Original Article

Comparison of analgesic efficacy of ultrasound-guided quadratus lumborum block versus erector spinae plane block in children undergoing elective open pyeloplasty – A randomized, double-blinded, controlled study

Isaac Lalfakzuala Ralte, Debesh Bhoi, Praveen Talawar[1], Ganga Prasad, Rajeshwari Subramaniam, Prabudh Goel[2]

Department of Anaesthesiology, Pain Medicine and Critical Care, [2]Department of Pediatric Surgery, All India Institute of Medical Sciences, New Delhi, [1]Department of Anaesthesiology, AIIMS, Rishikesh, Uttarakhand, India

Abstract

Background and Aims: Comparison of analgesic efficacy of ultrasound-guided transmuscular quadratus lumborum block (QL-3) and erector spinae block (ESP) in children undergoing open pyeloplasty was done in this study.

Material and Methods: This was a randomized, double-blinded, controlled study conducted in a tertiary care center, operating rooms, post-anesthesia care unit (PACU), and paediatric surgical ward. Sixty children of age 1–6 years, with American Society of Anesthesiologists (ASA) status I or II, undergoing elective open pyeloplasty were included in the study. Patients were randomized into two groups: group I (QL block-3) and group II (ESP). Both blocks were performed under USG guidance using 0.5 ml/kg of 0.25% ropivacaine after induction of general anesthesia. Postoperative Modified Objective Pain Score (MOPS), perioperative hemodynamic parameters, perioperative time for first rescue analgesia, total rescue analgesia, and incidence of complications were recorded. Statistical tests were applied as follows: (i) quantitative variables were compared using independent *t*-test/Mann–Whitney test (when the data sets were not normally distributed) between the two groups, and repeated measure analysis of variance (ANOVA)/Friedman test was used for comparison between different time intervals within the same group and (ii) qualitative variables were correlated using the Chi-square test/Fisher's exact test. A P value of <0.05 was considered statistically significant.

Results: Pain was assessed using MOPS in the postoperative period at 0, 30 min, 1, 2, 4, 6, 12, and 24 h. Overall, the pain scores were low and showed a decreasing trend toward baseline as time progressed. Group I showed lower score, but was statistically significant only at the sixth hour. Highest mean score was 2.4 ± 2.01 in group I and 2.67 ± 2.32 in group II. Perioperative hemodynamic parameters were comparable. Total rescue analgesia during the perioperative period was not statistically significant (intraoperative $P = 0.075$ and postoperative $P = 0.928$). Also, 63.33% patients in group I and 63% patients in group II required rescue analgesia in the postoperative period and were comparable. Mean ± standard deviation (SD) for first rescue analgesia time was 6.32 ± 12.57 in group I and 16.67 ± 31.25 in group II, but not significant. The distribution in group II was skewed, hence the larger value for group II, but when compared to group I, this was statistically not significant.

Conclusion: Both ultrasound-guided ESP block and QL block using 0.25% ropivacaine 0.5 ml/kg provided adequate analgesia during the first 24 h post-surgery in children undergoing open pyeloplasty. The fentanyl requirement during the first 24-h postoperative period was also decreased.

Keywords: Analgesia, ESP block, pediatric, pyeloplasty, QL block, ultrasound

Address for correspondence: Dr. Debesh Bhoi,
Department of Anaesthesiology, Pain Medicine and Critical Care,
All India Institute of Medical Sciences, New Delhi - 110 029, India.
E-mail: debeshbhoi@gmail.com

Access this article online

Quick Response Code:

Website: https://journals.lww.com/joacp

DOI: 10.4103/joacp.joacp_173_22

How to cite this article: Ralte IL, Bhoi D, Talawar P, Prasad G, Subramaniam R, Goel P. Comparison of analgesic efficacy of ultrasound-guided quadratus lumborum block versus erector spinae plane block in children undergoing elective open pyeloplasty – A randomized, double-blinded, controlled study. J Anaesthesiol Clin Pharmacol 2024;40:127-32.

