Comparison between erector spinae plane block and thoracic epidural in breast cancer surgeries under general anesthesia

Mohamed R. Seleem, Raafat A. Hammad, Sherif S. Sultan, Mohamed A. Sayed, Neveen G. Fahmy

Department of Anesthesia & Intensive Care and Pain Management, Faculty of Medicine, Ain Shams University, Cairo, Egypt

Correspondence to Mohamed R. Seleem, MSC, Department of Anesthesia & Intensive Care and Pain Management, Faculty of Medicine, Ain Shams University, Cairo, 11646, Egypt. Tel.: +201014139074;
e-mail: mohamed_ramadan593@yahoo.com

Received: 21 December 2021
Accepted: 03 February 2022
Published: 10 October 2022

The Egyptian Journal of Surgery 2022, 41:456–462

Background
Thoracic epidural (TE) analgesia was considered as the gold standard for intraoperative and postoperative analgesia in breast surgeries. However, it is not routinely used because of its associated hemodynamic effects. Erector spinae plane (ESP) block is recognized as a promising perioperative analgesic intervention in breast surgeries.
Aim
To compare between ESP block and TE analgesia in unilateral breast cancer surgeries without axillary clearance performed under general anesthesia.
Patients and methods
Forty female patients scheduled for unilateral cancer breast surgeries without axillary clearance under general anesthesia were enrolled in this study. After induction of general anesthesia, patients were divided into two groups: TE group received single-shot 10-ml 0.25% bupivacaine in the TE space, while ESP group received single-shot 20-ml 0.25% bupivacaine ultrasound-guided ESP block. The primary outcome was to assess the analgesic effects through recording intraoperative fentanyl consumption and postoperative narcotic consumption (morphine in the post-anesthesia-care unit and pethidine in the surgical ward), visual analog scale (VAS) score for pain assessment in the first postoperative 24 h. The secondary outcomes were to compare hemodynamic changes and any complications related to the technique or drugs used, and patient satisfaction.
Results
No statistical differences were found between the two groups regarding their demographic data. As regards narcotic consumption, intraoperative fentanyl consumption was significantly higher in ESP group (P<0.001), postoperative morphine consumption in post-anesthesia-care unit was not statistically different between the groups (P=0.67), while pethidine consumption in the surgical ward was higher in TE group (P<0.001). Concerning pain assessment, VAS scores in ESP group were statistically lower when compared with TE group starting from 2 to 12 h postoperatively, and higher in patients' satisfaction about analgesia in the first 24 h postoperatively (i.e. 95% satisfied in ESP vs. 55% in TE) (P=0.01). As regards hemodynamic effects, TE group showed lower mean arterial blood-pressure recordings with a significant difference between the ESP group at 10 min, 30 min, and 1 h after the intervention (P=0.034, P<0.001, and P=0.006, respectively), TE group showed a significant difference with lower heart-rate recordings in comparison with ESP group, at 30 min after the block (P=0.002).
Conclusion
The current study revealed that ESP block showed lower postoperative pethidine consumption and lower VAS scores from 2 to 12 h. Postoperatively, while TE block showed lower intraoperative fentanyl consumption. ESP block showed better hemodynamic stability and higher patients' satisfaction to analgesia. We propose that ESP block should be included in the armamentarium of regional analgesic techniques for breast surgeries.

Keywords:
breast cancer surgeries, erector spinae plane block, narcotic consumption, ultrasound-guided, visual analog scale score

Egyptian J Surgery 2022, 41:456–462

1110-1121

Introduction

Breast cancer is the first common cancer among women and is the second common as regards whole incidence of cancer in Egypt [1]. In the United States,

one out of eight women develop breast cancer during their lifetime. Breast cancer surgeries are common procedures, particularly in middle-aged women [2], with an increased incidence of postoperative pain that is moderate to severe in nature. Acute postoperative pain is an integral risk factor in the development of chronic postmastectomy pain; 40% of women will have severe acute postoperative pain after breast cancer surgery, whereas 50% will develop chronic postmastectomy pain with impairment of quality of life [3]. An increase in postoperative morbidity and mortality could be a consequence of inadequate analgesia [4].

