



Comparison between Ultrasound-Guided Transversus Abdominis Plane Block and Ultrasound-Guided Erector Spinae Plane Block During Pediatric Laparoscopic Surgeries: A Randomized, Controlled, Prospective Study

Amira Gamal Abd Elgaleel^{1*}, Ahmed Hussein Sayed², Ramy Mohamed Elkoniessy³, Mohamed Elayashy Mohamed⁴, Maha Gamil Hanna⁵

^{1,2,3,4,5}Anesthesia, Intensive Care and Pain management Department, Faculty of Medicine, Cairo University, Cairo, Egypt

*Corresponding author: Amira Gamal Abd Elgaleel, Anesthesia, Intensive Care and Pain management Department, Faculty of Medicine, Cairo University, Cairo, Egypt,
Email: Amiragxxx@gmail.com

Submitted: 11 February 2023; Accepted: 08 March 2023; Published: 04 April 2023

ABSTRACT

Background: Pain after laparoscopic surgeries is caused by the incision and visceroperitoneal pain due to peritoneal stretch and inflammation. Neonates and infants have increased sensitivity to narcotics. Ultrasound-guided erector spinae plane block (USG-ESP) is a novel technique reported to have analgesic effect on somatic and visceral pain. We aimed to compare ultrasound guided TAPB (USG-TAPB) with USG-ESP in providing peri-operative analgesia in pediatric participants undergoing laparoscopic surgeries.

Methods: This single blinded, prospective, randomized controlled study was carried out on 84 participants aged from 2 months to 7 years old, scheduled for elective general laparoscopic surgeries. Participants were randomly allocated into two groups to receive either intraoperative ESPB and intravenous fentanyl (42 participant) or intraoperative TAPB and intravenous fentanyl (42 participant), and then further classified into child and infant groups.

Results: FLACC score was lower in the ESPB (in infant and child) with significance in the 4th, 8th and 12th hour assessment in infant and child group ($P \leq 0.05$). The time to first postoperative analgesic requirement was significantly longer in the ESPB than in the TAPB ($P < 0.001$).

Conclusions: When performing laparoscopic procedures on minors, ESPB proved to be an effective localized anesthetic method. ESPB had a more analgesic character than TAPB because its participants experienced extended block durations and less pain in the immediate postoperative phase.

Keywords: *Ultrasound-Guided Transversus Abdominis Plane Block, Ultrasound-Guided Erector Spinae Plane Block, Pediatric, Laparoscopic Surgeries*

INTRODUCTION

Depending on the extent of the abdominal operation, participants may experience incisional and visceral discomfort that can be

alleviated with proper perioperative analgesics. Administration of central neuraxial methods (epidural or caudal catheter) has become standard in major juvenile abdominal surgery.

However, a central neuraxial block may be comparatively prohibited in some cases (such as coagulopathy, post-spinal-surgery recovery, and congenital spine abnormalities) [1].

Furthermore, intravenous opiates may induce hypopnea and apnea in neonates and babies with greater susceptibility to narcotics (for example, premature delivery or sleep apnea), which may necessitate re-intubation and extended artificial breathing [2, 3]. And that's on top of the anesthesia and the sickness you might experience after surgery.

Since this is the case, it is essential that pain treatment for this population of participants take a multi-pronged strategy. Although laparoscopic abdominal surgery is generally thought to cause less pain than laparotomy [4, 5], many participants still report of substantial postoperative pain [6].

Following laparoscopic procedures, participants may experience incisional pain as well as visceroperitoneal pain from peritoneal strain and irritation [6].

Some writers argue that the most important factor is the visceral discomfort brought on by tissue damage during the excision [7].

The sensory nerve supply to the anterior abdominal wall is blocked using regional anesthetic techniques such as transversus abdominis plane block (TAPB), erector spinae plane block (ESPB), epidural analgesia, and paravertebral block [1, 8-10]. These techniques allow for improved respiratory mechanics, reduced opioid consumption and its related adverse effects, enhanced recovery after surgery (ERAS), increased participant satisfaction, and decreased stress response. In addition to helping with rehabilitation and speeding up healing after surgery, effective pain management [12].

While TAPB effectively relieves somatic and posterior abdominal pain (covering nearly the entire anterior abdominal region), it has no effect on the visceral neurons [13].

It has been observed that ultrasound-guided ESPB (US-ESPB) can alleviate both localized and systemic pain [14, 15].

Many operations on the abdomen and genital regions of children of all ages are now routinely performed using laparoscopic techniques [16].

Participant benefits from laparoscopic surgery include shorter recovery times, less postoperative discomfort, earlier oral intake, earlier movement, speedier release, and a more aesthetically pleasing result [17].

Recently, laparoscopic surgery methods and tools have advanced to the point where many diagnostic and surgical operations can be performed laparoscopically, not just on adults but also on children [17].