Submitted: 10-May-2022 **Revised:** 20-Jul-2022
Accepted: 26-Jul-2022 **Published:** 29-Jul-2023

Introduction

Open pyeloplasty through an anterior subcostal incision is a commonly performed procedure in pediatric population for ureteropelvic junction obstruction. However, it can also be done as laparoscopy-assisted extracorporeal pyeloplasty or robot-assisted pyeloplasty.[1] Adequate postoperative analgesia is required to facilitate early mobilization to reduce postoperative complications. This can be achieved by using multimodal analgesic techniques, which include combination of systemic analgesia and regional anesthesia. Conventionally, opioid-based systemic or neuraxial analgesia is used along with other multimodal analgesic medications, but it is associated with increased incidence of nausea, vomiting, respiratory depression, risk of neuraxial injury, and delayed discharge.[2] With the advent of ultrasound (US), different truncal blocks have come into practice as opioid-sparing analgesic modalities, namely, transverse abdominis plane (TAP), quadratus lumborum (QL), erector spinae plane (ESP) block, and so on.[3,4]

Transmuscular QL block (QL-3) has been found to provide excellent postoperative analgesia in pediatric patients in various surgeries.[3-5] The QL block has been shown to have a wider spread of dye (from T5 to L1 spine level) in radiological studies, when compared to classic TAP block, and has the advantage of blocking visceral pain,[6] although the spread is dependent on the site of injection.

The ESP block was first performed by Forero *et al.*[7] at T5 thoracic level for neuropathic pain. The local anesthetic (LA) is deposited below the erector spinae muscle (ESM) at or around the transverse process under ultrasound guidance, which tends to reach the thoracic paravertebral space blocking both posterior and anterior rami along with sympathetic ganglia, as shown in cadaveric studies.[7] The spread to paravertebral space is more at the congruent transverse process level and also one or two levels adjacent in cranial and caudal directions.

In this study, we hypothesize that the ESP block may provide superior analgesic efficacy due to its proximity to congruent thoracic paravertebral space, compared to QL block, in children undergoing open pyeloplasty.

Material and Methods

The study was a randomized, double-blinded, controlled study where the patients and observers were blinded about the group. After obtaining the Institute Ethics Committee's (IEC) approval, the trial was registered prospectively with the clinical trial registry of the concerned country (CTRI/2018/03/012527). Written informed consent was taken from the parents or guardians of pediatric patients of American Society of Anesthesiologists (ASA) I–II, aged between 1 and 6 years, who were scheduled for elective open pyeloplasty surgery under general anesthesia. Sixty-four patients were included in our study between May 2018 and September 2019. Those who refused to participate or those with developmental delay, coagulopathy, infection at the local site, significant cardiac, liver, or renal disease, or obesity were excluded. The children were randomized into two groups (30 each) – group I (QL-3 block) and group II (ESP block) – using sealed opaque envelopes concealing the randomization number.

All the children included in the study were thoroughly assessed preoperatively by history, physical examination, and laboratory evaluations. On the day of surgery, patients were shifted to the operation theater after they were administered premedication (oral midazolam 0.5 mg/kg), and standard ASA monitors were attached. Peripheral intravenous (IV) access was secured after inhalation induction (oxygen/sevoflurane). Those already having IV access were induced with fentanyl (2 μg/kg), propofol (3 mg/kg), and then atracurium (0.5 mg/kg) secure airway with an endotracheal tube of appropriate size. Anesthesia was maintained using O_2, air, and isoflurane at a fresh gas flow of 1 l/min to maintain a minimum alveolar concentration (MAC) of 0.8–1 and pressure-controlled ventilation.

Group I then received transmuscular approach (anterior QL block/QL-3)[8] under all aseptic precautions in a lateral position (side to be blocked upward). A high-frequency (13–6 MHz) linear probe (Fujifilm Sonosite M-turbo/Edge; Bothell, WA, USA) was placed transversely at the flank immediately cranial to the iliac crest. The QL muscle was identified by its attachment to the lateral edge of the transverse process of lumbar vertebrae, with the psoas major muscle (PM) anteriorly and the ESM posteriorly forming the "shamrock" pattern. A 22-G, 50-mm echogenic block needle was inserted "in plane" to the ultrasound probe, targeting the plane between the QL muscle and the PM muscle. The plane was confirmed by hydrodissection with 0.5–1 ml of normal saline, and then ropivacaine 0.25% (0.5 ml/kg) was deposited [Figure 1].