There are challenges encountered in achieving optimum postoperative analgesia and prevention of chronic postsurgical pain in these types of procedures. Several analgesic methods have been used over the years, including systemic medications, local anesthetic (LA) infiltration, intercostal nerve block, pectoral nerve block, thoracic paravertebral nerve block, and thoracic epidural (TE) analgesia. TE analgesia has many drawbacks: high failure rate even in experienced hands, technical difficulty in application, hemodynamic effects in the form of hypotension and bradycardia, risk of bleeding (epidural hematoma), dural puncture, risk of spinal cord damage, and patchy block. Regional analgesic techniques have provided better-quality acute pain control and subsequently less chronic pain. The proposed mechanisms for decreased persistent pain include decreased central sensitization (windup) and lower incidence of opioid-induced hyperalgesia [5]. Furthermore, effective acute pain control preserves immune functions, both by suppressing the surgical-stress response and by decreasing the need for general anesthetics and opioids. Opioids, especially morphine, inhibit both cellular and humoral immune functions, this effect may be responsible for the higher rates of postsurgical local recurrence and/or metastasis [6]. Good postoperative analgesia can inhibit migration of cytokines, slowing down movement of proinflammatory factors to wound tissue and reducing the release of inflammatory factors such as tumor-necrosis factor and interleukin-6. Wounds can recover quickly in this context [7].

Erector spinae plane (ESP) block, which is a novel analgesic technique that was described by Forero *et al.* [8], has become a recognizable peripheral-nerve plane block for regional analgesia in thoracic surgeries. ESP is technically much easier to apply generally as compared with neuraxial, peripheral-nerve blocks, and other regional modalities [9]. A LA is injected deep into the erector spinae muscle and superficial to the tip of the transverse process of a thoracic vertebra at the myofascial plane. The instilled LA can induce sensory block at the multidermatomal levels across the posterior, lateral, and anterior thoracic wall, probably due to the diffusion of the LA into the paravertebral space. In addition to its effect at the rami communicans that supply the sympathetic chain, the ESP block affects the dorsal and ventral primary rami of the thoracic nerves [10]. Since much of breast-tissue innervation is from thoracic nerves, therefore, ESP block's possible role in perioperative analgesia for breast cancer surgeries should be considered. We postulate that ESP block could have comparable analgesic efficacy and possible longer duration of action in comparison with TE block.

Aim

The primary outcome was to compare perioperative analgesic effect of ESP block compared with TE analgesia, while the secondary outcomes were to compare hemodynamic changes and any complications related to the technique or drugs used, and patient satisfaction to analgesia in unilateral breast cancer surgeries without axillary clearance, done under general anesthesia.

Patients and methods

Using PASS 11 program for sample-size calculation, setting the confidence interval at 95%, power 85%, and alpha error at 5%, and results from previous study on ESP block [11], a sample size of 30 patients (15 in each group) can detect a difference of 20% between the two groups regarding opioid consumption. With adjustment for possible dropouts of 10%, a sample size of the total number 40 patients (20 per group) was sufficient to achieve the study objective. This prospective randomized clinical study was then performed on forty female patients, aged 18–65 years old, with BMI less than 35 $kg.m^{-2}$ and the American Society of Anesthesiologists physical status I–II enrolled for elective breast cancer surgery without axillary clearance. Excluded from the study, patients who refused to be enrolled in the study, morbidly obese patients (BMI ≥40 kg/m^2), patients with vertebral-column anomalies or kyphoscoliosis, patients on anticoagulants or antiplatelets other than aspirin or with bleeding diathesis, pregnancy or lactation, significant psychiatric or mental disorders, known allergic reactions to LA, neuropathy or neurological deficits, patients with infection at the block site, patients on oral narcotics with the last dose within 24 h preoperatively, or Herpes Zoster infection active form. The study was performed in Ain Shams University Hospitals after approval of the local ethics committee: Research Ethics Committee (REC) with identification no. FMASU MD 411a/2020/2021 and approval of Pan African Clinical Trial Registry with identification

No. PACTR202110766260656 and informed written consent. Patients were divided according to the intervention done into two equal groups: ultrasound (US)-guided single-shot ESP block group, single-shot TE analgesia group. All patients who completed the study had a clinical assessment on the preoperative visit.

Technique

On arrival at the operating theater, patients were connected to standard monitors: noninvasive arterial blood pressure, ECG, and pulse oximetry. Patients received midazolam (0.035–0.05) mg/kg intravenous for anxiolysis. General anesthesia was induced by propofol (1.5–2 mg/kg) intravenous and fentanyl (1 μg/kg) intravenous, atracurium (0.5 mg/kg) intravenous administered for tracheal intubation. Maintenance of general anesthesia was done with isoflurane (1.2–2%).