This study set out to evaluate the efficacy of (USG-TAPB) versus (USG-ESPB) in delivering peri-operative analgesia to adolescent participants having laparoscopic procedures.

PARTICIPANTS AND METHODS

This single blinded, prospective, randomized controlled study was carried out on 84 participants aged from 2 months to 7 years old, with American Society of Anesthesiology I or II, scheduled for elective general laparoscopic surgeries (inguinal hernia repair, hiatus hernia repair, undescended testis, cholecystectomy, splenectomy, and etc.) at Kasr Al-Ainy hospital, Children's hospital (Aboul Riesh), Cairo University, Egypt.

The study was done after approval from the Local Ethical Committee. An informed written consent was obtained from the relatives of the participants.

Exclusion criteria were participants guardian refusal, contraindication for regional anesthesia [allergy from local anesthesia, bleeding diathesis bleeding disorder (prothrombin concentration of prothrombin (PC) < 75% or platelets < 150,000/L), anticoagulant use, cutaneous lesion, laceration, or infection at the incision location, presence of severe kidney or liver disease, and emergency procedure.

Randomization

Participants were randomly allocated into two groups to receive either intraoperative ESPB and

intravenous fentanyl (42 participant) or intraoperative TAPB and intravenous fentanyl (42 participant), and they were further classified in to 2 groups (child and infant), on the basis of a computer-generated randomization table designed by a scholar who was not involved in the investigation. The nurse in charge of the operation room randomly selected the participant's block from a stack of sealed envelopes.

The data collector (different from the personnel who gave the block) who had involved in participant monitoring intra and post operatively did not know which block was done.

All participants were subjected to laboratory workups including Liver enzymes, bleeding time, coagulation time, prothrombin time, and partial thromboplastin time.

Anaesthetic application

After venous catheter placement, all infants were given atropine (0.1-0.2mg/kg) and antibiotic prevention per hospital policy. Continuous tracking of electrocardiography, pulse oximetry, non-invasive arterial blood pressure, end-tidal CO₂, inhaled gas analyser, and temperature was the norm. After the connection of the monitor, a measurement of the subject's resting pulse, systolic blood pressure, and diastolic blood pressure was taken at a time of zero (T₀).

Endotracheal intubation was facilitated by inducing general anesthesia (GA) with propofol 2.5mg/kg over 20-30 seconds, fentanyl 1mic/kg, and atracurium 0.5mg/kg in both groups (Erector Spinae group and TAP block group). Isoflurane (1 MAC) and atracurium tablets were used to keep the participant asleep and the muscles relaxed. Prior to the conclusion of operation, cefotaxime 50 mg/kg and paracetamol 15mg/kg were administered to each participant.

Neither intraperitoneal nebulization nor surgery site local anesthetic were used. All participants had their pneumoperitoneum drained at the conclusion of operation. Once the procedures had been completed, the participants were extubated and taken to the postpartum recuperation area.

All injections were done under general anesthesia, in a germ-free environment, and with the aid of ultrasound. The ultrasound machine was a SonoSite M Turbo (USA) with a linear multi-frequency 6-13 MHz transducer for the screening instrument. (L25 x 6-13 MHz linear array).

In group E (Ultrasound guided Erector Spinae block, ESPB) [2]

After induction of general anesthesia, participants were put in lateral position with securing of airway and IV access; the back region was disinfected and sterilized. The transducer was wrapped with a sterile dressing, and sterile ultrasound gel used for scanning.

Transverse process and erector spinae muscle can be seen when the probe is positioned on the spinous process at T7 level on the para-sagittal plane and then moved laterally by 2.5-3cm. A 22G needle "Stimuplex" was positioned between the transverse process and the erector spinae muscle using the in-plane technique, moving from the head to the tail. A test dose of 1 cm D5W can widen the facial plane and confirm the needle-tip location (hydro dissection) before the injection of local anesthetic. The erector spinae muscle and transverse process were then injected with bupivacaine 0.25% at a rate of 0.5 ml/kg, being careful not to surpass the toxic dosage of 2.5mg/kg. Both the left and right sides underwent the same treatment.

In Group T (transversus abdominis plane block, TAP)

The sterile field around the ultrasonic probe and needle entrance was prepared with the participant lying supine. Between the iliac crest and the lowest part of the rib cage, the TAP block was administered horizontally behind the midaxillary line. The probe was positioned transverse to the belly, roughly over the midaxillary line, in the plane between the internal oblique and transversus abdominis muscle. Between the transversus and internal oblique, behind the midaxillary line, a 22G echogenic needle was inserted to emerge perpendicular to the ultrasonic beam. Following this, a dose of 0.5ml/kg

bupivacaine 0.25% was administered into the participant as a local anesthetic. TAP block was also performed on the counter lateral side.

In both groups, intravenous fentanyl (0.25mcg/kg) with a maximum dose of 2mcg/kg was administered if the heart rate or arterial blood pressure increased by more than 20% of baseline values in response to the surgical stimulus or thereafter throughout the entire operation.

