Efficacy of erector spinae plane block versus serratus anterior plane block for perioperative analgesia in lateral thoracotomy surgeries: a randomized controlled trial

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Background
Lateral thoracotomy is considered one of the most painful types of surgical access. Post lateral thoracotomy pain is attributable to several mechanisms including muscle incisions, rib retraction or resection, intercostal nerves injury, and the presence of an indwelling chest tube. Inadequate pain management can lead to increased postoperative complications, especially in compromised patients. Acute pain may affect pulmonary function and clearance of secretions. Thus, postoperative pain control is crucial in decreasing morbidity and mortality after major thoracic surgery. Numerous analgesic techniques are available for the management of acute postthoracotomy pain, including patient controlled analgesia, regional nerve blockades, and neuraxial blocks. Thoracic epidural analgesia and thoracic paravertebral block are currently the recommended techniques for managing postthoracotomy pain.

Objectives
Our aim was to evaluate the analgesic efficacy of both techniques [erector spinae plane block (ESPB) and serratus anterior plane block (SAPB)] in patients undergoing lateral thoracotomy surgeries.

Patients and methods
Randomized controlled study in which 32 patients American Society of Anesthesiology I–II–III undergoing lateral thoracotomy were enrolled. With age more than or equal to 18 and less than or equal to 60 years. Patients were allocated into two groups: group 1 (SAPB) *N*=16 and group 2 (ESPB) *N*=16. After induction of anesthesia patients received either ultrasound-guided ESPB or SAPB with injection of 20 ml 0.25% bupivacaine. The total amount of morphine consumption in the first 24 h postoperatively. Total amount of intraoperative fentanyl and block related complications were recorded, visual analog scale score, both at rest and during movement, nausea and vomiting scores, and overall patient satisfaction were recorded.

Results
Statistically significant reduction in the mean postoperative morphine consumption was found in group 2 with 4.20±1.55 mg compared to 7.25±2.01 mg in group 1 ($P<0.001$). Statistically significant reduction in the mean intraoperative fentanyl consumption in group 2 with 129.38±40.08 μg compared to 165.63±39.66 μg in group 1 ($P<0.001$). Group 2 showed statistically significant lower scores at visual analog scale at rest and at movement. Among those who required postoperative morphine the mean time to 1st postoperative analgesia in group 1 (*N*=16) was 5.50 ±2.84 h compared to 9.09±3.62 h group 1 (*N*=16). Two (12.5%) patients of group 1 developed muscle hematoma and two (12.5%) patients complaint from pain at injection site in group 2.

Keywords:
post-thoractomy pain, serrutus anterior plane block, Erector spinae plane block

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Introduction

Management of postthoracotomy pain is usually requiring a great effort to control it and to avoid postoperative complications that may results from improper management such as atelectasis and retention of secretions [1].

Despite their side effects, thoracic epidural analgesia and administration of opioid drugs remain the most popular methods to deal with postthoracotomy pain [2].

A variety of plane blocks can be used with ultrasound guidance to produce efficient regional anesthesia and analgesia.

One of these blocks is the serratus anterior plane block (SAPB) which showed to provide effective analgesia to a variety of surgeries like breast surgeries, cardiac surgeries, and thoracotomy surgeries [3,4].

On the other hand, erector spinae plane block (ESPB) is an interfacial plane block that delivers adequate analgesia to the thoracic wall by administering the local anesthetic solution directly beneath the erector spinae muscle [5].

In this study, we will compare the effect of ultrasound-guided SAPB with the effect of ultrasound-guided ESPB for perioperative analgesia in lateral thoracotomy surgeries.

Patients and methods

After approval of the study by the research committee and the ethical committee, a randomized, controlled, double-blinded, trial was conducted at Cardiothoracic theater, Cairo University hospitals on 28 participants, all of them were scheduled for lateral thoracotomy surgery, and all of them gave informed consent.

Inclusion criteria

Patients with American Society of Anesthesiology physical status I, II, and III and aged between 20and 60 years.

Exclusion criteria

Patient refusal, allergy to local anesthetics, coagulation disorders, impairment of renal functions (creatinine >1.5 mg/dl) and hepatic insufficiency (Child B or Child C).

The patients were randomly assigned into one of the two groups, based on computer generated random number tables in opaque sealed envelopes prepared by an anesthesiologist who is not part of the study.

On the day before surgery, all patients were evaluated, detailed medical and surgical history was taken, and thorough physical and systemic examinations were done.

The following investigations were done: complete blood count, liver enzymes, prothrombin time, prothrombin concentration, kidney functions, serum electrolytes and ECG.