At this point – after general-anesthesia induction and before skin incision – all patients were randomly divided into two groups: one group of patients received single-shot ESP block group, while in the other group, single-shot TE-block-performed group. Randomization was achieved by a computer-generated number list and using the sequentially numbered opaque sealed-envelope technique. Patients were randomized to receive either single-shot ESP block (ESP group), or single-shot TE block (TE group). In the ESP group, the patient was positioned for performing the block in lateral decubitus with the side to be blocked upward; skin preparation performed using 10% povidone iodine. The block was performed using US-guided high-frequency linear probe covered with a sterile cover. A 22-G, 100-mm, insulated facet-type needle was used. The block was performed at the T4 level of the spine using an in-plane approach. The probe was placed 2–3 cm laterally to the spine using a sagittal approach. After the erector spinae muscle and the transverse processes were identified, the needle was inserted deep into the muscle just superficial to T4 transverse vertebral process, the needle directed from a cranial to caudal direction. Following confirmation of the correct position of the needle tip with administration of 0.5–1 ml of LA, single-shot 20 ml of 0.25% bupivacaine was administered for block performance after negative aspiration of blood. LA distribution was observed in both cranial and caudal directions. In the TE group, the patient was positioned in the lateral position with the side to be blocked upward and skin preparation was performed using 10% povidone iodine. An 18-G Tuohy needle was inserted into the posterior midline at the level of T4–5 intervertebral space, or one space close to this space considering being an easier access; the TE space was identified by means of loss-of-resistance to injection of saline, single-shot 10 ml of bupivacaine 0.25% was injected once after negative aspiration of blood or cerebrospinal fluid. During anesthesia maintenance for both groups, fentanyl boluses were given 1 μg/kg if the heart rate increased by 20% from the baseline heart rate and/or the systolic blood pressure increased by 20% from the baseline blood pressure with maximum fentanyl given 2 μg/kg intravenous, doses of atracurium 0.1 mg/kg intravenous given as required. Paracetamol 1 g of intravenous was administered for postoperative analgesia at the end of surgery and granisetron 1 mg of intravenous was administered to prevent postoperative nausea and vomiting. At the end of surgery, neuromuscular reversal was provided with the administration of 0.05 mg/kg of neostigmine intravenous and 0.02 mg/kg of atropine intravenous. Patient extubation was done after satisfying extubation criteria, then patients were transferred to the recovery room.

The pain assessment after full recovery was performed using visual analog scale (VAS) [12]. VAS is a pain-rating scale. Scores are based on self-reported measures of symptoms that are recorded with a single handwritten mark placed at one point along the length of a 10-cm line that represents a continuum between the two ends of the scale with 'no pain' on the left end (0 cm) of the scale, and the 'worst pain' on the right end of the scale (10 cm) [13]. VAS was recorded in the post-anesthesia-care unit (PACU) and at 2, 4, 8, 12, and 24 h postoperatively. In the PACU, whenever the VAS score was more than 3, morphine 2 mg of intravenous was given every 5 min, until the VAS score is 3 or less, with the maximum dose 10 mg in the PACU, while in the surgical ward, pethidine 25-mg intravenous increments were given with a 10-min interval, whenever the VAS score was more than 3, until VAS was 3 or less. In both groups, total intraoperative and postoperative opioid consumption was recorded in the first 24 h. Intraoperative hemodynamic changes and any complications related to the interventions or drugs used were recorded. Patient's satisfaction regarding postoperative analgesia in the first 24 h was assessed by asking the patient (0=dissatisfied, 1=satisfied).

Statistical analysis

Data were analyzed using Statistical Package for Social Science (SPSS, SPSS Inc., Chicago, Illinois, USA), version 22.0. Quantitative data were expressed as mean±SD. Qualitative data were expressed as frequency and percentage.

The following tests were used: independent samples *t* test of significance was used when comparing between two means. χ^2 test of significance was used to compare proportions between two qualitative parameters.

Mann–Whitney *U* test: for two-group comparisons in nonparametric data. The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the *P* value was considered significant as the following: *P* value less than 0.05 was considered significant, *P* value more than 0.05 was considered nonsignificant.