Anesthesia was withdrawn, atropine 0.02 mg/kg and 0.05 mg/kg of protamine were administered to counteract the effects of the muscle relaxant, the participant was extubated, and then taken to the Post Anesthesia Care Unit (PACU). The total amount of fentanyl used during operation was documented, as was the total length of time the participant was under anesthesia. The FLACC measure was used to evaluate the quality of analgesia provided shortly after surgery, as well as 1, 4, 8, and 12 hours later. Paracetamol

15mg/kg (was given as rescue analgesia for participants if FLACC score >3 and its time was recorded as the 1st time of rescue analgesia and the participants received IV paracetamol 15mg/kg /8h not exceeding 75mg/kg/day.

No routine analgesia was given for the participants with successful block. We consider the block is failed when the 1st time of rescue analgesia is less than one hour post operatively, in this condition the participants received IV paracetamol 15mg/kg/8h not exceeding 75mg/kg/day.

Measurement tools

In the PACU and the ward, participant was assessed immediately postoperatively and then at 1st, 4th, 8th, and 12th hour post-operatively using FLACC (Face, Legs, Activity, Cry, Consolability) score for Pain assessment.

TABLE 1: Face, Legs, Activity, Cry, Consolability Pain Score

Category	Scoring		
	0	1	2
Face	No distinct expression or smile	Occasional frown or grimace, introverted, uninterested	Frequent to constant jawline tremors and mandible clenching
Legs	Standard or relaxed position	Uneasy, agitated, anxious	Kicking or drawing the legs in
Activity	Normal position, lying silently, easy movement	Tense, writhing, and swaying back and forth	Arched, inflexible or limb jerks
Cry	No crying	Moans or whimpers; infrequent	Constant crying, shouts or sobs, and frequent complaints
Consolability	Content, calm	Distractable when occasionally touched, hugged, or spoken to, but reassuring	challenging to reconcile or soothe

Each category is scored on the 0–2 scale, which results in a total score of 0–10 [0: Relaxed and comfortable, 1–3: Mild discomfort, 4–6 = Moderate pain, 7–10 = Severe discomfort or pain or both].

Blood pressure and heart rate also were recorded during the operation every 15 min, immediately

postoperatively and then at 1st, 4th, 8th, and 12th hours post-operatively.

Study outcomes

Primary outcome was the time to 1st request of analgesia post operative, secondary outcome(s) were total intraoperative fentanyl consumption in each group, pain assessment score using FLACC

scale, hemodynamic changes intra-operative (every 15 min), immediately post-operative and at 1st, 4th, 8th, and 12th hours post-operatively.

Sample Size Calculation

First, we did a pilot trial on real participants, using the same doctors, the same surgical techniques, and the same medications as the main study. The sample number is best estimated by performing a pilot study, as suggested by Abdulatif et al. [18].

Time to first emergency analgesia was 4.2 ± 1.27 hours for ten children having laparoscopic surgery with TAPB in a pilot research that was not included in the final data analysis. The sample size needed to identify a 20% difference in the duration to first rescue analgesia between the two groups was determined using MedCalc software version 14.10.2 (MedCalc software bvba, Ostend, Belgium). With an alpha error of 0.05 and a power of 80%, a total of 72 individuals (36 in each cohort) would be needed for the research. To account for potential attrition, we raised the sample size to 84 participants (42 participants in each cohort).

Statistics

SPSS for Windows, Version 15 was used to

analyze the data. (SPSS Inc., Chicago, IL, USA). In this study, we used the chi-squared test to evaluate categorical data and present the results numerically and as a proportion. The Kolmogorov-Smirnov test was used to examine the distribution of the continuous data. If the data followed a normal distribution, we used the single student t-test to compare the means (and standard deviations) of the groups. The Mann–Whitney U test was used to examine the central tendency of skewed data, which was reported as medians (quartiles). A two-way repeated measures ANOVA was conducted to assess the interaction between the block (between-groups component) and duration (repeated measures). The Bonferroni test was used for post hoc paired comparisons. The cutoff for significance was set at a p value of 0.05.

RESULTS

We initially screened 102 participants for suitability, with 84 meeting the inclusion criteria and randomly assigned to receive either ESPB (42 participant) or TAPB (42 participant), and they were further classified in to 2 groups (child and infant). All participants enrolled were followed successfully, with no participants lost to follow-up. Figure 1