All patients were informed about the visual analog scale (VAS) score on a scale from 0 to 10 with 0 representing no pain and 10 represent the worst imaginable pain.

In the preanesthetic room: baseline hemodynamics were recorded; heart rate (HR) and mean arterial blood pressure (MBP). An intravenous access was secured; premedication in form of Midazolam 0.05 mg/kg, Ranitidine 50 mg, and Ondansetron 0.15 mg/kg was administered just before surgery over 15 min intravenously. In the operating theater full monitors were applied.

Patients were randomly allocated into one of the two groups depending on the type of the block provided in the theater. General anesthesia was administered to group SAPB followed by an ultrasound-guided SAPB, which was done before surgical incision. Group ESPB received general anesthesia and ultrasound-guided ESPB before surgical incision.

The ultrasound-guided serratus anterior plane block

After positioning the patient in the lateral decubitus and under sterile conditions. A linear ultrasound transducer (10–12 MHz) placed in a sagittal plane over the mid-clavicular region of the thoracic cage. The fifth rib identified in the mid-axillary line, the following muscles identified overlying the fifth rib: the latissimus dorsi (superficial and posterior), teres major (superior) and serratus muscles (deep and inferior). As an extra reference point, the thoracodorsal artery was used to aid in the identification of the plane superficial to the serratus muscle. The needle (Braun stimuplex ultra insulated echogenic needle 22 G) introduced in-plane with respect to the ultrasound probe targeting the plane superficial to the serratus muscle, confirmed by infiltration of Saline before injection of local anesthetic under continuous ultrasound guidance, aspiration was done to prevent intravascular injection then 30 ml of 0.25% bupivacaine injected.

The ultrasound-guided erector spinae plane block

After positioning the patient in the lateral decubitus and under sterile conditions. A linear ultrasound transducer was used to determine the apex of T5 transverse process, the probe then was moved to a sagittal plane to visualize the erector spinae muscles lying underneath the trapezius muscle. A 22-G needle (Braun stimuplex ultra insulated echogenic needle), was inserted medially in-plane relative to the ultrasound probe and directed towards the transverse process. Once the needle was underneath the anterior fascia of the erector spinae muscle, 1 ml normal saline was injected for hydro-dissection sign to verify the

needle tip, and then a volume of 20 ml 0.25% bupivacaine was injected under the erector spinae muscle into the newly formed space.

Clinical monitoring for all patients included five lead electrocardiography, pulse oximetry, capnography, noninvasive and invasive arterial blood pressure, and central venous pressure measurement.

Induction of anesthesia was done using fentanyl (1–2 μg/kg), propofol (1–2 mg/kg), and atracurium (0.5 mg/kg), followed by intubation either with single lumen endotracheal tube or double lumen endotracheal tube which required confirmation by clinical assessment and fiberoptic bronchoscope, a central venous catheter was inserted in the internal jugular vein. The temperature probe was inserted in the nasopharynx.

Ventilation done via both lungs with tidal volume 6–8 ml/kg, respiratory rate 10–12 b/m, I : E ratio 1 : 2 and FIO_2 100%, and in case of intubation by double lumen endotracheal tube, and after stabilization of respiratory parameters (by ABG) and upon surgeon request, one lung ventilation will be performed with adjustment of the ventilation parameters to maintain the $PaCO_2$ in the range of 34–36 mmHg and peak airway pressure less than 40 cmH_2O. If there is an increase in the peak airway pressure, The tidal volume decreased and respiratory rate increased with avoidance of over inflation and volume trauma of the ventilated lung.

Anesthesia was maintained by isoflurane 1–2% in 100% oxygen and top up doses of muscle relaxant, and if there were an increase in the systolic blood pressure (SBP) and the HR for more than 20% of the base line values recorded before the operation, incremental doses of fentanyl (0.15 μg/kg) would be administrated.

At the end of the surgical procedure, patients were extubated and transferred to the postoperative ICU.

The postoperative pain was assessed by VAS score ranging from 0 (no pain) to 10 (worst pain) and patients were asked to refer to the source of pain to exclude other causes of pain (as chest drains) apart from the thoracotomy. Management of postoperative pain was done by giving all patients 15 mg/kg i.v. Paracetamol every 6 h; starting the first dose 40 min before the end of surgery. In addition, patients with a VAS higher than 4 were given i.v. morphine (Acupan; Biocodex, Beauvais, France) in a dose of 20 mg for 20 min with a maximum of 120 mg for 24 h. Morphine consumption postoperatively recorded.