Group II received the ESP block under all aseptic precautions placing patients in a lateral position (side to be blocked upward). A high-frequency linear probe (13–6 MHz) was placed longitudinally in the paravertebral region at thoracic level (T7) vertebra. A 22-G, 50-mm echogenic needle was introduced using the in-plane technique in a craniocaudal

direction to make a contact with the transverse process. After hydrodissecting the plane, ropivacaine 0.25% (0.5 ml/kg) was injected below the ESM, just above the transverse process [Figure 2].

Intraoperatively, patients were monitored continuously for heart rate (HR), noninvasive blood pressure (NIBP), pulse oximetry (SpO_2), end-tidal CO_2, and temperature. Whenever the HR and mean arterial pressure (MAP) increased by 20% from baseline, fentanyl 0.5 μg/kg IV was administered as a rescue analgesia. Toward the end of the surgery, paracetamol 10–15 mg/kg IV and ondansetron 0.1 mg/kg IV were given. Neuromuscular blockade was reversed with neostigmine 0.05 μg/kg and glycopyrrolate 0.01 μg/kg. After ensuring adequate reversal and regaining of spontaneous breathing, trachea was extubated.

All the patients were shifted to postoperative anesthesia care (PACU) for a period of 6 h and then shifted to ward for further follow-up. Assessment of pain was done by Modified Objective Pain Score (MOPS) at 0, 30 min, 1st, 2nd, 4th, 6th, 12th, and 24th hour, and fentanyl 0.25 μg/kg IV was administered as rescue analgesia. Postoperative adverse effects like nausea, vomiting, or complications like any motor weakness (using modified Bromage scale) were recorded.

The data were analyzed using Statistical Package for the Social Sciences (SPSS) version 21.0. Categorical variables were presented as number and percentage (%) and continuous variables as mean ± standard deviation (SD) and median. Normality of data was tested by Kolmogorov–Smirnov test. If the normality was rejected, then nonparametric test was used. Statistical tests were applied as follows: (i) quantitative variables were compared using independent *t*-test/Mann–Whitney test (when the data sets were not normally distributed) between the two groups, and repeated measure analysis of variance (ANOVA)/Friedman test was used for comparison between different time intervals within the same group and (ii) qualitative variables were correlated using the Chi-square test/Fisher's exact test. A P value of <0.05 was considered statistically significant.

On the basis of the pilot study, MOPS score at 30 min was 2.6 ± 1.14 in group I and 1.4 ± 1.67 in group II. Taking these values as the reference, the minimum required sample size with 90% power of study and 5% level of significance was 30 patients in each study group. So, the total sample size taken was 60 (30 patients per group).

Results

Sixty-four children were enrolled for the study. However, four were excluded as they did not meet the inclusion criteria as depicted in Consolidated Standards of Reporting Trials CONSORT diagram [Figure 3]. Demographics were comparable between the two groups [Table 1]. Pain assessed using MOPS scores was low and showed a decreasing trend toward baseline as time progressed. Group I showed lower score, which was statistically significant only at the sixth hour ($P = 0.040$) [Table 2 and Figure 4]. Highest mean score was 2.4 ± 2.01 in group I and 2.67 ± 2.32 in group II.