Results

A total of 40 female patients were assessed for eligibility, randomized into two groups of 20 patients each, allocated to receive ESP block or TE block, then they were followed up for 24 h and the results were analyzed, participant flow diagram is shown in Fig. 1.

There were no statistically significant differences between groups concerning patient demographics. Tables 1 and 2 show recorded perioperative narcotic consumption. Intraoperatively, fentanyl consumption in the ESP group significantly exceeded that in the TE group, while postoperative morphine consumption in the PACU was comparable between groups. Pethidine usage in the surgical ward was significantly higher in TE group compared with ESP group (Fig. 2).

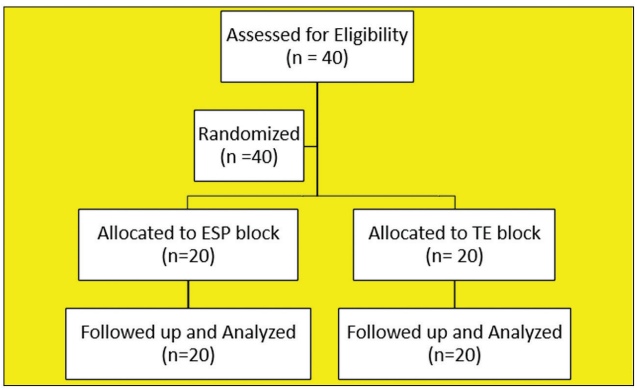
VAS values were noted in Table 3, values in PACU and 24 h after surgery were comparable, while other readings taken at 2, 4, 8, and 12 h postoperatively were significantly higher in the TE group (Fig. 3).

Table 4 shows the recorded mean arterial blood-pressure readings in the two studied groups. Readings after 10 min, 30 min, and 1 h after receiving the block were significantly lower in the TE group. Readings recorded in 8, 12, and 24 h postoperatively were significantly higher in TE group. Other readings showed no differences between groups (Fig. 4).

Table 5 shows a comparison between the two groups concerning heart rate. Thirty minutes after receiving the block, there was a statistically significantly lower reading in TE group, while readings at 8, 12, and 24 h were statistically higher in TE group. Other readings were comparable between groups (Fig. 5).

Table 6 shows that more patients (95%) were satisfied about postoperative analgesia in the ESP group when compared with TE group (only 55%).

Figure 1



Participant flow diagram representing patient's recruitment.

Table 1 Comparison between the two studied groups regarding their demographic data

Variables	ESP (*N*=20)	TE (*N*=20)	*t*	*P*
Age (years)	41.85 ± 14.89	43.4 ± 9.88	0.388	0.7
BMI (kg/m^2)	27.25 ± 5.41	28.3 ± 4.04	0.696	0.49

Data expressed as mean±SD. ESP, erector spinae plane; *t*, Student *t* test; TE, thoracic epidural. *P* value more than 0.05: nonsignificant; *P* value less than 0.05: significant.

Discussion

The need for ideal postoperative pain management is of great importance. Although TE analgesia has been considered as the golden standard, ESP block is now emerging as an efficient and easier-to-perform alternative regional intervention. The value of ESP block as a rescue analgesic technique was highlighted by Forero *et al.* [14] in a case report discussing thoracotomy after a failed epidural technique.