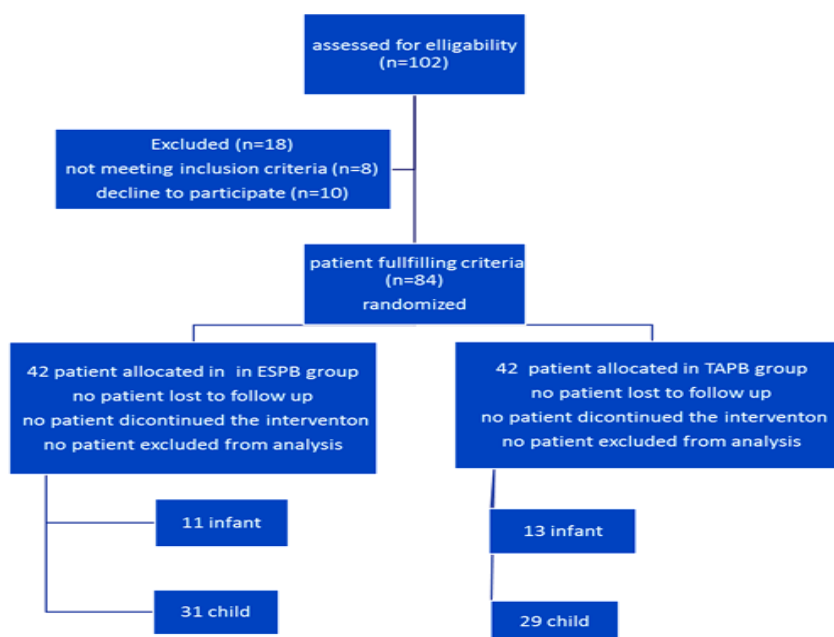


FIGURE 1: Consort flowchart Consort, Consolidated Standards of Reporting Trials

There is no significant difference concerning demographic data shown in table 2.

TABLE 2: Demographic and operative data in infant and child group (n = 84)

Variable	Age group	ESPB (n=42)	TAPB (n=42)	P value
Male gender	Infant (n=24)	6 (54%)	7 (54%)	1.00
	Child (n=60)	17 (54%)	14 (48%)	0.74
Age	Infant (n=24) months	6.2 ± 2.1)	6.8 ± 1.6	0.31
	Child (n=60) Years	4.5 ± 1.6	5.2 ± 1.1	0.11
Duration of surgery (minutes)	Infant (n=24)	85.97 ± 6.64	88.6 ± 5.2	0.17
	Child (n=60)	92.3 ± 7.64	95.6 ± 8.1	0.19

Data are presented as mean ± SD or frequency (%).

There was no significant difference in intra operative systolic blood pressure, diastolic blood pressure, and HR neither between the two groups

nor within groups when compared to base line reading in infant and child group. Figure 2



FIGURE 2: Intra operative; systolic blood pressure in (A) infant and (B) child, diastolic blood pressure in (C) infant and (D) child, HR in (E) infant and (F) child

Systolic blood pressure, diastolic blood pressure and HR were higher in TAPB with significant difference at 4th, 8th and 12th h in infant and child group, there is also significance within

TAPB at 4th, 8th and 12th hour, and within ESPB at 12th hour in comparison to baseline reading in infant and child group ($P \leq 0.05$). Figure 3