Pain level recorded at PACU admission (H0) when the patient was able to communicate, then every 3 h for the first 12 h, then recorded every 6 h until the 24th hour (H3, H6, H9, H12, H18, and H24).

Regarding the postoperative nausea and vomiting (PONV), a four-point scale used to assess it where 0=no PONV, 1=mild nausea, 2=severe nausea, 3=vomiting, and patients with a scale 2 or more given ondansetron 4 mg intravenously, with a maximum dose 16 mg/day.

Two anesthesiologists helped each other in this study, anesthesiologist A inducted the case as mentioned and then he left the theater until anesthesiologist B gave the patient one of the two blocks of the study without telling anesthesiologist A which block was done to keep blind randomization. The anesthetist B has a proper training and experience for both techniques and he gave the blocks for all the patients.

Measurements

The baseline reading of SBP and HR, and intraoperatively, SBP and HR recorded every 10 min till extubation. The duration of surgery and fentanyl requirements also recorded. Any episodes of bradycardia (HR<40 beats/min), hypotension (SBP<85 mmHg), nausea and vomiting recorded during the first 24 h after surgery. Extubation time (time from discontinuation of inhalational anesthetic to eye opening to command and extubation). Total dose of intravenous morphine postoperatively (mg/24 h). PONV assessed by PONV scale. Postoperative itching, block complications (rash, urine retention, block pain, and muscle hematoma). Failure rate of the block (the block was considered a failed block if the patient required more than two doses of rescue analgesia in the first hour postoperatively and if the patient VAS score continued to be more than or equal to 4 after rescue analgesia, and this patient was excluded from the study).

Study outcomes

(1) Primary outcome: the time to first analgesic requirement when VAS score is higher than 4 after this operation.
(2) Secondary outcome(s): intraoperative hemodynamics (HR–MAP). The use of intraoperative pain rescue analgesia, extubation time, severity of postoperative pain assessed by

VAS score during rest and movement, total dose of intravenous morphine post operatively (mg/24 h), PONV assessed by PONV scale

Statistical analysis

Sample size

As the primary outcome is time to first request for analgesia in patients undergoing lateral thoracotomy, we found in a previous study that the time to first request for analgesia was 6.2±1.6 [6]. So a sample size that could detect a mean difference of 25% between both study groups was calculated using MedCalc Software, version 14 (MedCalc Software bvba, Ostend, Belgium), and it was estimated to be at least 28 patients (14 patients per group) to have a study power of 80% and an alpha error of 0.05 and in order to compensate for possible dropouts this number was increased to 32 patients (16 patients per group).

Statistical analysis

Statistical analysis was done using SPSS software (SPSS Inc., Chicago, iL, USA). Data are presented as numbers (%) (for categorical data), mean (SD) for normally distributed continuous data, median (quartiles) for skewed data. Normality was checked using Shapiro test. Analysis was done using χ^2, mixed design analysis of variance, and Kruskal–Wallis as appropriate. A P value of 0.05 is considered statistically significant.

Results

The present study included two groups of patients (a total of 32 participants).

The first group included 16 participants (group SAPB received general anesthesia and ultrasound-guided SAPB. The second group included 16 participants (group ESPB received general anesthesia and ultrasound-guided ESPB before surgical incision).

In both groups there were no significant difference regarding the type of surgery (bullectomy, lobectomy, lung biopsy, and pneumonectomy) and medical history (e.g. diabetes mellitus, systemic hypertension, bronchial asthma, chronic obstructive pulmonary disease) as shown in Table 1.

Regarding the postoperative analgesia, the patients in the SAPB group needed rescue analgesia earlier than the ESPB group. There was statistically significant

Table 1 Comparison between serratus anterior plane block group and erector spinae plane block group according to lateral thoracotomy and medical history

	SAPB group (N=16) [n (%)]	ESPB group (N=16) [n (%)]	χ^2	P value
Lateral thoracotomy				
Bullectomy	3 (18.8)	4 (25.0)		
Lobectomy	8 (50.0)	8 (50.0)	0.286	0.963
Lung biopsy	4 (25.0)	3 (18.8)		
Peumonectomy	1 (6.3)	1 (6.3)		
Medical history				
BA	0	2 (12.5)		
BA+DM	1 (6.3)	0		
BA+HTN	0	1 (6.3)		
Child A HCV	1 (6.3)	0		
COPD+DM	0	1 (6.3)		
COPD+HTN	3 (18.8)	0		
Dementia DM and on edpakin mood stabilizer	1 (6.3)	0		
DM+HTN	2 (12.5)	3 (18.8)		
HCV Child A	0	1 (6.3)		
HTN	1 (6.3)	3 (18.8)	21.533	0.366
HTN+BA	1 (6.3)	0		
HTN+CTH	1 (6.3)	0		
HTN+DM hyperthyroidism	1 (6.3)	0		
IHD on med TTT post-CTH	1 (6.3)	0		
IHD+BA	0	1 (6.3)		
IHD+BA	1 (6.3)	0		
MF	1 (6.3)	2 (12.5)		
Post-CTH pleural effusion	1 (6.3)	0		
Uncontrolled HTN	0	2 (12.5)		