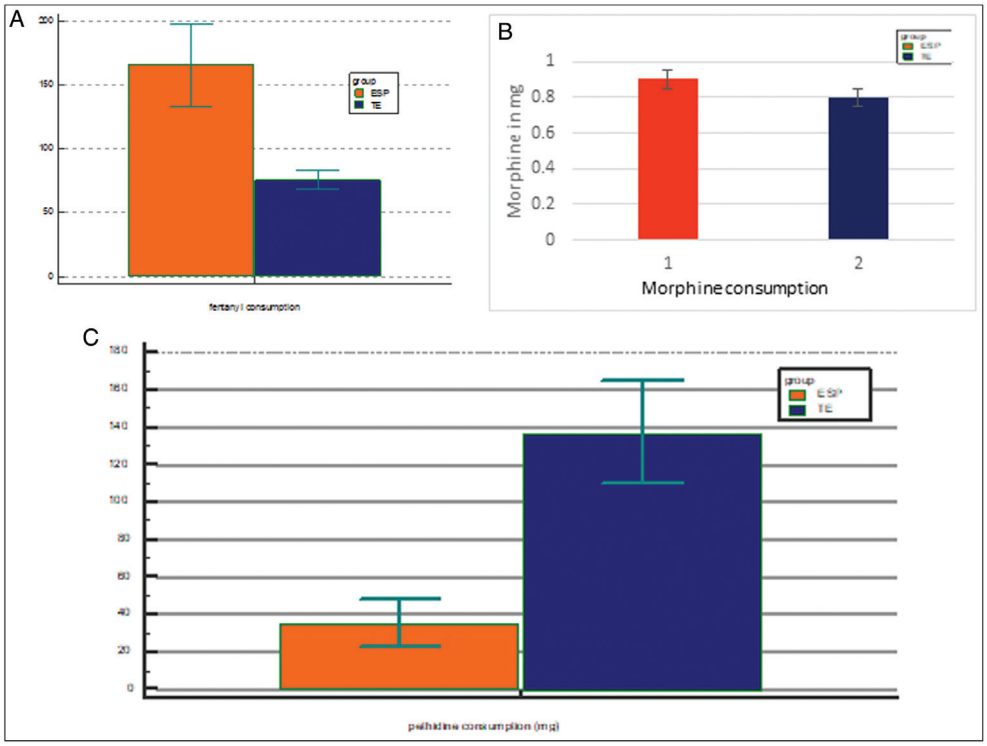
In the current study, intraoperative fentanyl usage was significantly higher in ESP block reflecting higher intraoperative analgesia induced by TE. This may be attributed to the rapid onset of TE analgesia when compared with ESP block. Once the LA is injected into the epidural space, its action takes place to the adjacent nerves. On the other hand, the ESP block takes time to reach its target and manifests its effects. Many mechanisms may be involved in ESP block to work. The most accepted one is the physical spread to nerves in the fascial plane deep into the erector spinae muscle as well as the adjacent tissue compartments [15]. It seems that this pathway needs time to take place when compared with TE. Another possible explanation for the better intraoperative analgesia of TE is the better coverage of the operative field needed for breast surgeries. Breast cancer surgeries usually extend more than the breast, including the underlying

Table 2 Comparison between the two studied groups regarding perioperative narcotic consumption

Narcotic consumption	ESP (*N*=20)	TE (*N*=20)	*t*	*P* value
Intraoperative fentanyl (μg)	165.5 ± 32.2	75.25 ± 7.5	12.2	<0.001
PACU morphine (mg)	0.9 ± 0.83	0.8 ± 0.6	0.4	0.67
Ward pethidine (mg)	35 ± 12.57	137.5 ± 27.5	15.2	<0.001

Data expressed as mean±SD. ESP, erector spinae plane; PACU, post-anesthesia-care unit; *t*, Student *t* test; TE, thoracic epidural. *P* value more than 0.05: nonsignificant; *P* value less than 0.05: significant.

Figure 2



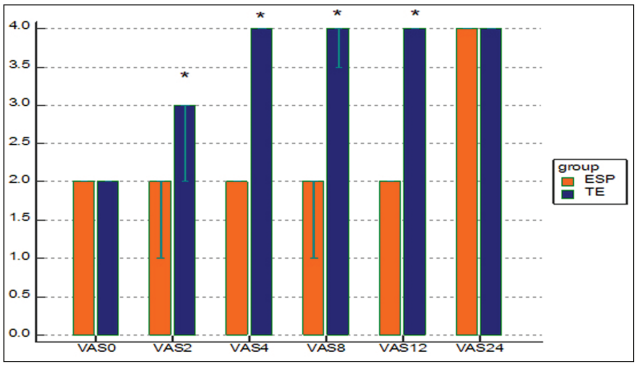
(a–c) Comparison between the two studied groups regarding perioperative narcotic consumption.

Table 3 Comparison between the two studied groups regarding visual analog scale score at different times

Time	ESP (*N*=20)	TE (*N*=20)	*Z*	*P* value
PACU	2 (2–2)	2 (2–2)	1.04	0.293
	Range (2–3)	Range (1–3)		
2 h	2 (1–2)	3 (2–3)	4.67	<0.001
	Range (1–2)	Range (2–3)		
4 h	2 (2–2)	4 (4–4)	5.64	<0.001
	Range (1–3)	Range (3–4)		
8 h	2 (1–2)	4 (3.5–4)	5.29	<0.001
	Range (1–4)	Range (3–4)		
12 h	2 (2–2)	4 (4–4)	5.7	<0.001
	Range (1–3)	Range (3–4)		
24 h	4 (4–4)	4 (4–4)	0.44	0.66
	Range (3–4)	Range (3–4)		

Data expressed as median (interquartile range) (range). ESP, erector spinae plane; PACU, post-anesthesia-care unit; TE, thoracic epidural; *Z*, Mann–Whitney test. *P* value more than 0.05: nonsignificant; *P* value less than 0.05: significant.

