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ORIGINAL RESEARCH REGIONAL ANESTHESIA

Bilateral erector spinae plane block vs quadratus lumborum block for pediatric postoperative pain management after laparoscopic abdominal surgery: a double blinded randomized study

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Abstract

Background: Postoperative pain management in children can be effectively controlled using regional analgesic techniques. In general, neuraxial blocks pose a higher risk of adverse effects and complications in comparison to peripheral nerve blocks. Recently, both quadratus lumborum block (QLB) and erector spinae plan block (ESPB) have been used to achieve adequate postoperative analgesia in children. We compared the efficacy of both in postoperative pain management after laparoscopic abdominal surgery.

Methodology: Eight five patients with laparoscopic abdominal surgery received either bilateral QLB or ESPB at the level of T8 transverse process with 0.5 ml/kg of 0.25% bupivacaine to achieve adequate postoperative analgesia. FLACC score was used to assess pain score after surgery and the need for rescue opioid analgesia.

Results: The average dose of fentanyl was lower and the time to the first dose of rescue analgesic was longer in QLB group when compared to ESPB group. In addition, FLACC scores were significantly lower in QLB group in comparison to ESPB group at the 6th, 8th, 12th and 20th h after surgery.

Conclusion: Quadratus lumborum block can provide longer and more effective postoperative analgesia in pediatric patients following laparoscopic abdominal surgery in comparison to erector spinae plan block.

Key words: Bilateral; Block; Pediatric; Pain Management; Laparoscopic; Surgery.

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1. Introduction

Pediatric laparoscopic surgery was described for the first time in the early twentieth century. Its use has increased since last decade. A laparoscopic approach potentially reduces the surgical stress, fluid shifts and postoperative respiratory and wound complications. Anesthesia for these procedures pose certain challenges for anesthetic practitioners.[1] Pain following laparoscopy results from rapid peritoneal distension, visceral manipulation, irritation and traction of vessels and phrenic nerves, and presence of the residual gas in the peritoneum and the inflammatory mediators.[2,3]

Pain can be controlled using a multimodal approach with opioids, NSAIDs and regional analgesic techniques. This can be achieved in children by performing lumbar epidural catheter, caudal block, or a peripheral nerve block including quadratus lumborum block (QLB) or erector spinae plane block (ESPB).[4]

In general, neuraxial blocks pose a higher risk of adverse effects and complications than the peripheral nerve blocks.[5] On the other hand, the caudal block has a relatively shorter duration (4 to 6 h) than a peripheral nerve block. The peripheral nerve blocks have the advantage of greater overall safety and efficacy for lower abdominal surgeries than the caudal block.[6]

Ultrasound guided QLB is a well-known local analgesic technique providing perioperative somatic, perhaps even visceral analgesia for patients of all ages undergoing abdominal surgery.[7] In quadratus lumborum 2 block (QLB2), the point of injection is intentionally moved from the anterolateral side of the QL muscle to the posterior wall. This allows the local anesthetic to spread between the posterior aspect of the quadratus muscle and the medial layer of the thoracolumbar fascia, which is close to the thoracic paravertebral space.[8,9]

ESPB is a newly described regional analgesic technique suitable for children undergoing laparoscopic upper abdominal surgery. It blocks both somatic and visceral pain.[10,11] The local anesthetic is injected deep to the erector spinae muscle.[11,12] This allow the spread of local anesthetic cranio-caudally up to nine dermatomes and antero-posteriorly into the paravertebral space reaching the ventral and dorsal spinal rami.[13,14,15]

To date, no studies have compared postoperative pain control in children receiving an ESPB with those receiving a QLB2 for abdominal laparoscopic surgery. We hypothesized that the ESPB would confer a level of postoperative pain control higher to that of a QLB2.

We compared ESPB with QLB2, regarding the total fentanyl required and the frequency of additional fentanyl doses required as rescue analgesia, together with the number of patents who required rescue analgesia in the first 48 h after surgery between both studied groups. The secondary objective was to compare FLACC scores and parent satisfaction level at stationary time intervals in the two groups.