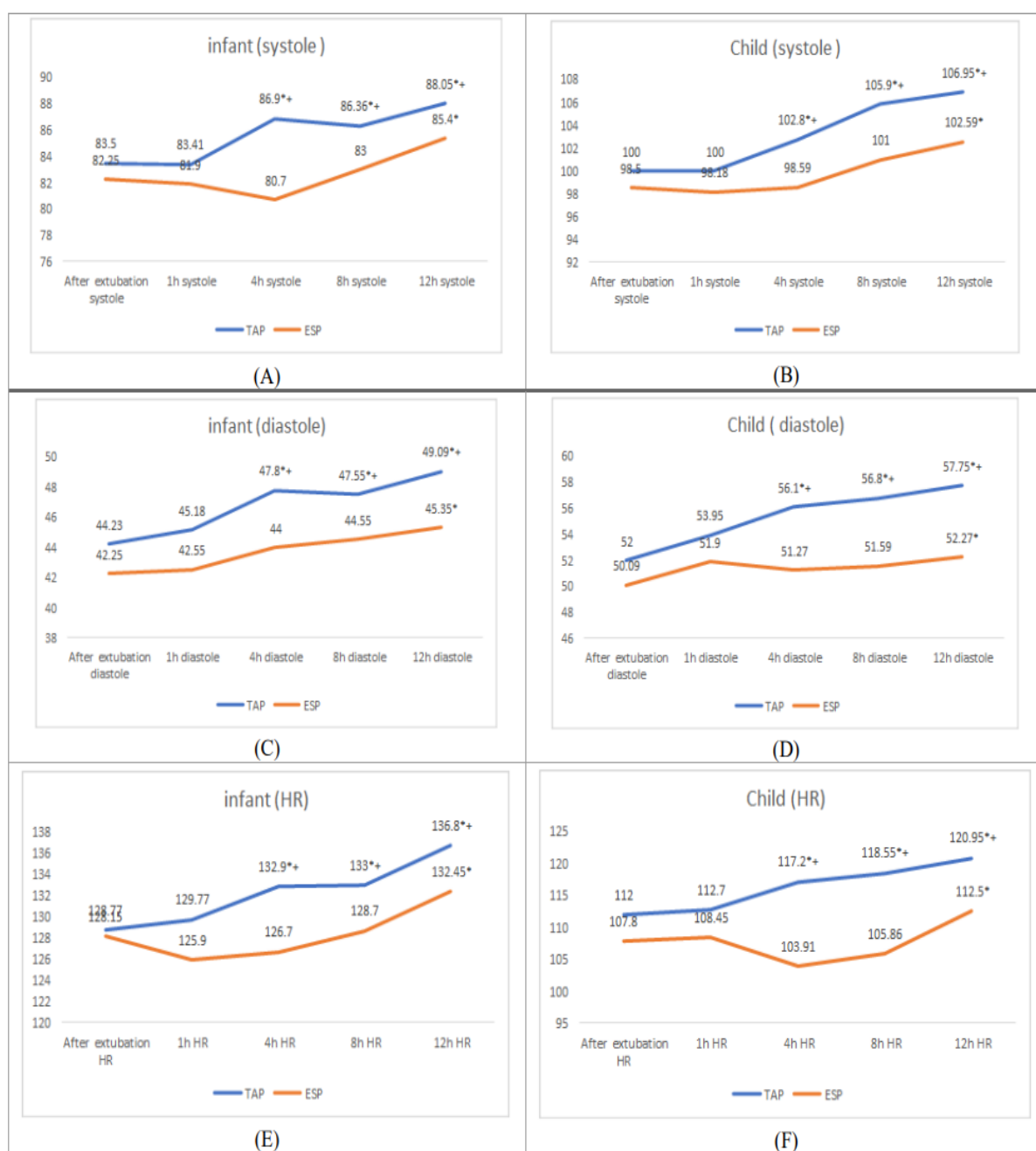


FIGURE 3: Post-operative; systolic blood pressure in (A) infant and (B) child, diastolic blood pressure in (C) infant and (D) child, HR in (E) infant and (F) child. (+) denotes significance between the 2 group and (*) denote significance within groups.

FLACC score was lower in the ESPB in (infant and child) with significance in the 4th, 8th and

12th hour assessment in infant and child group ($P \leq 0.05$). Table 2

TABLE 3: Post-operative FLACC score in infant and child

variable	Age group	ESPB (n=42)	TAPB (n=42)	P value
FIACC (1 hour)	Infant (n=24)	2.1 ± 1.8	2.5 ± 1.6	0.42
	Child (n=60)	2.32 ± 1.7	2.65 ± 2.36	0.38
FIACC (4 hours)	Infant (n=24) months	1.6 ± 1.7	3.5 ± 2.2	0.001*
	Child (n=60) years	1.68 ± 1.9	2.72 ± 1.36	<0.001*
FIACC (8 hours)	Infant (n=24)	1.4 ± 1.5	3.7 ± 2.4	<0.001*
	Child (n=60)	1.52 ± 1.57	2.68 ± 1.65	<0.001*
FIACC (12 hours)	Infant (n=24)	1.5 ± 1.56	2.8 ± 2.32	0.02*
	Child (n=60)	2.1 ± 1.68	2.77 ± 1.78	0.03*

Data are presented as mean ± SD. FLACC: Face, Legs, Activity, Cry, Consolability scale, * significant as P value ≤ 0.05. ESPB: Erector Spinae Plane Block, TAPB: Transversus Abdominis Plane Block.

The time to first postoperative analgesic requirement was significantly longer in the ESPB than in the TAPB (P < 0.001). Table 3

TABLE 3: 1st time of rescue analgesia post-operative in infant and child

		ESPB (n=42)	TAPB (n=42)	P value
1st time of rescue analgesia (hours post-operative)	Infant	9.64 ± 2.28	4.05 ± 1.54	< 0.001*
	Child	9.75 ± 2.2	4.5 ± 1.14	< 0.001*

Data are presented as mean ± SD, * significant as P value ≤ 0.05. ESPB: Erector Spinae Plane Block, TAPB: Transversus Abdominis Plane Block.

DISCUSSION

Although it is possible to perform laparoscopic surgery with minimal discomfort, many people avoid it. Intravenous opioids carry risks of respiratory depression and slowed healing, so they are typically avoided in minors. Neuraxial analgesia reduces opioid use, shortens post-operative healing time, and lowers overall hospital stay duration.

Rather than subjecting the child to the frequent complications of opioids and neuraxial analgesia, effective regional blocks are strongly recommended because they restrict the psychosocial impact of pain in the child and mother. However, children who undergo laparoscopic procedure frequently experience urine retention and severe muscle block.

There was preliminary evidence that ESPB might be useful during surgical procedures on adults. However, its potential application in the same process in minors lacked investigation.

Time to first analgesic use was also prolonged in the ESPB, and the FLACC score for pain evaluation was lower up to 12 hours. P < 0.0001 indicates statistical significance in the ESPB cohort.

