EGYPTIAN JOURNAL OF ANAESTHESIA
2023, VOL. 39, NO. 1, 440–445
https://doi.org/10.1080/11101849.2023.2216534

Comparison between serratus anterior plane block versus erector spinae plane block for postoperative analgesia after video-assisted thoracoscopic surgery (VATS)

Sameh Salem Hafny Taha, Beshoy Eshak Aziz Hanna, Gamal Eldin Mohammad Ahmed Elewa, Hadil Magdy Abd Elhamid Mohamed, Dalia Fahmy Emam Ali and Mohamed MoienMohamed Elsaid

Department of Anesthesiology, Intensive Care and Pain Management, Faculty of Medicine, Ain-Shams University, Cairo, Egypt

ABSTRACT

Background: Video-assisted thoracoscopic surgery is a minimally invasive technique resulting in decrease levels of pain. However, to provide more effective pain control after VATS, this necessitates analgesia that inhibits somatic and visceral nerve fibers.

Aim of the study: Aim of the study is to compare SAPB or ESPB for postoperative analgesia following VATS, as determined by the time until the first analgesic requirement. Comparisons of adverse effects and total analgesic requirement in the first 24-hour post-operative were the secondary endpoints.

Patients and Methods: Forty patients participated in this prospective randomized clinical study. At the conclusion of surgery, 20 patients underwent a single-injection US-guided ESPB, and 20 patients underwent a SAPB after VATS. Inclusion Criteria: (ASA) 1–3. Exclusion criteria: Patients <20 or >80 years old, patients who refuse to take part in the research, patients have a history of medication allergies, contraindication to regional anesthesia, severe hepatic and renal dysfunction

Results: As regarding to demographic information, there were no significant changes between the two groups. Timing of the first analgesic requirement was statistically faster among SAPB Group (12.54 ± 6.46 h) compared to ESPB Group (18.29 ± 6.05 h). Postoperative pethidine required was significantly higher in SAPB group than in ESBP group [ESPB (35.71 ± 19.67 mg) < SAPB (63.08 ± 25.29 mg), with *p*-value <0.05. No remarkable side effects were found in the two groups.

Conclusion: Both ESPB and SAPB can be used for pain control after VATS. Our study showed that US-directed ESPB offers more effective pain management than SAPB.

ARTICLE HISTORY
Received 22 March 2023
Revised 21 April 2023
Accepted 17 May 2023

KEYWORDS
VATS; serratus anterior plane block; erector spinae plane block

1. Background

Thoracic surgery has been performed with video-assisted thoracoscopic surgery for many years. Due to its minimal surgical incision and high level of acceptability, it is frequently accepted [1]. Inadequate postoperative pain management can result in persistent postoperative pain over time, has a considerable detrimental impact on respiratory mechanics, and may elevate the likelihood of postoperative pulmonary complications (PPCs) [2]. Early and adequate pain management is required to enable free coughing and forced breathing, which is beneficial for reducing lung atelectasis and promoting a rapid return of respiratory function.

Blanco et al. (2013) indicated that local anesthetics (LAs) may be given either superficially or deeply to the serratus anterior muscle, which is technically simple to carry out, can completely block the surgical area and seems as a promise for chest wall analgesia after VATS.

Erector spinae plane block, which is an interfascial plane block, was identified in 2018 by **Forero and his colleagues** [3]. It can be used for several purposes such as to relieve pain in shoulder, hip, lumbar, thoracic and abdominal areas. This paraspinal block works by focusing on the dorsal and ventral rami to relieve pain in the anterior, lateral and posterior chest walls [4,5]. Erector spinae plane block was proven to greatly reduce surgical discomfort 24 h post operatively [6].

2. Aim of the work

Aim of the study is to compare SAPB or ESPB for postoperative analgesia following VATS, as determined by the time until the first analgesic requirement. Comparisons of adverse effects and total analgesic requirement in the first 24-h post-operative were the secondary endpoints.