2. Methodology

After obtaining formal approval from IRB, this study was conducted in Mansoura University Children's Hospital in collaboration with the pediatric surgical department. All patient who were scheduled for complex laparoscopic abdominal surgery were included in this study, under convenient sampling, after parental informed consent was obtained, starting from March 2021.

For postoperative pain management, 90 patients of either sex, age 2−7 y undergoing elective laparoscopic abdominal surgery were randomly allocated into two groups: in one group, QLB was performed, and in the second group, ESPB was performed. All blocks were performed by an anesthesiologist on the pediatric regional anesthesia team, under ultrasound guidance, in the prone position after induction of general anesthesia, prior to the surgical incision. The local protocol in our hospital is to use a short-acting opioid, such as fentanyl on induction of anesthesia and a prophylactic anti-emetic, ondansetron and/or dexamethasone intraoperatively.

Refusal of the guardians to participate in the study, open abdominal surgery, hypersensitivity to local anesthetics, a coagulation disorder, and renal or hepatic disease were the exclusion criteria for the patients.

Sample size was calculated using G*Power version 3.1.9.2 (Kiel University, Kiel, Germany) software. The primary outcome was the total dose of fentanyl consumption in the first postoperative 48 h. Based on a previous study measuring the number of patients who required analgesia in the first 24 hours in Children after low abdominal surgery. From this study, 12% of patients in first group and 40% in the second group required postoperative analgesia at 24 hours after surgery. a total sample of 74 patients (37 in each group) were required to achieve a power (1–β) of 80%, and type I α error of 0.05. Eight patients were added to each group to compensate for any drop out. Thus, the final sample was 45 patients in each group.[16]

Anesthesia was induced with propofol 1−1.5 mg/kg, fentanyl 1 µg/kg, and rocuronium 1 mg/kg. Pressure controlled ventilation (PSV) mode was used with sevoflurane in 50% oxygen and air.

For performing QLB (group QLB), patients were placed in prone position and the skin was cleaned and disinfected. A low frequency (4–8 MHz) convex transducer (LOGIQe®, GE Healthcare, USA) was covered with a sterile sheath. For the posterior QLB, the transducer was placed at the level of the anterior superior iliac spine, and moved cranially until the 3 abdominal wall muscles were clearly visible. According to the characteristics of the quadratus lumborum with tendon attached to the transverse process, the muscle which was pointed by the transverse process was the quadratus lumborum. The probe was tilted down to identify the posterior side of the quadratus lumborum. A short oblique, 22 G, 50 mm insulated needle (Sonoplex Stim®, Pajunk™, Germany) was inserted in-plane from the ventral side to the dorsal side followed by a negative aspiration test and injection of 2 ml normal saline to confirm the position. Ropivacaine 0.25% was injected, 0.5 ml/kg on each side, between the quadratus lumborum and the thoracolumbar fascia.[17]

An ultrasound-guided ESPB (group ESPB) was performed with the patient lying in prone position. After skin disinfection, sterile draping was placed and the ultrasound probe was sheathed. The level of the block was at the transverse process of T8. The block was performed using a 9–12 MHz linear probe (LOGIQe®, GE Healthcare, USA), which was placed in a parasagittal plane 2 cm from the posterior midline. The deep plane to the erector spinae muscle (ESM) was identified, and a 22 G, 50 mm insulated needle (Sonoplex Stim®, Pajunk, Germany) was inserted craniocaudally in plane between the transverse process and the fascia of the ESM. Negative aspiration test was done and 2 ml normal saline were injected to confirm the position. After that 0.5 ml/kg of 0.25% bupivacaine was injected to confirm the correct position by visualizing the solution lifting the ESM off the transverse process. Spread of local anesthetic between the T10 and L4 transverse processes was thereafter visually tracked with the transducer on either side.[18]

Surgical incision was performed after 20 min. Additional doses of fentanyl 1 µg/kg was given to blunt the surgical stress response, if a rise in heart rate and or blood pressure more than 25% from the baseline values was noted. Acetaminophen 15 mg/kg was administered 20 min before the end of the surgery and every 6 h in PACU. All patients were extubated by the end of operation.