ESPB, erector spinae plane block; SAPB, serratus anterior plane block. Using: χ^2 test; P value more than 0.05 NS.

increase mean ESPB group (9.09±3.62) compared to SAPB group (5.50±2.84) according to the time of first rescue analgesia (h) (Table 2).

Regarding the hemodynamics, the HR showed statistically significant increase in SAPB group compared to ESPB group at 90, at 120, at 150, and at 180 min (Table 3).

The MBP was statistically significantly increased in SAPB group compared to ESPB group at 90, at 120, at 150, and at 180 min (Table 4).

Postoperatively, the HR and the MBP were significantly increased in SAPB group compared to ESPB group after 8 h, after 12, after 16, and after 20 h (Tables 5 and 6).

Regarding the opioid consumption, the intraoperative fentanyl consumption and the postoperative morphine requirements were higher in SAPB group than the ESPB group (Table 7 and Fig. 1).

The VAS score showed statistically significant decreased pain in ESPB group compared to SAPB group at rest and movement from after 2 h to after 24 h (Tables 8 and 9).

The PONV showed no significant difference between the two groups (Fig. 2), as well the postoperative complications as rash, urine retention, block pain, and muscle hematoma were nearly similar in the both groups (Table 10).

Table 2 Comparison between serratus anterior plane block group and erector spinae plane block group according to time of first rescue analgesia (h)

Time of first rescue analgesia (h)	SAPB group (*N*=16)	ESPB group (*N*=16)	*t* test	*P* value
Mean±SD	5.50±2.84	9.09±3.62	−2.658	0.015*
Range	2–12	4–16		

ESPB, erector spinae plane block; SAPB, serratus anterior plane block. Using: *t* independent sample *t* test. **P* value less than 0.05 S.

Discussion

We found that ultrasound-guided ESPB provides more safe and effective analgesia in lateral thoracotomy surgeries compared to ultrasound-

Table 3 Comparison between serratus anterior plane block group and erector spinae plane block group according to intraoperative heart rate (beat/min)

Intraoperative heart rate (beat/min)	SAPB group (*N*=16)	ESPB group (*N*=16)	*t* test	*P* value
Baseline				
Mean±SD	91.50±12.52	93.00±14.35	−0.315	0.755
Range	70–110	67–114		
Postinduction				
Mean±SD	85.19±12.19	87.38±11.94	−0.513	0.612
Range	59–102	69–113		
At 1 min				
Mean±SD	81.44±14.09	81.88±12.85	−0.092	0.928
Range	62–109	59–102		
At 30 min				
Mean±SD	79.56±15.01	79.06±12.75	0.102	0.920
Range	59–109	62–105		
At 60 min				
Mean±SD	77.63±13.11	78.75±11.85	−0.255	0.801
Range	56–96	57–96		
At 90 min				
Mean±SD	81.92±11.06	78.54±11.32	2.175	0.046*
Range	62–95	64–100		
At 120 min				
Mean±SD	82.83±11.65	77.31±11.56	3.219	0.024*
Range	60–98	62–98		
At 150 min				
Mean±SD	82.57±13.06	77.20±4.76	4.689	0.012*
Range	68–101	70–82		
At 180 min				
Mean±SD	83.67±15.78	76.60±4.04	3.551	0.029*
Range	66–104	71–81		

ESPB, erector spinae plane block; SAPB, serratus anterior plane block. Using *t* independent sample *t* test; *P* value more than 0.05 NS. **P* value less than 0.05 S.