CONTACT Beshoy Eshak Aziz Hanna beshoyaziz310@gmail.com Department of Anesthesiology, Intensive Care and Pain Management, Faculty of Medicine, Ain-Shams University, Cairo, Egypt

3. Patients and methods

Approval of the research ethical committee of faculty of medicine, Ain Shams University, was obtained and informed written consents were taken from all the participants. This prospective randomized clinical research was performed in Ain Shams University Hospitals.

Inclusion Criteria: ASA I–III, of both sex and age 20–80 years scheduled for VATS.

Exclusion criteria: Patients <20 or >80 years old, patients who refuse to take part in the research, patients having a history of medication allergies, contraindication to regional anesthesia, severe hepatic impairment, renal dysfunction, psychological illness, being pregnant and having a BMI of ≥40 ≤ 18 kg/m^2.

4. Study procedure

In the anesthesia clinic, preoperative assessment was done by careful history taking, full physical examination, laboratory evaluation and investigations. Before the procedure, each patient provided a signed informed consent. Every patient was instructed on how to use a 10-cm visual analog pain scale to gauge their own degree of discomfort (0= no pain, 10= maximum pain imaginable).

4.1. Intraoperative settings

Fentanyl (1 µg/kg), propofol (2 mg/kg) and atracurium (0.5 mg/kg) were IV utilized for general anesthesia induction. Intubation was done using a double-lumen endobronchial tube. Anesthesia was continued using isoflurane 2 vol. %, 50% O_2 and 50% air. Moreover, three milligram of Granisetron was given as prophylactic against nausea and vomiting post-operatively. During operation, 6 mL/kg/h of Ringer's solution was administered.

At the end of surgery, the patient was positioned laterally. All blocks were done using ultrasound-guid ance by the same experienced senior doctors.

4.2. SAPB group: (superficial)

At the fifth rib, on the midaxillary line in the transverse plane, a high-frequency linear probe was positioned. Using 2–3 ml LA, skin was anesthetized, after identification of the pleural line, rib above serratus anterior and latissimus dorsi muscles. The needle was then inserted in-plane, angled at 45° in the direction of the fifth rib. A 3 mL of normal saline was intected as a test dose. Then, 20 mL of 0.25% bupivacaine was administered (Figure 1).

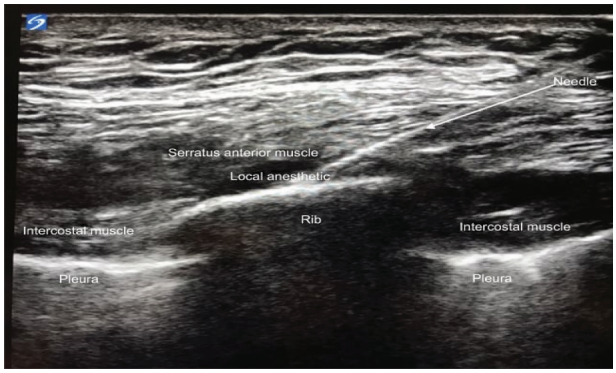

Figure 1. Spread of LA between the serratus anterior muscle and the underlying rib.

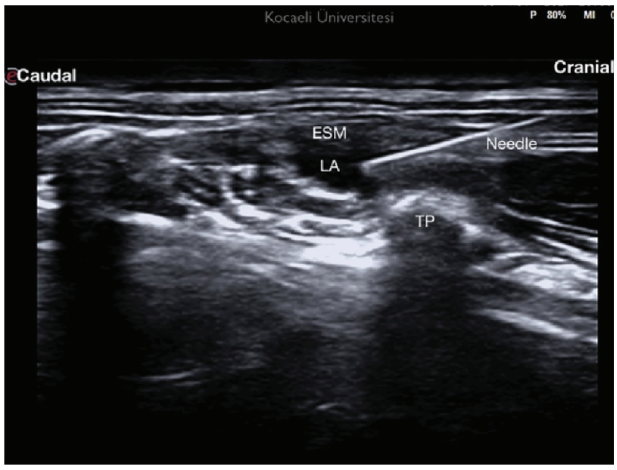

Figure 2. Spread of LA between erector spinae muscle and transverse process.