During the intraoperative period, there was an increase in hemodynamic parameters at 10 min, but the difference was statistically not significant, as 0.25% ropivacaine may not provide surgical anesthesia. However, the HR was statistically significant at 20, 30, 40, 80, and 120 min. In

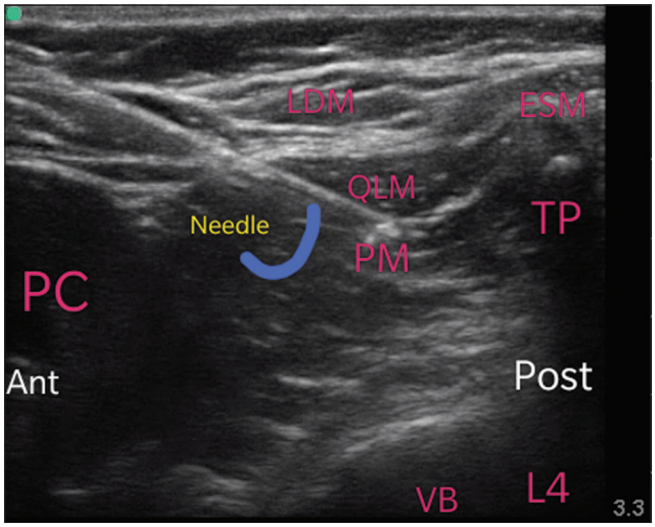

Figure 1: Ultrasound image of needling technique of QL block. Ant = anterior, ESM = erector spinae muscle, LDM = latissimus dorsi muscle, Post = posterior, PC = peritoneal cavity, PM = psoas major muscle, QLM = quadratus lumborum muscle, TP = tip of transverse process of L4, VB = vertebral body of L4

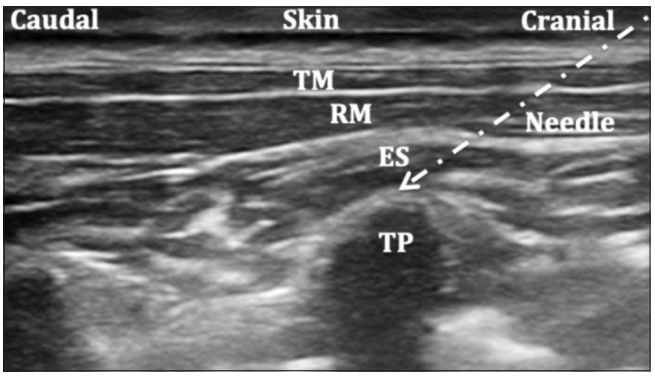

Figure 2: Ultrasound image of needling technique of ESP block. ES = erector spinae muscle, RM = rhomboid major, TM = trapezius muscle, TP = transverse process