Table 4 Comparison between serratus anterior plane block group and erector spinae plane block group according to intraoperative mean arterial blood pressure (mmHg)

Intraoperative mean arterial blood pressure (mmHg)	SAPB group (*N*=16)	ESPB group (*N*=16)	*t* test	*P* value
Baseline				
Mean±SD	99.94±13.33	100.56±11.64	–0.141	0.889
Range	80–129	79–114		
Postinduction				
Mean±SD	84.94±13.33	85.56±11.64	–0.141	0.889
Range	65–114	64–99		
At 1 min				
Mean±SD	83.87±8.86	86.09±12.42	–0.715	0.317
Range	65–105	64–110		
At 30 min				
Mean±SD	83.13±12.10	86.31±13.94	–0.691	0.495
Range	65–108	64–115		
At 60 min				
Mean±SD	82.44±8.37	84.06±10.88	–0.473	0.639
Range	64–93	62–100		
At 90 min				
Mean±SD	88.77±7.44	84.08±8.14	–1.995	0.046*
Range	72–101	66–95		
At 120 min				
Mean±SD	90.54±7.17	86.08±8.14	–2.455	0.038*
Range	80–102	68–97		
At 150 min				
Mean±SD	93.20±4.44	90.00±3.16	2.313	0.026*
Range	88–99	86–94		
At 180 min				
Mean±SD	95.20±4.44	91.75±4.92	2.105	0.037*
Range	90–101	88–99		

ESPB, erector spinae plane block; SAPB, serratus anterior plane block. Using *t* independent sample *t* test; *P* value more than 0.05 NS.
**P* value less than 0.05 S.

Table 5 Comparison between serratus anterior plane block group and erector spinae plane block group according to postoperative heart rate (beat/min)

Postoperative heart rate (beat/min)	SAPB group (*N*=16)	ESPB group (*N*=16)	*t* test	*P* value
Immediately postoperative				
Mean±SD	83.69±18.54	81.94±11.92	0.318	0.753
Range	51–110	53–103		
After 2 h				
Mean±SD	76.19±14.34	77.00±10.48	–0.183	0.856
Range	53–103	54–97		
After 4 h				
Mean±SD	75.31±14.13	77.06±6.39	–0.451	0.655
Range	51–105	58–90		
After 8 h				
Mean±SD	82.56±12.86	78.25±7.10	2.174	0.025*
Range	59–104	55–91		
After 12 h				
Mean±SD	84.06±14.24	78.88±7.76	3.280	0.021*
Range	53–100	56–91		
After 16 h				
Mean±SD	81.56±16.99	77.69±6.53	2.852	0.041*
Range	53–110	57–86		
After 20 h				
Mean±SD	83.81±12.76	79.94±8.14	2.025	0.034*
Range	53–110	55–95		
After 24 h				
Mean±SD	80.75±13.98	78.94±8.19	0.447	0.658
Range	51–110	54–94		

ESPB, erector spinae plane block; SAPB, serratus anterior plane block. Using *t* independent sample *t* test; *P* value more than 0.05 NS.
**P* value less than 0.05 S.

Table 6 Comparison between serratus anterior plane block group and erector spinae plane block group according to postoperative mean arterial blood pressure (mmHg)

Postoperative mean arterial blood pressure (mmHg)	SAPB group (*N*=16)	ESPB group (*N*=16)	*t* test	*P* value
Immediately postoperative				
Mean±SD	89.31±12.43	88.50±7.51	0.224	0.824
Range	71–117	73–100		
After 2 h				
Mean±SD	88.19±12.60	86.75±15.90	0.283	0.779
Range	67–113	64–114		
After 4 h				
Mean±SD	93.56±12.98	91.31±12.80	0.494	0.625
Range	72–116	73–114		
After 8 h				
Mean±SD	97.56±12.98	93.06±11.06	2.206	0.030*
Range	76–120	70–109		
After 12 h				
Mean±SD	98.81±12.98	94.06±12.49	2.155	0.029*
Range	77–121	69–120		
After 16 h				
Mean±SD	96.81±12.98	92.50±9.82	3.060	0.039*
Range	75–119	75–105		
After 20 h				
Mean±SD	92.38±10.71	95.75±12.22	–2.338	0.047*
Range	78–119	70–115		
After 24 h				
Mean±SD	91.75±8.20	94.00±5.90	–0.891	0.380
Range	78–109	82–103		

ESPB, erector spinae plane block; SAPB, serratus anterior plane block. Using *t* independent sample *t* test; *P* value more than 0.05 NS. **P* value less than 0.05 S.

