion in the QL block.

Our study found that the QL block group had a higher rate of reasonable parent satisfaction than the caudal and control groups. Consistent with this finding, Ipek et al.[13] a notable increase in parental satisfaction was observed in the QL2 block compared to the caudal block. In addition, Ragab et al.[8] revealed that a significant proportion of parents from both study groups expressed happiness (88.5%). However, within this majority, around 27% of the QL group reported being very satisfied, suggesting that the QL group exhibited greater satisfaction than the caudal block group.

Limitations: Initially, the evaluation of the dermatomal level was not relevant in the context of pediatric patients. We were uncertain whether

a caudal block gave a higher level of dermatomal sensory block. Furthermore, the QL block in this investigation consisted solely of one approach. Therefore, whether alto-be-seen block approaches can yield comparable outcomes remains to be determined. Similarly, our results do not apply to the lumbar epidural block, which is more potent and efficacious than the caudal block.

4. Conclusion

The current investigation revealed that the QL block yielded superior and enduring pain relief in the first 24 hours following unilateral lower abdomen surgery in pediatric patients, contrasted with caudal block and control groups. Group QL exhibited a greater level of parental satisfaction. The research groups did not report any significant adverse effects.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article

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Conflicts of interest

There are no conflicts of interest.

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