

Comparative Study between Ultrasound-Guided Serratus Anterior Plane Block versus Thoracic Epidural Analgesia for Post-Thoracotomy Pain: A Prospective, Randomized, Clinical Trial

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Abstract

Objectives and Aim: Thoracotomies are widely recognized to cause acute pain which is associated with many complications. The target study aimed to assess the safety and efficacy of SAPB compared to TEA for relieving severe thoracotomy pain. **Patients and Methods:** Forty patients scheduled for thoracotomy randomly allocated either to receive SAPB or thoracic epidural (TEA). Visual analogue pain score (VAS) at rest and coughing every 6 hrs. Postoperative, hemodynamic parameters (heart rate and MAP), pain rescue analgesic consumption in the first 24 hrs., complications, and duration of hospital stay recorded. **Results:** In our study, we found that the recently described SAPB, while maintaining stable blood pressure, provided excellent analgesia comparable to that offered by TEA for acute post-thoracotomy pain. Hypotension was more noteworthy in those who had epidurals than those with serratus anterior plane (SAP) catheters. Morphine rescue analgesia, as well as Visual Analogue Scale (VAS) pain scores during normal tidal breathing, were like in both groups. **Conclusion:** We recommend that the Serratus anterior plane block appears to be a safe and effective alternative for postoperative analgesia after thoracotomy.

Keywords

Thoracotomy, Serratus Anterior Block, Thoracic Epidural

1. Introduction

Currently, multimodal approaches are used for postoperative analgesia. Regional anaesthesia methods are frequently combined with nonsteroidal anti-inflammatory drugs (NSAID) and opioids as analgesia after major surgery. Pain after thoracotomy can cause ventilation-perfusion disorder and hypoxemia, together with changes in lung mechanics [1] [2].

Treatment of acute post-thoracotomy pain is particularly important not only to keep the patient comfortable but also to decrease pulmonary complications. Many methods of pain management, for example, intercostal nerve block, cryo-analgesia, lumbar epidural, intrapleural analgesia, thoracic epidural, paravertebral block, IV narcotics, intrathecal or epidural narcotics, and transcutaneous nerve stimulation, and NSAIDs [3] [4].

Thoracic epidural analgesia (TEA) is recommended for post-thoracotomy analgesia because of its numerous benefits. In addition to providing optimum relief of acute postoperative pain, the perioperative use of TEA has also been supposed to reduce the incidence of chronic post-thoracotomy pain. However, epidural catheter placement can have failure rates as high as 30% [5].

A recent ultrasound-guided regional anaesthetic block, the serratus anterior plane block targeting the plane above or below the serratus anterior muscle in the midaxillary line had described. It believed in making analgesia to a hemithorax through blocking the lateral branches of the intercostal nerves [6].

Ultrasound-guided local anaesthetic injection in the fascial plane either superficial or deep to the serratus anterior muscle (SAM) in the lateral chest wall apparently anaesthetizes cutaneous branches of the intercostal nerves which innervating the surgical site [7].

This study aimed to assess the safety and efficacy of serratus anterior plane block (SAPB) compared to thoracic epidural analgesia (TEA) for relieving acute thoracotomy pain.

2. Patients and Methods

This study was conducted in Benha University Hospital from April 2017 to Nov. 2019. After institutional ethical committee approval, patients were evaluated prospectively at Benha University Hospital after obtaining a written consent at the anaesthesia preoperative clinic. This prospective randomized comparative clinical trial was conducted on 40 patients. Their ages ranged between 20 - 60 years of ASA physical status I, II and III, was scheduled for thoracotomy under general anaesthesia. Patients with bleeding disorders; coagulopathy, on an anti-coagulant medication, morbidly obese, patients with neurologic disorders, uncompensated cardiac, respiratory, hepatic, or renal impairment and patients with a history of allergy to drugs used in the study were excluded.

Patients were randomly allocated into two groups by using sealed envelopes prepared by a blinded assistant.

Group I (20 patients): (Serratus anterior plane block SAPB group), performed

before extubation with the injection of 30 ml of 0.25% bupivacaine followed by 5 ml/hr. of 0.125% bupivacaine.

Group II (20 patients): (Thoracic epidural group), Thoracic epidural catheter was inserted preoperatively and activated before extubation.

Full history taking, complete clinical examination, full laboratory investigation were done for all patient of both groups. One day before surgery, all patients interviewed to explain the visual analogue scale (VAS). In the preoperative room, the patient lied in the semi-sitting position (30 degrees to 45 degrees). Large size I.V. line (18 gauges) was inserted, and 500 mL of ringer lactate was administrated. Midazolam 0.02 mg /kg was given to the patient as a premedication, and O₂ supplementation 3 L/min via nasal cannula was applied. Pulse oximeter and non-invasive blood pressure cuff were connected to the patient.

At the operation room, 5-Lead ECG, non-invasive blood pressure monitoring, pulse oximeter, and temperature monitoring was applied thoracic epidural catheter was inserted under ultrasound guide in group II patients.

General anaesthesia was conducted for all patients using propofol 2 mg/kg, fentanyl 2 µg/kg, and cisatracurium 0.5 mg/kg was administrated to facilitate endotracheal intubation by 7.5 cuffed endotracheal tube. Capnography was inserted to monitor end-tidal CO₂. Anaesthesia was maintained with isoflurane (1.5%) in 50% air in oxygen mixture. All patients were mechanically ventilated using volume-controlled positive-pressure ventilation with a tidal volume of 8 mL/kg, respiratory rate 12/min, I/E ratio 1:2 to maintain end-tidal carbon dioxide tension around 35 mmHg, and peak inspiratory pressure below 30 cm H₂O.