Table 7 Comparison between serratus anterior plane block group and erector spinae plane block group according to intraoperative fentanyl consumption (μg)

Intraoperative fentanyl consumption (μg)	SAPB group (*N*=16)	ESPB group (*N*=16)	*t* test	*P* value
Mean±SD	165.63 ±39.66	129.38 ±40.08	2.716	0.013*
Range	100–200	100–200		

ESPB, erector spinae plane block; SAPB, serratus anterior plane block. Using *t* independent sample *t* test. **P* value less than 0.05 S.

guided SAPB in the form of less intraoperative fentanyl consumption, less postoperative morphine consumption, less VAS scores, and less block associated complications.

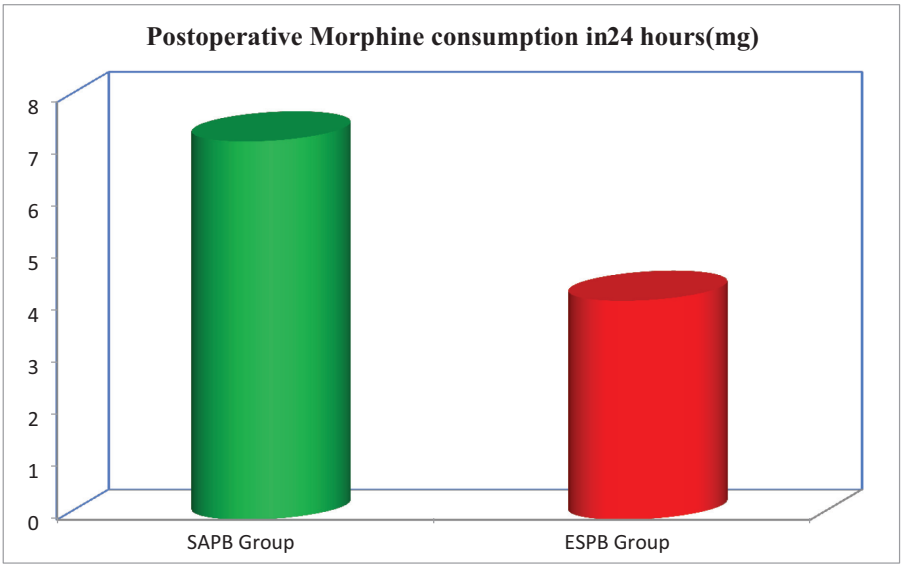
Wang and colleagues had previously compared the effect of ESPB and local wound infiltration on the control of perioperative pain in patients undergoing open thoracotomy surgeries. They demonstrated that the intraoperative sufentanil, postoperative morphine consumption, postoperative tramadol consumption, and postoperative pain, nausea, and vomiting were significantly less in ESPB when compared to wound infiltration. The result of this study goes in harmony with the result of our study as in our study using the ESPB was effective in controlling pain in the postoperative period but in our study we used 20 ml of bupivacaine 0.25% at T5, while they used 20 ml of ropivacaine 0.5% at the level of T5 to do the ESPB [7].

In the same context, Fiorelli and colleagues studied the effect of ESPB and intercostal nerve block on the perioperative pain in patients scheduled for mini-thoracotomy for lung resection. The study results revealed that the static and dynamic. Numeric Rating Scale values were significantly less in the ESPB group than the intercostal nerve block group throughout the study duration. Moreover, the results showed significant lower consumption of opioids either intraoperative (remifentanil) or in the postoperative period in the ESPB group [8].

In a prospective randomized study by Ciftci and colleagues performed on 60 patients scheduled for video-assisted thoracoscopic surgery comparing the effect of ESPB with a control group who did not receive any block for perioperative pain. They used 20 ml of bupivacaine 0.25% which is the same drug, volume, and concentration of our study.

The results showed that the opioid consumption at first 24 h, use of rescue and VAS scores were statistically lower in group 1 who received ESPB [9].

Figure 1



Bar chart between SAPB group and ESPB group according to postoperative morphine consumption in 24 h (mg). ESPB, erector spinae plane block; SAPB, serratus anterior plane block.

Table 8 Comparison between serratus anterior plane block group and erector spinae plane block group according to visual analog scale at rest

VAS at rest	SAPB group (*N*=16)	ESPB group (*N*=16)	*U* test	*P* value
Immediately postoperative				
Median (IQR)	2 (1)	1 (2)	1.377	0.197
Range	1–4	1–3		
After 2 h				
Median (IQR)	3 (1)	2 (1)	3.997	<0.001**
Range	2–4	1–4		
After 4 h				
Median (IQR)	3 (1)	2 (2)	3.216	0.003*
Range	2–4	1–5		
After 8 h				
Median (IQR)	3 (2)	2 (2)	3.732	0.002*
Range	1–5	1–5		
After 12 h				
Median (IQR)	3 (1)	2 (1)	4.227	<0.001**
Range	1–4	1–2		
After 16 h				
Median (IQR)	3 (1)	2 (2)	3.080	0.004*
Range	2–4	1–4		
After 20 h				
Median (IQR)	3 (2)	2 (1)	4.679	<0.001**
Range	2–4	1–3		
After 24 h				
Median (IQR)	3 (1)	2 (1)	4.091	<0.001**
Range	2–5	1–2		