Furthermore, the ESPB had substantially lower FLACC results across the board. However, we did not find any statistically significant differences in postoperative vitals between the groups.

After skin excision and during the early postoperative phase in the PACU, both blocks had a similar effect on hemodynamic measures in both groups.

Similarly, Tugger et al. [20] assessed ESPB's efficacy as part of multimodal analgesic following laparoscopic cholecystectomy. The first set of participants had a T7 contralateral ESPB with 0.5ml/kg of 0.25% bupivacaine. Group B received TAPB treatment. Participants who received ESPB reported significantly lower

postoperative pain ratings and longer-lasting relief compared to those who did not.

However, a recent cadaveric investigation revealed that ESPB caused local anesthetic agent to disseminate to the epidural space, neural foramen, and intercostal space [21].

In comparison to the TAPB, this wider distribution of local anesthetic agent may have anesthetized a bigger dermatomal region. In addition, TAPB can influence the somatic and parietal components of postoperative pain following laparoscopic surgery; however, the absence of an abdominal component may lead to insufficient analgesics in some participants.

Conversely, ESPB blocks both visceral and somatic nerve impulses, making it a great method for abdominal surgery [15, 22, 23].

However, the efficacy of ESPB has been evaluated in a variety of clinical settings in the current literature [24–26], and it was found to decrease postoperative NRS ratings in a randomized controlled study [20].

Similar to our findings, a previous research found that USG-ESPB decreased tramadol intake after laparoscopic cholecystectomy by a greater amount compared to oblique subcostal TAPB [27].

Another research found that compared to TAPB, ESPB was more effective in providing post-c-section analgesics, with less pain reported by participants using the visual analog scale (VAS).

Similar results were observed in our research, where the FLACC score dropped significantly faster with ESPB than with TAPB over a 12-hour timeframe. (mean time to rescue analgesia administration: 9.37h & 10.33h for ESPB and was 4.2h & 4.36h for TAPB for child and infant respectively).

Eleven participants who underwent laparoscopic or open abdomen surgery with ESPB were studied in a separate research. Most of the 11 participants who underwent the ESPB procedure reported pain levels between 0 and 2 on the numeric rating scale (NRS) following surgery [29].

Evidence from a case study described by Tulgar et al. [30] suggests that ultrasound-guided ESPB at the L4 transverse process level for post-operative analgesia can produce favorable outcomes in terms of steady hemodynamics during surgery. In contrast to the case report, the present investigation involved children aged 2 months to 7 years old and involved a range of dosing strategies.

The T6-L1 nerve segments are typically targeted during ultrasound-guided TAPB, and the degree of sensory inhibition can vary depending on the technique used [27].

Classic mid-axillary US-TAPB has been shown to decrease postoperative pain ratings and opioid intake [31, 32], particularly following lower abdominal operations.

Basaran et al. [33] found that oblique subcostal TAPB (OSTAPB) effectively decreased postoperative discomfort and enhanced respiratory performance following laparoscopic cholecystectomy.

Recent research has shown that US-TAPB effectively relieves pain across the full anterior abdominal wall, but has much less of an impact on the lateral abdominal wall and virtually none on the posterior abdominal wall. A decrease in TAPB was observed from the anterior to the rear abdominal wall, as described by the authors [34].

When compared to local anesthetic port-site infiltration with morphine PCA and paracetamol, the TAPB experienced a 14-minute rise in anesthesia time for juvenile participants having laparoscopic appendectomy, but saw very little clinical gain. We cannot suggest regular use of the TAPB in this participant population because it does not improve outcomes when local infiltration is used [9].

There are even accounts that demonstrate TAPB's ineffectiveness. The widespread use of local anesthesia could be to blame. The T9 segmental nerve cannot be reached with a single infusion of 20ml of anilin blue dye in the transversus abdominal plane, according to research conducted on human cadavers using ultrasonography guidance.

The injected dye encompassed the segmental nerves T10 in 50% of cases, T11 in 100% of cases, T12 in 100% of cases, and L1 in 93% of cases, respectively, in this research [35].

There is only one study accessible on TAP block in children, and it consists mainly of a summary of the method and a short case series. An ultrasound-guided ilioinguinal block was linked with improved postoperative analgesia after inguinal surgery than analgesia given by a TAPB in this prospective randomized trial [36].

Due to a lack of evidence in the pediatric population, more trials are needed, however, a controlled trial showed that minors having abdominal laparoscopic surgery benefited more from bilateral TAPB than from multimodal analgesia. Children who were given TAPB had a reduced need for analgesia during and after surgery, maintained hemodynamic stability, and got high marks from their parents in terms of happiness [37].

Another randomized research found that minors having abdominal laparoscopic surgery benefited further from bilateral TAPB than from multimodal analgesia. Children who were given TAPB had a reduced need for analgesia during and after surgery, maintained hemodynamic stability, and got high marks from their parents in terms of happiness [38].