4.3. ESPB group

A high-frequency ultrasonic probe was positioned in a longitudinal orientation 3 cm laterally from the midline, while the patient was in lateral position. Superficial to the transverse process (TP), three muscles, rhomboid major, trapezius and erector spinae, were found. Under aseptic precautions, skin was anesthetized using 2–3 ml of LA. Then, in-plane to the US transducer, a spinal needle was introduced in a caudal-cranial trajectory towards the TP until hitting the TP while traversing all muscles. After injecting 3 mL of normal saline as a test dosage, 20 mL of 0.25% bupivacaine was administered (Figure 2).

Isoflurane was discontinued after the block was completed, and atracurium-reversing medications (atropine 0.02 mg/kg and neostigmine 0.05 mg/kg) were administered. The patient was then permitted to be transferred from the operating room to the intensive care unit (ICU) after regaining consciousness.

4.4. Postoperative settings

All patients in the ICU received 1 g of intravenous paracetamol every 8 h for the first 24 h following

Table 1. Comparison between the two groups according to demographic data.

Demographic data	ESPB group (*n*=20)	SAPB group (*n*=20)	Test value	*p*-Value
Age (years)	45.15±9.37	49.70±6.29	t: -1.803	0.079
Sex				
Female	9 (45.0%)	7 (35.0%)	x^2: 0.417	0.519
Male	11 (55.0%)	13 (65.0%)		
Weight (kg)	74.60±6.30	72.20±4.81	t: 1.354	0.184
Duration of surgery (min)	131.17±28.27	129.15±24.22	t: 0.243	0.810

Using: t-independent sample t-test; #x^2: Chi-square test; *p*-value >0.05 NS.
ESPB: erector spinae plane block, SAPB: serratus anterior plane block.
SD: standard deviation, n: number, Kg: kilogram, min: minute.

surgery. IV pethidine 25 mg was given as rescue analgesia if VAS was ≥3; it can be repeated on demand (with least interval between two doses 15 min), with maximum dose 150 mg/day.

The following data were taken:

(1) Demographic data including age, sex and weight.
(2) Hemodynamic data (MAP (mmhg), HR (beat/min), oxygen saturation (%)) on ICU admission, 2, 4, 8, 16, 24 h post-operative.
(3) Respiratory rate (breath/min) on ICU admission, 2, 4, 8, 16, 24 h.
(4) Visual Analog Scale on ICU admission, 2, 4, 8, 16, 24 h post-operative.
(5) Total analgesic consumption during first 24 h.
(6) Adverse effects related to LAs.

4.5. Statistical analysis

Approval of the research ethical committee of faculty of medicine, Ain Shams University, was obtained and informed written consents were taken from all the participants.

The sample size contains 40 patients divided into two equal groups, randomized using opaque sealed envelopes to receive either an erector spinae plane block (ESPB group) or a serratus anterior plane block (SAPB group). Sample size was calculated using PASS® version 11 program, according to Ekinci et al.'s 2020 study.

All data of patients were kept confidential with secret codes and private file for each patient was maintained; all given data were used for the current medical research only. Any unexpected risk that appeared during the course of the research was cleared by participants and the ethical committee on time.

The collected information was analyzed by SPSS v20.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data were summarized as mean and standard deviation (SD). Percentages and frequencies were used to represent qualitative data. When comparing means, a t-test for significance with independent samples was utilized. For non-parametric data, the Mann Whitney U test was employed to compare the two groups. The chi-square (x2) test was used to compare percentages across different qualitative characteristics. A 95% CI and a 5% margin of error were chosen as the parameters for the study. For continuous data, they were tested for normality by the Shapiro-Wilk test and Kolmogorov–Smirnov test. The significance level was set at $p < 0.05$.