ESPB, erector spinae plane block; IQR, interquartile range; SAPB, serratus anterior plane block; VAS, visual analog scale. Using Mann–Whitney *U* test; *P* value more than 0.05 NS. **P* value less than 0.05 S. ***P* value less than 0.001 HS.

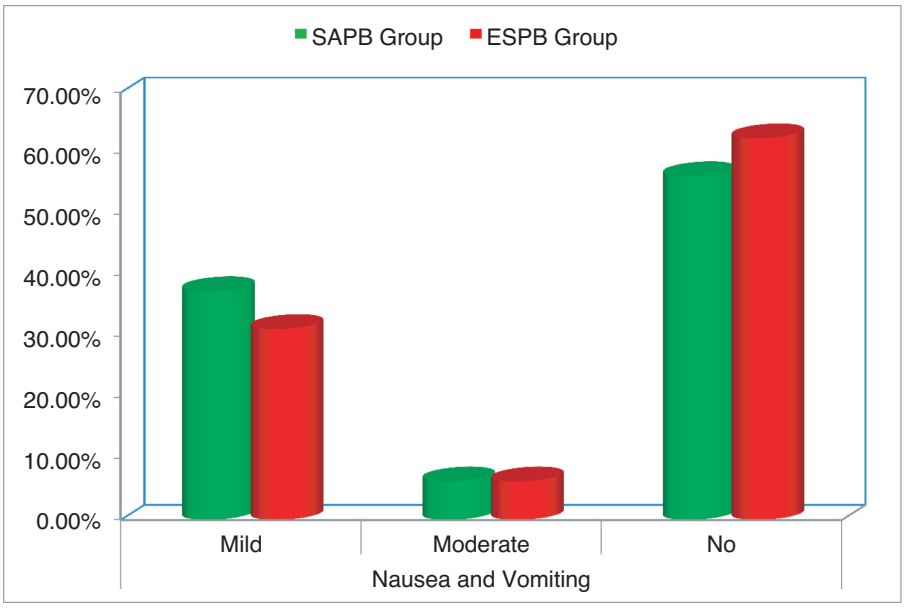
In 2019, a study by Eldemrdash and Abdelzaam published in *Open Journal of Anesthesiology*, compared the analgesic efficacy of ultrasound-guided ESPB versus paravertebral block versus SAPB in patients underwent radical mastectomy. The study revealed lower VAS scores and longer duration of analgesia in ESPB group than SAPB group, and the paravertebral block group showed lower VAS scores than SAPB but higher than ESPB, also the duration of analgesia was longer than SAPB but shorter than

Table 9 Comparison between serratus anterior plane block group and erector spinae plane block group according to visual analog scale at movement

VAS at movement	SAPB group (*N*=16)	ESPB group (*N*=16)	*U* test	*P* value
Immediately postoperative				
Median (IQR)	3 (1)	2 (1)	1.712	0.110
Range	2–5	2–3		
After 2 h				
Median (IQR)	4 (2)	3 (1)	3.873	<0.001**
Range	3–6	2–5		
After 4 h				
Median (IQR)	4 (2)	3 (2)	3.218	0.003*
Range	3–6	2–6		
After 8 h				
Median (IQR)	4 (2)	3 (1)	3.556	<0.001**
Range	2–6	2–6		
After 12 h				
Median (IQR)	4 (2)	3 (1)	4.629	<0.001**
Range	2–5	2–3		
After 16 h				
Median (IQR)	4 (1)	3 (1)	3.174	0.004*
Range	3–5	2–5		
After 20 h				
Median (IQR)	4 (1)	3 (1)	4.881	<0.001**
Range	3–5	2–4		
After 24 h				
Median (IQR)	4 (1)	3 (1)	4.029	<0.001**
Range	3–6	2–4		

ESPB, erector spinae plane block; IQR: Interquartile range; SAPB, serratus anterior plane block; VAS, visual analog scale. Using Mann–Whitney *U* test; *P* value more than 0.05 NS. **P* value less than 0.05 S. ***P* value less than 0.001 HS.