Concerning limitations, there was no comparison group that received no treatment. Although TAPB has been extensively researched, ESPB is a relatively new method for use in laparoscopic surgeries.

CONCLUSION

The results of this research demonstrated that ESPB is a safe and effective localized anesthetic for use in pediatric laparoscopic procedures. Moreover, TAPB's anesthetic profile was inferior. Pain ratings were significantly reduced and block duration was significantly higher in the early postoperative phase for those who received ESPB compared to those who received TAPB. Both blocks were able to maintain hemodynamic parameters from skin cut through early post-

operative time in PACU, demonstrating similar perioperative hemodynamics.

Financial support and sponsorship

Nil

CONFLICT OF INTEREST

Nil

REFERENCES

1. Suresh S, Chan VW. Ultrasound guided transversus abdominis plane block in infants, children and adolescents: a simple procedural guidance for their performance. *Paediatr Anaesth*. 2009;19:296-9.
2. Fredrickson MJ, Seal P. Ultrasound-guided transversus abdominis plane block for neonatal abdominal surgery. *Anaesth Intensive Care*. 2009;37:469-72.
3. Coté CJ, Karl HW, Notterman DA, Weinberg JA, McCloskey C. Adverse sedation events in pediatrics: analysis of medications used for sedation. *Pediatrics*. 2000;106:633-44.
4. Gupta R, Singh S. Challenges in paediatric laparoscopic surgeries. *Indian J Anaesth*. 2009;53:560-6.
5. EYu D, Gusev A, Bekin A, Romanova E. Laparoscopic Surgery as the Gold Standard for the Treatment of Inguinal Hernia in Children. *Pediatric Pharmacology*. 2018;15:90-4.
6. Barczyński M, Herman RM. A prospective randomized trial on comparison of low-pressure (LP) and standard-pressure (SP) pneumoperitoneum for laparoscopic cholecystectomy. *Surg Endosc Other Interv Tech*. 2003;17:533-8.
7. Ekstein P, Szold A, Sagie B, Werbin N, Klausner JM, Weinbroum AA. Laparoscopic surgery may be associated with severe pain and high analgesia requirements in the immediate postoperative period. *Ann Surg*. 2006;243:41-6.
8. Yu N, Long X, Lujan-Hernandez JR, Succar J, Xin X, Wang X. Transversus abdominis-plane block versus local anesthetic wound infiltration in lower abdominal surgery: a systematic review and meta-analysis of randomized controlled trials. *BMC Anesthesiol*. 2014;14:121.
9. Sandeman DJ, Bennett M, Dilley AV, Perczuk A, Lim S, Kelly KJ. Ultrasound-guided transversus abdominis plane blocks for laparoscopic