5. Results

Regarding demographic information and duration of surgery, there were no significant changes between the two groups (Table (1)). Regarding hemodynamics, there was no significant difference between the two groups according to their MAP "mmHg", mean of HR "beat/min", SAO2%) and respiratory rate (breath/min). During post operative period, timing of first analgesic requirement hours was statistically significant between both groups; it was faster in SAPB Group (12.54 ± 6.46 h) compared to ESPB Group (18.29 ± 6.05 h) (Table (2)). According to the VAS score after 8 h, 16 h and after 24 h, it showed significant changes between the two groups (Table (3)). Total amount of analgesia used in the first 24 h (pethidine "mg") was documented. There was statistically significant difference between both groups; it was higher in SAPB group (63.08 ± 25.29 mg) than in ESPB group (35.71 ± 19.67 mg) (Table (4)). No statistically significant changes existed in the groups regarding complication (Table (5)). None of the patients experienced any side effects from LAs, including pneumothorax, bleeding or localized infections.

Table 2. Comparison between the two groups according to the time of first analgesic requirement "hrs".

	ESPB group (*n*=7)	SAPB group (*n*=13)	U-test value	*p*-Value
Time of first analgesia (hrs)	18.29±6.05	12.54±6.46	2.194	0.039*

Using: U: Mann-Whitney test .
**p*-value <0.05 is significant .
ESPB: erector spinae plane block, SAPB: serratus anterior plane block.
SD: standard deviation, n: number, hrs: hours.

Table 3. Comparison between both the groups as regarding to VAS score.

VAS	ESPB group (*n*=20)	SAPB group (*n*=20)	U-test value	*p*-Value
PACU	1 (0–0)	1 (0–0)	0.000	1.000
After 2 h	1 [1]	1 [1]	−0.411	0.681
After 4 h	1 [1,2]	1 [1,2]	−1.057	0.291
After 8 h	2 [1,2]	2 [2,7]	−2.528	0.011*
After 16 h	2 [2]	3 [2,7]	−2.094	0.036*
After 24 h	2 [2,7]	3 [2,7,8]	−2.161	0.028*

Using: U-Mann-Whitney test.
Data are expressed median and (IQR) Interquartile range.
p-value >0.05 is insignificant; **p*-value <0.05 is significant.
ESPB: erector spinae plane block, SAPB: serratus anterior plane block.

Table 4. Comparison between the groups according to total amount of analgesia consumed in first 24 h (pethidine "mg").

	ESPB group (*n*=7)	SAPB group (*n*=13)	U-test value	*p*-Value
Total amount of analgesia consumed in first 24 h (pethidine "mg")	35.71±19.67	63.08±25.29	−2.476	0.023*

Using: U: Mann-Whitney test .
**p*-value <0.05 is significant .
ESPB: erector spinae plane block, SAPB: serratus anterior plane block.
SD: standard deviation, n: number, mg: milligram.

Table 5. Comparison between the groups according to complications.

Complications	Group ESPB (*n*=20)	Group SAPB (*n*=20)	x^2	*p*-Value
Hypotension	0 (0%)	0 (0%)	0.000	1.000
Pneumothorax	0 (0%)	0 (0%)	0.000	1.000
Local anesthetic toxicity	0 (0%)	0 (0%)	0.000	1.000
Respiratory depression	0 (0%)	0 (0%)	0.000	1.000
Nausea	3 (15%)	5 (25%)	0.609	0.435
Vomiting	2 (10%)	4 (20%)	0.765	0.382

Using: x^2: Chi-square test; *p*-value >0.05: NS.
ESPB: erector spinae plane block, SAPB: serratus anterior plane block.
n: number.

6. Discussion

Our study has shown no significant changes between the two groups regarding demographic information and duration of surgery. Regarding hemodynamics, there was no significant difference between the two groups according to their MAP "mmHg", mean of HR "beat/min", SAO2%) and respiratory rate (breath/min). During post operative period, timing of first analgesic requirement hours was statistically significant between both groups; it was faster in SAPB group (12.54 ± 6.46 h) compared to ESPB group (18.29 ± 6.05 h). According to the VAS score after 8 h, 16 h and after 24 h, it showed significant changes between the two groups. Total amount of analgesia used in first 24 h (pethidine "mg") was documented. There was statistically significant difference between both groups; it was higher in SAPB group (63.08 ± 25.29 mg) than in ESPB group (35.71 ± 19.67 mg). No statistically significant changes existed in the groups regarding complication. None of the patients experienced any side effects from LAs, including pneumothorax, bleeding or localized infections.