Figure 3



Comparison between the two studied groups regarding VAS score at different times. ESP, erector spinae plane; TE, thoracic epidural; VAS, visual analog scale. *Significant: *P* value less than 0.05.

muscles with innervations that differ from the breast. It is known that nerve supply of the breast includes the intermediate supraclavicular nerves from the lower fibers of the cervical plexus providing innervation to the upper and lateral portions of the breast, these nerves may not be blocked with ESP block. Therefore, TE analgesia was more effective intraoperatively in our study.

Postoperatively, the results of our study point out to the efficacy of ESP block in providing effective analgesia after breast cancer surgeries. This efficacy was shown in the form of significantly lower consumption of pethidine and significantly lower VAS scores. During this period of management, ESP block seems to be well-established and controlling postoperative analgesia in a good form. The interesting and beneficial note here is the duration of effect, which was long enough postoperatively to up to 12 h when compared with TE analgesia. The duration of ESP in Zhang *et al.* [16]study in 2021 extended up to 645 min when using 20 ml of 0.5% ropivacaine.

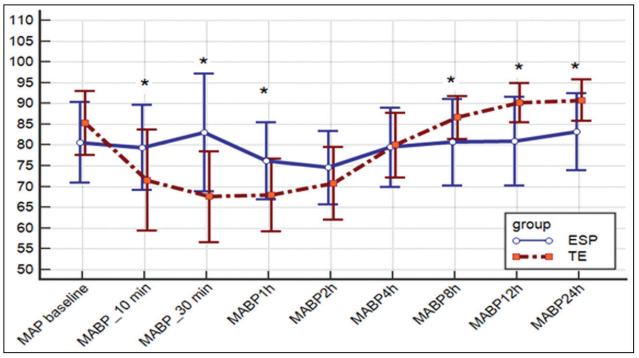
In support of our results, Nagaraja *et al.* [9] recorded VAS scores persistently less than or equal to 4 in two

Table 4 Comparison between the two studied groups regarding mean arterial blood-pressure recordings at different times

Time	ESP (*N*=20)	TE (*N*=20)	*t*	*P*
Baseline preoperative	80.65±9.72	81.25±5.74	0.24	0.81
10 min	79.45±10.24	71.6±12.2	2.2	0.034
30 min	83.1±14.16	67.6±10.91	3.88	< 0.001
1 h	76.25±9.28	68.0±8.8	2.89	0.006
2 h	74.6±8.85	70.8±8.69	1.37	0.179
4 h	79.5±9.57	80.0±7.75	0.182	0.86
8 h	80.7±10.38	86.65±5.24	2.29	0.028
12 h	80.95±10.63	90.2±4.7	3.56	0.001
24 h	83.25±9.32	90.8±4.96	3.2	0.003

Data expressed as mean±SD. ESP, erector spinae plane; *t*, Student *t* test; TE, thoracic epidural. *P* value more than 0.05: nonsignificant; *P* value less than 0.05: significant.

Figure 4



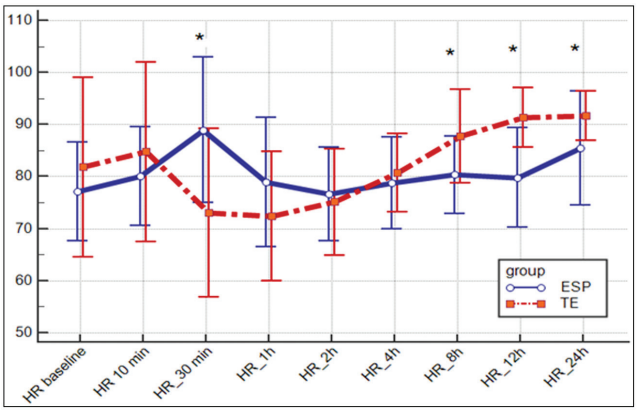
Comparison between the two studied groups regarding MAP recordings at different times. ESP, erector spinae plane; MABP, mean arterial blood pressure; TE, thoracic epidural (mmHg). *Significant: *P* value less than0.05.