In PACU, if any patient complained of pain and/or when FLACC score was more than 4, an additional dose of fentanyl 1 µg/kg was given and repeated in order to decrease FLACC score less than 4.

The data recorded and compared between both groups was the total dose of fentanyl given, first dose given and the frequency of additional doses, and number of patients who required rescue analgesia. FLACC (face, legs, activity, cry, console ability) scale score was recorded every hour for the first four hours then every four hours for the rest of 48 h. Parents satisfaction level was noted verbally from 1 to 10, with the lowest level of satisfaction at a value of 1 and the highest level at 10, the time required to perform each block and any associated complications were recorded.

Statistical analysis

The statistical analysis of data was done by using IBM SPSS Statistics for Windows, Version 22.0 (Armonk, NY: IBM Corp). The distribution of data was done by mean ± SD for quantitative data, frequency & proportion for qualitative data and median (range) for nonparametric data. The analysis of the data was done to test statistically significant difference between the groups. Objective pain discomfort score was analyzed by Mann-Whitney t test. For quantitative date Student's t-unpaired test was used to compare between the two groups. Chi square test was used for qualitative data. $P \leq 0.05$ was considered significant at confidence interval 95%.

3. Results

A total of 90 patients were enrolled in this study, 85 cases completed the study; three cases were dropped from QLB group and two from ESPB group.

Demographic and perioperative data of all patients are given in Table 1. No significant differences were noticed between both groups in terms of demographic, perioperative clinical data and the time required to perform the nerve blocks (Table 1).

The average rescue dose of fentanyl/kg was statistically lower and the time to the first dose of rescue analgesic was longer in QLB group when compared to ESPB group. Frequency of fentanyl rescue doses, number of patients who required additional fentanyl doses and range of parents' satisfaction about analgesic management of their children showed no significant values when both groups were compared together (Table 2).

FLACC scores were significantly lower in QLB group as compared to ESPB group, at the 6th, 8th, 12th and 20th h after surgery (Table 3).

Table 1: Patients characteristics, surgery time, block performance time of the studied groups.

Parameter	Group QLB N = 42	Group ESPB N = 43	P value
Age (months)	46.31 ± 15.69	47.65 ± 17.79	0.717
Gender M/F (n)	18/24	20/23	0.452
Body weight (kg)	31.77 ± 6.57	33.11 ± 8.19	0.408
Operation time (min)	98.60 ± 37.54	96.51 ± 34.77	0.791
Block performance time (min)	9.43 ± 1.21	9.79 ± 1.83	0.287

Data expressed as mean ± SD

Table 2: Comparison data of rescue analgesia, and parent satisfaction

Variable	Group QLB N = 42	Group ESPB N = 43	P value
Average amount fentanyl (µg/kg)	1.43 ± 0.53	2.00 ± 0.47*	0.034
Frequency of fentanyl doses [n (range)]	1 (1-2)	2 (1-3)	0.390
Time of first dose (h)	11.57 ± 1.51	8.50 ± 1.78*	0.002
Number of patients who required analgesia	8 (19.05)	10 (23.26)	0.546
Parent satisfaction	8 (6-10)	7 (6-10)	0.462

**P < 0.05 significant when Group QLB compared to Group ESPB. Data are expressed as mean ± SD, number and %, median and IQ.*

4. Discussion

This prospective study was designed to compare two different regional postoperative analgesic techniques in pediatric patients undergoing laparoscopic abdominal surgery. In the current study, the average amount of fentanyl needed as rescue postoperative analgesia was significantly lower in QLB and the time to the first dose of rescue analgesic was longer in QLB group when compared to ESPB group. Meanwhile, up to sex hours post-operatively, there was no difference in FLACC scores between the two groups, but after sex hours there was significantly lower pain scores in QLB group than the ESPB group, and this trend continued for up to 20 h after surgery.