Video-assisted thoracic surgery (VATS) is a minimally invasive procedure; a small incision allows a video camera to enter into the thoracic cavity. This procedure allows for rapid recovery and improved pulmonary function **(Piccioni et al., 2018; Li et al., 2018)** [9]. Enhanced recovery after surgery (ERAS) is a multimodal treatment that aims to improve the quality of recovery following surgery. The role of pain management in ERAS pathways is important because effective pain management reduces surgical stress, reduces pain-related complications and allows for rapid recovery following VATS **(Piccioni et al., 2018)** [10].

Several techniques may be preferred for pain management after (VATS), including local wound infiltration, thoracic epidural; more recently, ultrasound-guided fascial plane blocks as serratus anterior plain block (SAPB), thoracic paravertebral block (PVB) and erector spinae plane block (ESB) have been utilized to prolong analgesia.

SAPB is an interfacial plane block that may provide analgesia in patients who have undergone thoracoscopic surgery **(Park et al., 2018; Okmen and Okmen, 2018)** [11,12]. This technique blocks only the lateral braches of the intercostal nerves so that it can provide analgesia in the hemithorax and axilla. Blanco et al. in 2013 proposed SAPB as a substitution to PVB for surgeries on the anterior and lateral thoracic wall, including breast surgeries **(Blanco et al ., 2013)** [8]. SAPB is an easy block for teaching and performing because the serratus anterior muscle is an easy sonographic landmark to identify for this block; also, pleura and ribs are well defined. Complications of PVB include

pneumothorax, vascular puncture, intrathecal or epidural spread and sympathetic block leading to hemodynamic instability **(Batra et al., 2011)** [13].

Another promising interfacial block is the erector spinae plane block (ESPB), where the local anaesthetic (LA) injected deep to erector spinae (ES) muscles can diffuse and block the ventral and dorsal primary rami and sympathetic fibers ***(Okmen and Okmen, 2018***) [12]. It provides a multilevel dermatomal block as ES fascia extends from the nuchal fascia to the sacrum that can control pain from the anterior, lateral and posterior chest wall **(López et al., 2018** [14]. ES plane is a safe plane devoid of any vital structures that may be exposed to needle injury. This decreases the incidence of inadvertent hematoma.

There was hemodynamic stability in both the groups, consistent with **D'Ercole et al.'s study in 2018** [15], who demonstrated that patients who received ESPB had no change in hemodynamic profile despite the sympathetic block. **Altıparmak et al., in 2019** [16], performed a case report by administering ESPB in a preterm neonate for esophageal atresia and found that intraoperative hemodynamic measurements remained stable.

Eldemrdash and Abdelzaam, in 2019 [17], showed prolonged post-operative duration of analgesia in group (ESPB) compared to group (SAPB). Opioid consumption post-operative was lower in ESB group than in SAPB group up to 24 h . **Abdallah et al., in 2017** [18], found that following ambulatory breast cancer surgery, PONV decreased, analgesia duration increased and both intraoperative and postoperative opioid intake were reduced. **Klein et al., in 2000** [19], found that analgesic requirement (morphine consumption) was lower in the ESPB group than in SAPB group during the first 24 h post-operative. **Gaballah and colleagues, in 2019** [20], found that ESPB had superior analgesia compared with SAPB. **Finnerty and colleagues, in 2020** [21], reported prolonged duration of analgesia in ESPB in comparison with SAPB. This goes with our study where there was prolonged postoperative duration of analgesia in ESPB group compared to SAPB group.

Altıparmak et al., in 2019 [16], reported that no additional fentanyl was needed during skin incision and thoracotomy group for 24 h postoperative. ESPB group required more analgesia earlier than control group. Similar to our study, first time to require analgesia was faster in SAPB group (12.54 ± 6.46 h) compared to ESPB group (18.29 ± 6.05 h).