- appendectomy in children: a prospective randomized trial. *Br J Anaesth.* 2011;106:882-6.
10. Chin KJ, Adhikary S, Sarwani N, Forero M. The analgesic efficacy of pre-operative bilateral erector spinae plane (ESP) blocks in participants having ventral hernia repair. *Anaesthesia.* 2017;72:452-60.
 11. Kehlet H, Holte K. Effect of postoperative analgesia on surgical outcome. *Br J Anaesth.* 2001;87:62-72.
 12. Capdevila X, Barthelet Y, Biboulet P, Ryckwaert Y, Rubenovitch J, d'Athis F. Effects of perioperative analgesic technique on the surgical outcome and duration of rehabilitation after major knee surgery. *Anesthesiology.* 1999;91:8-15.
 13. Mitra S, Khandelwal P, Roberts K, Kumar S, Vadivelu N. Pain relief in laparoscopic cholecystectomy--a review of the current options. *Pain Pract.* 2012;12:485-96.
 14. 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.
 15. Chin KJ, Malhas L, Perlas A. The Erector Spinae Plane Block Provides Visceral Abdominal Analgesia in Bariatric Surgery: A Report of 3 Cases. *Reg Anesth Pain Med.* 2017;42:372-6.
 16. Nishant K, Bhattarai B, Adhikary S. Anaesthetic management for laparoscopic cholecystectomy in a child. *J Soc Anesthesiol Nepal.* 2014;1:83-5.
 17. Ahmed A. Laparoscopic surgery in children--anaesthetic considerations. *J Pak Med Assoc.* 2006;56:75-9.
 18. Abdulatif M, Mukhtar A, Obayah G. Pitfalls in reporting sample size calculation in randomized controlled trials published in leading anaesthesia journals: a systematic review. *Br J Anaesth.* 2015;115:699-707.
 19. Lejus C, Surbled M, Schwoerer D, Renaudin M, Guillaud C, Berard L, et al. Postoperative epidural analgesia with bupivacaine and fentanyl: hourly pain assessment in 348 paediatric cases. *Paediatr Anaesth.* 2001;11:327-32.
 20. Tulgar S, Kapakli MS, Senturk O, Selvi O, Serifsoy TE, Ozer Z. Evaluation of ultrasound-guided erector spinae plane block for postoperative analgesia in laparoscopic cholecystectomy: A prospective, randomized, controlled clinical trial. *J Clin Anesth.* 2018;49:101-6.
 21. Forero M, Rajarathinam M, Adhikary S, Chin KJ. Erector spinae plane (ESP) block in the management of post thoracotomy pain syndrome: A case series. *Scand J Pain.* 2017;17:325-9.
 22. Halabi WJ, Kang CY, Nguyen VQ, Carmichael JC, Mills S, Stamos MJ, et al. Epidural analgesia in laparoscopic colorectal surgery: a nationwide analysis of use and outcomes. *JAMA Surg.* 2014;149:130-6.
 23. El-Boghdadly K, Pawa A. The erector spinae plane block: plane and simple. *Anaesthesia.* 2017;72:434-8.
 24. Ueshima H, Inagaki M, Toyone T, Otake H. Efficacy of the Erector Spinae Plane Block for Lumbar Spinal Surgery: A Retrospective Study. *Asian Spine J.* 2019;13:254-7.
 25. Gürkan Y, Aksu C, Kuş A, Yörükoğlu UH, Kılıç CT. Ultrasound guided erector spinae plane block reduces postoperative opioid consumption following breast surgery: A randomized controlled study. *J Clin Anesth.* 2018;50:65-8.
 26. Altıparmak B, Korkmaz Toker M, Uysal A, Turan M, Gümüş Demirbilek S. Comparison of the effects of modified pectoral nerve block and erector spinae plane block on postoperative opioid consumption and pain scores of participants after radical mastectomy surgery: A prospective, randomized, controlled trial. *J Clin Anesth.* 2019;54:61-5.
 27. Urigel S, Molter J. Transversus abdominis plane (TAP) blocks. *Aana J.* 2014;82:73-9.
 28. Malawat A, Verma K, Jethava D, Jethava DD. Erector spinae plane block and transversus abdominis plane block for postoperative analgesia in cesarean section: A prospective randomized comparative study. *J Anaesthesiol Clin Pharmacol.* 2020;36:201-6.
 29. Luis-Navarro JC, Seda-Guzmán M, Luis-Moreno C, Chin KJ. Erector spinae plane block in abdominal surgery: Case series. *Indian J Anaesth.* 2018;62:549-54.
 30. Ahiskalioglu A, Tulgar S, Celik M, Ozer Z, Alici HA, Aydin ME. Lumbar Erector Spinae Plane Block as a Main Anesthetic Method for Hip Surgery in High Risk Elderly Participants: Initial Experience with a Magnetic Resonance Imaging. *Eurasian J Med.* 2020;52:16-20.
 31. Chatrath V, Khetarpal R, Kumari H, Kaur H, Sharma A. Intermittent Transcutaneous Electrical Nerve Stimulation versus Transversus Abdominis Plane Block for Postoperative Analgesia after Infraumbilical Surgeries. *Anesth Essays Res.* 2018;12:349-54.
 32. Chou R, Gordon DB, de Leon-Casasola OA, Rosenberg JM, Bickler S, Brennan T, et al. Management of Postoperative Pain: A Clinical Practice Guideline From the American Pain Society, the American Society of Regional Anesthesia and Pain Medicine, and the American

- Society of Anesthesiologists' Committee on Regional Anesthesia, Executive Committee, and Administrative Council. *J Pain*. 2016;17:131-57.
33. Basaran B, Basaran A, Kozanhan B, Kasdogan E, Eryilmaz MA, Ozmen S. Analgesia and respiratory function after laparoscopic cholecystectomy in participants receiving ultrasound-guided bilateral oblique subcostal transversus abdominis plane block: a randomized double-blind study. *Med Sci Monit*. 2015;21:1304-12.
 34. Ma J, Jiang Y, Tang S, Wang B, Lian Q, Xie Z, et al. Analgesic efficacy of ultrasound-guided subcostal transversus abdominis plane block. *Medicine (Baltimore)*. 2017;96:e6309.
 35. Khalil MMH. Ultrasound-guided rectus sheath block for pediatric participants undergoing elective abdominal midline operations: a randomized controlled trial. *Ain Shams J Anesthesiol*. 2016;9:403-8.
 36. Aksu C, Gürkan Y. Ultrasound guided erector spinae block for postoperative analgesia in pediatric nephrectomy surgeries. *J Clin Anesth*. 2018;45:35-6.
 37. Al-Sadek WM, Rizk SN, Selim MA. Ultrasound guided transversus abdominis plane block in pediatric participants undergoing laparoscopic surgery. *Egypt J Anaesth*. 2014;30:273-8.
 38. Al-Sadek WM, Rizk SN, Selim MA. Ultrasound guided transversus abdominis plane block in pediatric participants undergoing laparoscopic surgery. *Egyptian Journal of Anaesthesia*. 2014;30:273-8.