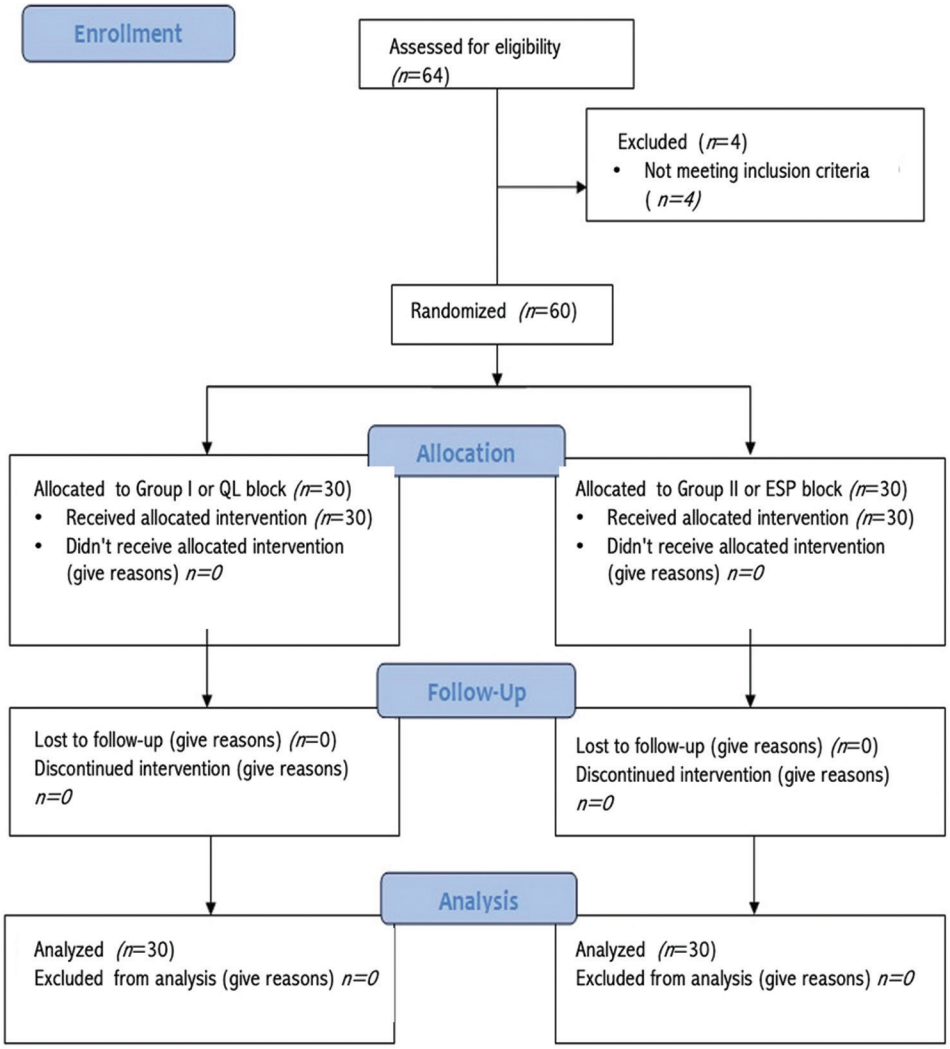

Figure 3: CONSORT flow diagram. ESP = erector spinae plane, QL = quadratus lumborum

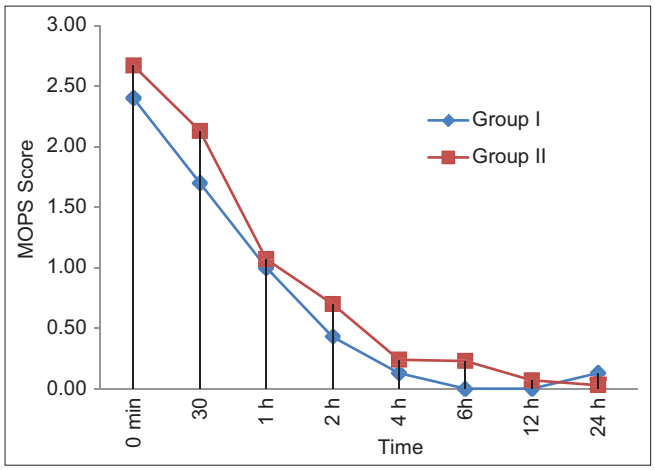

Figure 4: MOPS score trend. MOPS = Modified Objective Pain Score

the postoperative period, at 12 and 24 h, mean HR changes were statistically significant. During the intraoperative period, the mean fentanyl consumption was 16.12 ± 10.72 μg in group I and 11.62 ± 8.45 μg in group II, which was comparable ($P = 0.075$).

There was no statistically significant change in postoperative rescue analgesia in both groups, and the trend showed an increase in fentanyl boluses in the beginning, which was comparable. Mean total rescue analgesia during the perioperative period was relatively higher in the QL group, but statistically not significant (intraoperative $P = 0.075$ and postoperative $P = 0.928$). The time to first rescue analgesia in group I was 6.32 ± 12.57 min and in group II was 16.67 ± 31.25 min, but was statistically not significant. The distribution in group II was skewed, hence the larger value for group II, but when compared to group I, this was not statistically significant ($P = 0.327$). Also, 63.33% patients in group I and 63% patients in group II required rescue analgesia in the postoperative period and were comparable. We did not observe any lower limb motor weakness as evaluated by

Table 1: Demographic characteristics

Demographic characteristics	Group I (*n*=30)	Group II (*n*=30)
Age (years)	3.44±1.89	3.59±1.94
Weight (kg)	14.5±5.33	15.43±5.32
Sex		
Male	26 (86.67%)	21 (70.00%)
Female	4 (13.33%)	9 (30.00%)
Type of surgery		
Left pyeloplasty	20 (66.67%)	18 (60.00%)
Right pyeloplasty	10 (33.33%)	12 (40.00%)
Duration of surgery in min	113.33±6.61	109.67±8.5