In Gürkan et al.'s study, in 2020 [22], during breast surgery, patients who received ESPB demonstrated a 65% reduction in postoperative morphine requirement. [23]. After thoracotomy, in comparison to SAPB (19.57 7.63 mg), it was found that ESPB group used lower quantity of morphine postoperatively (8.52 4.29 mg). This study reported opioid consumption was higher in SAPB group in comparison to ESPB group intraoperatively. In our study, the total amount of analgesia required in first 24 h (pethidine "mg") was lower in ESPB group (35.71 ± 19.67 mg) compared to SAPB group (63.08 ± 25.29 mg).

This study shows lower incidence of postoperative nausea and hypotension in both the groups. Complication related to the techniques of the regional anesthesia was insignificant. **Eskander and colleagues, in 2022** [24], reported no complication in ESPB. **Thomas (2020)** [25] did not observe any complication after ESP was administered for pediatric renal surgeries.

Study limitations: The postoperative assessment was for a short duration; both blocks were administered with single-shot injection. The blocks were performed under general anesthesia; therefore, there was no better assessment of the block. Analgesia was found to be more effective in Hetta et al.'s study than in our study when **Hetta et al.** [26] injected 30 ml of bupivacaine into the SAPB as opposed to our study's 20 ml.

Recommendations: To extend the postoperative pain control, additional research involving catheter placement is required. Longer assessment periods in future research are required for both acute and chronic pain postoperatively. Regional block should be done before general anesthesia for better assessment of block function. More volume of LAs should be used to provide prolonged duration of analgesia.

7. Conclusion

Our study reported that erector spinae plane block may provide more prolonged pain control than serratus anterior plane block in patients undergoing VATS.

Disclosure statement

No potential conflict of interest was reported by the author(s).

References

[1] Petersen RH, Holbek BL, Hansen HJ, et al. Video-assisted thoracoscopic surgery-taking a step into the future. Eur J Cardiothorac Surg. 2017;51(4):694–695. DOI:10.1093/ejcts/ezw381

[2] Steinthorsdottir KJ, Wildgaard L, Hansen HJ, et al. Regional analgesia for video-assisted thoracic surgery: a systematic review. Eur J Cardiothorac Surg. 2014;45 (6):959–966. DOI:10.1093/ejcts/ezt525

[3] Forero M, Rajarathinam M, Adhikary SD, et al. Bloc du plan des muscles érecteurs du rachis pour la prise en charge de la douleur chronique à l'épaule : une présentation de cas. Can J Anesthesia/J canadien d'anesthésie. 2018;65(3):28893. DOI:10.1007/s12630-017-1010-1