Visoiu and Yakovleva were the first to report that QLB can be used for providing postoperative pain management with a catheter in pediatric colostomy repair to extend the period of analgesia.[19] Similarly, Chakraborty et al. performed continuous QLB using catheter after a nephrectomy for Wilms tumor in pediatric patients while in a supine position, with successful and effective postoperative analgesia.[20]

Although the mechanism of the QLB has not been fully clarified, cadaveric studies have been conducted to examine the spread of local anesthesia. Carline et al. tried to investigate the spread of local anesthetics in QLB. He performed QLB in 10 cadavers with the QL1, QL2, and QL-TM approaches. The local anesthetic in the QL1 (between the deep and mid-layer of the thoracolumbar fascia) and QLB2 (between the superficial and mid-layer of the thoracolumbar fascia, more toward the posterior side) had spread similarly to the subcostal nerves, with more effect on L1–L3 nerve roots. In contrast, no spread to the thoracic dermatome was observed.[21]

Preliminary case reports and some randomized controlled trials show encouraging analgesic effect of ESPB for rib fracture, thoracotomy, sternotomy, epigastric hernia repair, open abdominal surgery and laparoscopic abdominal surgery. Although effective, controversy remains regarding the accuracy and consistency of analgesic success following ESPB.

Local anesthetic spread following an ESPB injection will find its way antero-medially through the costotransverse foramen and / or inter transverse ligaments to enter the thoracic paravertebral space or epidural space to block the ventral rami of the thoracic spinal nerves. It may also spread laterally to reach the neighboring intercostal nerves.[22,23]

Table 3: Comparative pain scores (FLACC) in both groups

Postoperative Time interval	Group QLB NO (45)	Group ESPB No (45)	P value
1st h	0.5 (0-1)	1 (0-1)	0.915
2nd h	0 (0-1)	1 (0-1)	0.237
3rd h	0 (0-1)	1 (0-1)	0.591
4th h	2 (1-2)	2 (1-3)	0.062
6th h	3 (1-5)	4 (1-6)*	0.033
8th h	2 (1-4)	4 (1-6)*	0.002
12th h	4 (2-5)	5 (3-6)*	0.001
16th h	4 (2-5)	4 (2-5)	0.859
20th h	3 (2-4)	4 (2-5)*	0.007
24th h	3 (1-4)	3 (1-4)	0.459
28th h	2 (1-4)	2 (1-4)	0.522
32nd h	2 (1-2)	2 (1-3)	0.203
36th h	2 (1-2)	2 (1-3)	0.055
40th h	1.5 (1-2)	2 (1-3)	0.056
44th h	1 (1-2)	1 (1-2)	0.597
48th h	1 (0-2)	1 (0-2)	0.914

**P < 0.05 significant when Group QLB compared to Group ESPB. Data are expressed as median ± IQ.*

Cadaveric studies and radiological imaging studies have revealed differing findings. In a cadaveric study, Uvanusic et al. reported that no analgesic spread occurred anteriorly to the transverse process or paravertebral space.[24]

The difference of local anesthetic spread pattern between ESPB and QLB may explain the lower rescue dose of fentanyl and the longer time to the first dose of rescue analgesic and lower FLACC scores noted in QLB group when compared to ESPB group. ESPB is associated with a higher and more central spread of local anesthetic medications in comparison to QLB.[25]

5. Limitations

This study has some limitations; first, the volume and concentration of local anesthetic possibly affect the spread and sensory blockade, and thus a larger volume and/or higher concentration of local anesthetic may produce better sensory blockade and analgesic effects with either block. Second, prone position increased both blocks technique difficulty.

6. Conclusion

Quadratus lumborum plan block can provide longer and more effective postoperative analgesia in pediatric patients following laparoscopic abdominal surgery in comparison to erector spinae plan block.

7. Data availability

The numerical data generated during this study is available with the authors.

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9. Conflict of interest

No potential conflict of interest relevant to this article was reported.

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11. Authors contribution

HIT: Study design, data analysis

AMF, MME: Data collection

MME: Data analysis, Manuscript editing

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