Table 5 Comparison between the two studied groups regarding heart rate (bpm) recordings at different times

Time	ESP (*N*=20)	TE (*N*=20)	*t*	*P*
Baseline preoperative	76.8±9.24	77.2±10.7	0.13	0.9
10 min	80.1±9.49	84.8±17.24	1.07	0.292
30 min	88.95±14.0	73.1±16.19	3.31	0.002
1 h	78.95±12.49	72.35±12.39	1.68	0.102
2 h	76.6±8.96	75.1±10.178	0.495	0.62
4 h	78.75±8.8	80.7±7.48	0.76	0.455
8 h	80.35±7.42	87.7±9.0	2.8	0.008
12 h	79.8±9.58	91.35±5.74	4.6	<0.001
24 h	85.45±11.0	91.7±4.79	2.33	0.028

Data expressed as mean±SD. ESP, erector spinae plane; *t*, Student *t* test; TE, thoracic epidural. *P* value more than 0.05: nonsignificant; *P* value less than 0.05: significant.

Figure 5



Comparison between the two studied groups regarding HR recordings at different times. HR, heart rate, bpm; beat per minute. Significant: *P* value less than 0.05.

Table 6 Comparison between the two studied groups regarding patient satisfaction

Satisfaction	ESP [*n* (%)]	TE [*n* (%)]	χ^2 test	*P* value
Yes	19 (95)	11 (55)	6.533	0.01
No	1 (5)	9 (45)		

ESP, erector spinae plane; TE, thoracic epidural; χ^2, χ^2 test. *P* value more than 0.05: nonsignificant; *P* value less than 0.05: significant.

study groups of TE and ESP block performed for post-thoracotomy pain until 12 h postextubation in perioperative pain management in cardiac procedures. They stated that VAS scores were comparable between both groups, with the relative advantage of ESP block to be easier to perform.From review of literature, the ESP block has been studied in different modalities of surgeries with different degrees of success. Singh *et al.* [17] documented a significant decrease in the requirement of postoperative narcotic in patients undergoing modified radical mastectomies who received ESP block, and patient-satisfaction scores were better. Similarly, Gürkan *et al.* [18] in a randomized control trial on the analgesic effect of US-guided single-shot ESP for breast surgery observed a statistically significant decrease in postoperative morphine consumption, establishing its role for analgesia and postoperative opioid-sparing effect. Nair *et al.* [19] reported the efficacy of this block in a case series of five patients subjected to opioid-free mastectomy. Selvi and Tulgar [20] stated in their case reports that both visceral and somatic pain were efficiently abolished using ESP block in segmental mastectomy procedures.

In the present study, the postoperative consumption of opioids was unexpectedly high. This consumption was statistically significantly different between the two groups with the TE group utilizing as much as 137.5 mg of pethidine per patient. From these results, it is understood that a breast cancer surgery is generally a painful procedure. This may be attributed to the extent of tissue damage and extensive use of electric cautery during the surgery. Another finding is that a

single-shot TE injection with 10 ml of bupivacaine 0.25% is not enough for postoperative management of analgesia, especially when injected after induction of anesthesia and not before its termination. A higher dose may precipitate a greater drop in blood pressure than that noticed in our current study. Maybe the use of a mixture of bupivacaine and a vasoconstrictor has a role in extending the epidural-block duration. It is to be noticed that this high dosage of pethidine postoperatively may increase the incidence of postoperative nausea and vomiting, postoperative urinary retention, and ileus.

In the current study, patient satisfaction was higher in ESP block group versus TE group. This may be attributed to longer duration of analgesia provided by ESP block in the current study. Moreover, a higher degree of analgesia reflected by the lower VAS scores in the ESP block group may share in building patient satisfaction.

There are some limitations of this study. First, the sample size is limited to draw significant conclusions, and therefore, further studies with bigger sample size are advised. Second, the use of single shot in both groups rather than using a continuous mechanism with catheters to ensure prolonged postoperative satisfactory analgesia. Third, the performance of blocks after induction of anesthesia. Performance of blocks before induction of anesthesia would allow assessment of onset of the block to compare between the two types of block characteristics.