[4] Chin KJ, Adhikary SD, Forero M. Erector spinae plane (ESP) block: a new paradigm in regional anesthesia and analgesia. Curr Anesthesiol Rep. 2019;9(3):271–280.
[5] Tulgar S, Ahiskalioglu A, De Cassai A, et al. Efficacy of bilateral erector spinae plane block in the management of pain: current insights. J Pain Res. 2019;12:2597–2613.
[6] Ciftci B, Ekinci M, Celik EC, et al. Efficacy of an ultrasound-guided erector spinae plane block for postoperative analgesia management after video-assisted thoracic surgery: a prospective randomized study. J Cardiothorac Vasc Anesth. 2020;34(2):444–449. DOI:10.1053/j.jvca.2019.04.026
[7] Campos JH, Peacher D. Choosing the best method for postoperative regional analgesia after video-assisted thoracoscopic surgery. J Cardiothorac Vasc Anesth. 2020;34(7):1877–1880.
[8] Blanco R, Parras T, McDonnell JG, et al. Serratus plane block: a novel ultrasound-guided thoracic wall nerve block. Anaesthesia. 2013;68(11):1107–1113. DOI:10.1111/anae.12344
[9] Piccioni F, Segat M, Falini S, et al. Enhanced recovery pathways in thoracic surgery from Italian VATS Group: perioperative analgesia protocols. J Thorac Dis. 2018;10(S4):S555–63. DOI:10.21037/jtd.2017.12.86
[10] Li Q, Xie D, Sihoe A, et al. Video-assisted thoracic surgery is associated with better short-term outcomes than open thoracotomy in adult patients with intralobar pulmonary sequestration. Interact Cardiovasc Thorac Surg. 2018;26(2):284–287. DOI:10.1093/icvts/ivx311
[11] Park MH, Kim JA, Ahn HJ, et al. A randomized trial of serratus anterior plane block for analgesia after thoracoscopic surgery. Anaesthesia. 2018;73(10):1260–1264. DOI:10.1111/anae.14424
[12] Okmen K, Okmen BM. Evaluation of the effect of serratus anterior plane block for pain treatment after video-assisted thoracoscopic surgery. Anaesthesia Crit Care Pain Med. 2018;37(4):349–353.
[13] Batra RK, Krishnan K, Agarwal A. Paravertebral block. J Anaesthesiol Clin Pharmacol. 2011;27(1):5–11.
[14] López MB, Cadórniga ÁG, González JML, et al. Erector spinae block. A narrative review. Cent Eur J Clin Res. 2018;1(1):2839. DOI:10.2478/cejcr-2018-0005
[15] D'Ercole F, Arora H, Kumar PA. Paravertebral block for thoracic surgery. J Cardiothorac Vasc Anesth. 2018;32(2):915–927.
[16] Altıparmak B, Toker MK, Uysal Aİ, et al. Erector spinae plane block for pain management of esophageal atresia in a preterm neonate. J Clin Anesth. 2019;56:115–116.
[17] Eldemrdash AM, Abdelzaam EM. By ultrasonic-guided erectorspinae block, thoracic paravertebral block versus serratus anterior plane block by articaine with adrenaline during breast surgery with general anesthesia: a comparative study of analgesic effect post-operatively: double blind reandomized, controlled trial. Open J Anesthesiol. 2019;9:68–82.
[18] Abdallah FW, MacLean D, Madjdpour C, et al. Pectoralis and serratus fascial plane blocks each provide early analgesic benefits following ambulatory breast cancer surgery: a retrospective propensity-matched cohort study. Anesthesia & Analgesia. 2017;25(1):294–302. DOI:10.1213/ANE.0000000000001975
[19] Klein SM, Bergh A, Steele SM, et al. Thoracic paravertebral block for breast surgery. Anesthesia & Analgesia. 2000;90(6):1402–1405. DOI:10.1097/00000539-200006000-00026
[20] Gaballah KM, Soltan WA, Bahgat NM. Ultrasound-guided serratus plane block versus erector spinae block for postoperative analgesia after video-assisted thoracoscopy: a pilot randomized controlled trial. J Cardiothorac Vasc Anesth. 2019;33(7):1946–1953.
[21] Finnerty DT, McMahon A, McNamara JR, et al. Comparing erector spinae plane block with serratus anterior plane block for minimally invasive thoracic surgery: a randomised clinical trial. Br J Anaesth. 2020;125(5):802–810. DOI:10.1016/j.bja.2020.06.020
[22] Gürkan Y, Aksu C, Kuş A, et al. Erector spinae plane block and thoracic paravertebral block for breast surgery compared to IV-morphine: a randomized controlled trial. J Clin Anesth. 2020;59:84–88.
[23] Hassan ME, Wadod MA. Serratus anterior plane block and erector spinae plane block in postoperative analgesia in thoracotomy: a randomized controlled study. Indian J Anaesth. 2022;66(2):119–125.
[24] Eskander AM, Elanin KM, Kasemy ZA, et al. Ultrasound-guided erector spinae-plane block for postoperative pain in neonates undergoing tracheoesophageal fistula repair. Menoufia Med J. 2022;35(3):1355.
[25] Thomas AB. Comparison of single injection of erector spinae plane block and paravertebral block in reducing post operative pain in children: aprospective, double blinded, randomized controlled trial. Christian Medical College, Vellore; 2020.
[26] Hetta DF, Rezk KM. Pectoralis-serratus interfascial plane block vs thoracic paravertebral block for unilateral radical mastectomy with axillary evacuation. J Clin Anesth. 2016;34:91–97.