Figure 2



Bar chart between SAPB group and ESPB group according to nausea and vomiting. ESPB, erector spinae plane block; SAPB, serratus anterior plane block.

ESPB. In accordance of our results patients of ESPB group consumed less postoperative morphine compared to patients in SAPB group, but different type of local anesthetic was used in this study which is Articaine with Adrenaline [10].

On the other side, three studies have contradicted our results showing that medial and lateral pectoral nerves block (Pecs II block) that share the same mechanism of action with SAPB, has a better analgesic effect when compared to ESPB in modified radical mastectomy,

Table 10 Comparison between serratus anterior plane block group and erector spinae plane block group according to complications

Complications	SAPB group (*N*=16) [*n* (%)]	ESPB group (*N*=16) [*n* (%)]	χ^2	*P* value
Rash	1 (6.3)	2 (12.5)	0.368	0.544
Urine retention	1 (6.3)	1 (6.3)	0.000	1.000
Block pain	0	2 (12.5)	2.133	0.144
Muscle hematoma	2 (12.5)	0	2.133	0.144

ESPB, erector spinae plane block; SAPB, serratus anterior plane block. Using χ^2 test; *P* value more than 0.05 NS.

two of them are randomized trials and the third one is systematic review.

In the first study, Sinha and colleagues demonstrated that total morphine consumption in 24 h was less in Pecs II (4.40±0.94 mg) nearly similar to our study results (7.25±2.01 mg) in SAPB group. However in ESPB group it was 6.59±1.35 mg in contrast to 4.20 ±1.55 mg found in our study. Furthermore, the mean duration of analgesia in patients of group 2 (Pecs II) was longer that in the group 1 (ESPB). There was no incidence of adverse effects in either group. However, a different local anesthetic and different volume used in pecs II group (25 ml 0.2% ropivacaine) compared to only (20 ml 0.2% ropivacaine) in ESPB group contributing to the observed better analgesic effect. In addition to this, another type of local anesthetic was used other than the one used the present study [11].

The second study by Gad and colleagues included 50 patients divided into two equal groups. Comparing ESPB against modified pectoral plane block in modified radical mastectomy. A volume of 30 ml of 0.25% levobupivacaine was used in modified pectoral plane block in comparison with 20 ml of 0.25% levobupivacaine in ESPB patients. The results of this study showed that postoperative morphine consumption and stress hormone level in modified pectoral block group were significantly lower than ESPB group. Moreover, those who received modified pectoral block showed statistically significant less pain scores and requested less analgesia postoperatively than ESPB patients. This may be explained by the larger volume of local anesthetic and combination of Pecs I and II in modified pectoral block which may contribute to this better analgesic effect when compared to ESPB alone with less volume of local anesthetic. Also the areas of innervation are different as PEC covers the anterior and part of the lateral thorax, while ESPB covers posterior part of the chest; so the PEC block anesthetizes the medial and lateral pectoral nerves, which innervate the pectoralis muscles and this will be effective for muscular pain after mastectomy; while the ESPB blocks anesthetizes the dorsal and ventral rami of the spinal nerves, and this may explain the results of this study [12].

The third study is a systematic review done by Elhawary and colleagues reviewing 32 articles including six randomized controlled trials. They found that ESPB was associated with better analgesia and lower postoperative opioid consumption when compared with tumescent technique or using no block. However, ESPB showed lower efficacy in pain control compared with pectoral nerve block. Patients who received ESPB have shown less nausea and vomiting compared to other pain control modalities. The vast majority of the studies reported the ease of ESPB administration, with very low incidence of complications [13].

To summarize, based on the results of this randomized controlled study, we concluded that ultrasound-guided ESPB provides more safe and effective analgesia in lateral thoracotomy compared to ultrasound-guided SAPB in the form of less intraoperative fentanyl consumption, less postoperative morphine consumption, less VAS scores and less block associated complications.

Limitations

VAS score is quite subjective and may be affected by pain from different origin other than thoracotomy like pain from drain insertion or shoulder pain from phrenic nerve manipulation during the procedure.

To overcome this problem the score of VAS was confirmed by direct questions to the patient to identify the exact source of pain.

The study has a small number of patients and other researchers need to base the same study on a larger sample size to end up with more accurate results.

Conclusion

Based on the results of this randomized controlled study: ultrasound-guided ESPB provides more effective analgesia in lateral thoracotomy compared to ultrasound-guided SAPB in the form of less intraoperative fentanyl consumption, less postoperative morphine consumption, less VAS scores and less block associated complications.

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Conflicts of interest
There are no conflicts of interest.

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