Conclusion

The current study suggests that ESP block is better than TE, as it was higher in analgesia starting from 2 to 12 h postoperatively, with less narcotic consumption, and less hemodynamic changes and easy to apply. We propose that ESP block should be included in the armamentarium of regional anesthetic techniques in the daily anesthesia clinical practice.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1 Ibrahim AS, Khaled HM, Mikhail NN, Baraka H, Kamel H. Cancer incidence in Egypt: results of the national population-based cancer registry program. J Cancer Epidemiol 2014; 2014:437971.

2 Bolin ED, Harvey NR, Wilson SH. Regional anesthesia for breast surgery: techniques and benefits. Curr Anesthesiol Rep 2015; 5:217–224.

3 Gärtner R, Jensen MB, Nielsen J, Ewertz M, Kroman N, Kehlet H. Prevalence of and factors associated with persistent pain following breast cancer surgery. JAMA 2009; 302:1985–1992.

4 Blanco R. The 'pecs block': a novel technique for providing analgesia after breast surgery. Anesthesia 2011; 66:847–848.

5 Doehring A, Oertel BG, Sittl R, Lötsch J. Chronic opioid use is associated with increased DNA methylation correlating with increased clinical pain. PAIN 2013; 154:15–23.

6 Gupta AK, McKenna WG, Weber CN, Feldman MD, Goldsmith JD, Mick R, *et al*. Local recurrence in head and neck cancer: relationship to radiation resistance and signal transduction. Clin Cancer Res 2002; 8:885–892.

7 Carvalho LA, Torre JP, Papadopoulos AS, Poon L, Juruena MF, Markopoulou K, *et al*. Lack of clinical therapeutic benefit of antidepressants is associated overall activation of the inflammatory system. J Affect Disord 2013; 148:136–140.

8 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; 41:621–627.

9 Nagaraja PS, Ragavendran S, Singh NG, Asai O, Bhavya G, Manjunath N, Rajesh K. Comparison of continuous thoracic epidural analgesia with bilateral erector spinae plane block for perioperative pain management in cardiac surgery. Ann Card Anaesth 2018; 21:323–327.

10 Ince I, Ozmen O, Aksoy M, Zeren S, Ulas AB, Aydin Y. Erector spinae plane block catheter insertion under ultrasound guidance for thoracic surgery: case series of three patients. Eurasian J Med 2018; 50:204–206.

11 Altıparmak B, Toker MK, Uysal Aİ, Turan M, Demirbilek SG. Comparison of the effects of modified pectoral nerve block and erector spinae plane block on postoperative opioid consumption and pain scores of patients after radical mastectomy surgery: a prospective, randomized, controlled trial. J Clin Anesth 2019; 54:61–65.

12 Von Baeyer CL, Bergstrom KJ, Brodwin MG, Brodwin SK. Invalid use of pain drawings in psychological screening of back pain patients. Pain 1983; 16:103–107.

13 Alexander GM, Perreault MJ, Reichenberger ER, Schwartzman RJ. Changes in immune and glial markers in the CSF of patients with complex regional pain syndrome. Brain Behav Immun 2007; 21:668–676.

14 Forero M, Rajarathinam M, Adhikary S, Chin KJ. Continuous erector spinae plane block for rescue analgesia in thoracotomy after epidural failure: a case report. A&A Pract 2017; 8:254–256.

15 Chin KJ, El-Boghdadly K. Mechanisms of action of the erector spinae plane (ESP) block: a narrative review. Can J Anesth 2021 6:1–22.

16 Zhang Y, Liu T, Zhou Y, Yu Y, Chen G. Analgesic efficacy and safety of erector spinae plane block in breast cancer surgery: a systematic review and meta-analysis. BMC Anesthesiol 2021; 21:1–2.

17 Singh S, Kumar G, Akhileshwar XX. Ultrasound-guided erector spinae plane block for postoperative analgesia in modified radical mastectomy: a randomised control study. Indian J Anaesth 2019; 63:200–204.

18 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; 50:65–68.

19 Nair AS, Seelam S, Naik V, Rayani BK. Opioid-free mastectomy in combination with ultrasound-guided erector spinae block: a series of five cases. Indian J Anaesth 2018; 62:632–634.

20 Selvi O, Tulgar S. Use of the ultrasound-guided erector spinae plane block in segmental mastectomy. Turk J Anaesthesiol Reanim 2019; 47:158–160.