Table 2: Mean change in Modified Objective Pain Scale

Time interval	Mean±SD		*P*
	Group I (*n*=30)	Group II (*n*=30)	
0 min	2.4±2.01	2.67±2.32	0.689
30 min	1.7±1.39	2.13±2.27	0.699
1 h	1±1.05	1.07±1.66	0.406
2 h	0.43±0.57	0.7±1.51	0.401
4 h	0.13±0.35	0.24±0.69	0.878
6 h	0±0	0.23±0.77	0.040*
12 h	0±0	0.07±0.25	0.154
24 h	0.13±0.73	0.03±0.18	0.981

**P<0.05 is statistically significant. SD=Standard deviation*

modified Bromage scale. Postoperative nausea/vomiting was statistically insignificant in both groups.

Discussion

This prospective, randomized, double-blinded, controlled trial was conducted to compare the analgesic efficacy of US guided QL-3 block and ESP block in children undergoing open pyeloplasty. Both blocks were effective in relieving postoperative surgical pain, as evidenced by the MOPS score. Requirement for postoperative opioid consumption was also reduced in both groups, as evidenced by mean postoperative rescue analgesia consumption (group I 4.23 ± 4.2 vs. group II 4.7 ± 5.5, $P = 0.928$).

From its inception, the ESP block has gained extensive popularity and has been trialed a lot,[9-13] including in the pediatric population.[14-16] Initial studies regarding the mechanism of action proposed percolation of LA (0.3–0.5 ml/kg) through the intertransverse connective tissue into the paravertebral, epidural, and intercostal spaces to stain the ventral and dorsal rami of the spinal nerves spreading craniocaudally (three to six vertebral levels).[16] However, inconsistent sensory effects reported by a few studies indicate the possibilities of other mechanism. The anterior perforations within the fascial sheath also explain the same. We observed low pain scores for the ESP block, which is consistent with other reports.[10-13] Time for first rescue analgesia and postoperative opioid consumption were also found to be reduced.[9-11]

Our findings on the QL block were in accordance with recent literatures.[5,6,17,18,] This block provides excellent postoperative analgesia in pediatric patients in various surgeries.[3-5] Hussein *et al.*[8] conducted a randomized controlled trial in 54 children undergoing elective lower abdominal surgery, comparing QL-3 and intramuscular QL block and found the QL-3 to be superior. Ultrasound-guided QL block was compared to caudal epidural using 1 ml/kg of 0.2% ropivacaine with 0.03 mg/kg morphine for vesicoureteral reflux in 47 pediatric patients by Sato *et al.*[18] They observed that opioid requirement for the first 24 h of the postoperative period was significantly lower in the QL group, which is consistent with our study results; however, they had studied the posterior QL block (QL-2).

Unintended motor weakness had been reported in QL-3 block previously, whose possibility cannot be ruled out as the LA may stain the lumbar nerve root, as observed in cadaveric studies.[19] However, we did not observe this. Comparing two modalities of truncal block in pediatric patients and drawing a conclusion for fair selection between the two does provide an advantage for our trial; however, the limitations cannot be undermined. The sample size could be more, and adding an adjuvant to the LA could have provided longer duration analgesia. A future trial with continuous catheter and longer follow-up (48–72 h) can be planned to evaluate the analgesic efficacy in a better way.

Conclusion

Both QL-3 and ESP block demonstrated effective analgesia following pyeloplasty surgery, with reduced perioperative analgesia consumption and lower pain scores. Both QL and ESP block are simple and safe, which provide an extra mileage in managing postoperative pain, which is very crucial in the pediatric age group.

Ethical approval

Institute Ethics Committee approval was obtained on 12.02.2018.

(Reg No. CTRI/2018/03/012527)

Disclosures

No authors have any conflict of interest or disclosures with regard to this study. This research did not receive any specific grant from funding agencies in the public, commercial, or nonprofit sectors.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Polok M, Apoznański W. Anderson-Hynes pyeloplasty in children-long-term outcomes, how long follow up is necessary?. Cent European J Urol 2017;70:434-8.
2. Kendall MC, Castro Alves LJ, Suh EI, McCormick ZL, De Oliveira GS. Regional anesthesia to ameliorate postoperative analgesia outcomes in pediatric surgical patients: An updated systematic review of randomized controlled trials. Local Reg Anesth 2018;11:91-109.
3. Chakraborty A, Goswami J, Patro V. Ultrasound-guided continuous quadratus lumborum block for postoperative analgesia in a pediatric patient. A A Case Rep 2015;4:34-6.
4. Visoiu M, Yakovleva N. Continuous postoperative analgesia via quadratus lumborum block-Analternative to transversus abdominis plane block. Pediatr Anesth 2013;23:959-61.
5. Baidya DK, Maitra S, Arora MK, Agarwal A. Quadratus lumborum block: An effective method of perioperative analgesia in children undergoing pyeloplasty. J Clin Anesth 2015;27:694-6.
6. Öksüz G, Bilal B, Gürkan Y, Urfalioğlu A, Arslan M, Gişi G, *et al*. Quadratus lumborum block versus transversus abdominis plane block in children undergoing low abdominal surgery: A randomized controlled trial. Reg Anesth Pain Med 2017;42:674-9.
7. Forero M, Adhikary SD, Lopez H, Tsui C, Chin KJ. The erector spinae plane block: A novel analgesic technique in thoracic neuropathic pain. Reg Anesth Pain Med 2016;41:621-7.
8. Hussein MM. Ultrasound-guided quadratus lumborum block in pediatrics: Trans-muscular versus intra-muscular approach. J Anesth 2018;32:850-5.
9. Kaushal B, Chauhan S, Magoon R, Krishna NS, Saini K, Bhoi D, *et al*. Efficacy of bilateral erector spinae plane block in management of acute postoperative surgical pain after pediatric cardiac surgeries through a midline sternotomy. J Cardiothorac Vasc Anesth 2020;34:981-6.
10. Aksu C, Gurkan Y. Defining the indications and levels of erector spinae plane block in pediatric patients: A retrospective study of our current experience. Cureus 2019;11:e5342. doi: 10.7759/cureus. 5348.
11. Aksu C, Şen MC, Akay MA, Baydemir C, Gürkan Y. Erector spinae plane block vs quadratus lumborum block for pediatric lower abdominal surgery: A double blinded, prospective, and randomized trial. J Clin Anesth 2019;57:24-8.
12. Jadon A, Jain P, Sinha N. The erector spinae plane block for postoperative analgesia in abdominoplasty-A case. BAOJ Anesthesiol 2017;1:5.
13. Chin KJ, Adhikary S, Sarwani N, Forero M. The analgesic efficacy of pre-operative bilateral erector spinae plane (ESP) blocks in patients having ventral hernia repair. Anaesthesia 2017;72:452-60.
14. Mostafa SF, Abdelghany MS, Abdelraheem TM, Abu Elyazed MM. Ultrasound-guided erector spinae plane block for postoperative analgesia in pediatric patients undergoing splenectomy: A prospective randomized controlled trial. Pediatr Anaesth 2019;29:1201-7.
15. Chin KJ, El-Boghdadly K. Mechanisms of action of the erector spinae plane (ESP) block: A narrative review. Can J Anaesth 2021;68:387-408.
16. Hamilton DL, Manickam BP. Is the erector spinae plane (ESP) block a sheath block? Anaesthesia 2017;72:915-6.
17. Öksüz G, Doğan AB. The efficacy of quadratus lumborum block in children with laparoscopy-assisted pyeloplasty. Erciyes Med J 2019;41:77-9.
18. Sato M, Bosenberg A. Ultrasound-Guided Quadratus Lumborum Block Compared to Caudal Ropivacaine/Morphine in Children Undergoing Surgery for Vesicoureteric Reflex. Great Britain: Wiley-Blackwell; 2019;29: 738-743
19. Ueshima H, Hiroshi O. Incidence of lower-extremity muscle weakness after quadratus lumborum block. J Clin Anesth 2018;44:104.