At the end of the surgery, in group I, ultrasound-guided Serratus Anterior Plane block (SAPB) was done under sterile conditions and while the patients still on the lateral position with the diseased side up. The ultrasound transducer probe (10 - 12 MHz) was placed over the mid-axillary region of the thoracic cage in a sagittal plane. After that, we counted the rib laterally and inferiorly until reach to the fifth rib in the mid-axillary line, the needle (22 G, 50 mm Touhy needle) was introduced in-plane with respect to the ultrasound probe directed toward the plane superficial to the serratus muscle which is identified as a thick hypoechoic muscle deep to the latissimus Dorsi and is imaged over the rib [8]. Thirty mL of 0.25% bupivacaine under continuous ultrasound guidance was injected; then, a catheter was threaded. A continuous infusion of 5 ml/hr. of 0.125% bupivacaine was started through the catheter.

In group II, the thoracic epidural catheter was inserted under ultrasound guide preoperative. The ultrasound visualization of the needle improves the continuation of placing an epidural in the thoracic spine for postoperative analgesia [9].

The patients were put on the left lateral position on the operating table. At first, the midline and the location of the spinous process were checked manually. Then an ultrasound with a curved array probe (10 - 12 MHz) was used. After that, the scanning was performed by placing the probe in a transverse orientation to identify the midline and 12th rib. Then, the probe was placed in longitu-

dinal direction to determine the spinous process and ligament flavum-dura matter unit of the target spinal level. Once the Tuohy needle was visually localized in the previously mentioned position, the needle was advanced until the epidural space was detected with loss of resistance to air because the needle tip could not be visualized at all times under the US at these depths [10].

An epidural catheter was inserted 3 - 4 cm into the T6/T7 space, a loading dose of 15 ml of 0.25% bupivacaine was gradually administered under continuous monitoring of blood pressure (B.P.), and heart rate (H.R.) during injection. Then 5 ml/hr. of 0.125% bupivacaine infusion was started.

After the injection of bupivacaine in both groups, the reversal of neuromuscular block with neostigmine 0.06 mg/kg and atropine 0.02 mg/kg and the patient is extubated after fulfilling criteria of full reverse.

Demographic characteristics: Age, sex, weight and ASA physical status were recorded, and visual analogue pain score (VAS) was measured as soon as the patient is alert enough to report pain at rest and coughing every six hr.: Scale from zero (no pain) to ten (unbearable pain). Rescue analgesia in the form of morphine IV (0.1 mg/kg) was administered if the VAS scores are more than three. Also, we recorded the heart rate and mean arterial blood pressure postoperative at zero, 15 min, 30 min, 1 Hr and then every 2 hours for 24 hours. The total amount of rescue analgesic consumption was recorded in the first 24 hrs. The Duration of hospital stays from the first day postoperative until discharge was recorded. Postoperative complications, including nausea and vomiting, were recorded.

Statistical Analysis

Quantitative data were presented as mean \pm standard deviation and were analyzed by using the unpaired student t-test. Qualitative data were presented as numbers and percentages, were analyzed using the Chi-square test. Analysis data was done by using SPSS version 16. All tests were two-tailed. A p -value < 0.05 was considered significant.

The sample size was calculated based on the previous paper estimating the difference in pain score at 24 h between 2 groups with a pooled standard deviation of 4.6 between the two groups with an alpha error of 0.05 and power of 90%. A minimum of 20 patients per group was needed. The calculation of sample size was achieved by using Power and Software Version 3.1.2.

3. Results

Demographic characteristics and Duration of surgery were comparable between both groups (Table 1).

The visual analogue score showed no significant difference between groups at rest, and cough (Table 2, Table 3).

Mean arterial pressure showed a highly significant lower value in group II compared to group I (Figure 1).

Table 1. Demographic characteristics and duration of surgery.

	Group I N = 20	Group II N = 20	<i>p</i> -value
Age (yrs.)	42.6 ± 11.55	42.35 ± 12.19	0.9
Weight (Kg.)	75.2 ± 9.65	78.3 ± 11.2	0.35
Sex	♂	11 (55%)	0.52
	♀	9 (45%)	
ASA	I	5 (25%)	0.79
	II	12 (60%)	
	III	3 (15%)	
Duration of surgery (min.)	93.5 ± 31.5	95.75 ± 30.6	0.82

Data presented as mean ± SD. Gender presented as numbers.

Table 2. Visual analogue score at rest.

	Group I N = 20	Group II N = 20	<i>p</i> -value
Baseline	3 [2 - 3]	2 [2 - 3]	0.127
6 hrs.	2 [1.25 - 3]	2 [1 - 2]	0.117
12 hrs.	2 [2 - 3]	2 [1 - 2.75]	0.072
18 hrs.	2 [1 - 2.75]	2 [1 - 2]	0.238
24 hrs.	2 [1.25 - 3]	1.5 [1 - 2]	0.083

Values were given as mean, standard deviation (range).

Table 3. Visual analogue score during cough.

	Group I N = 20	Group II N = 20	<i>p</i> -value
Baseline	2 [2 - 2]	2 [1 - 2]	0.073
6 hrs.	2 [1 - 2]	2 [1 - 2.75]	0.417
12 hrs.	3 [2 - 3]	2 [2 - 3]	0.051
18 hrs.	2 [1.25 - 2.75]	1 [1 - 2]	0.115
24 hrs.	1 [1 - 2]	1 [1 - 1]	0.065

Values were given as mean, standard deviation (range).

There was no significant difference between the two groups as regard heart rate throughout the 24 hours (**Figure 2**).

There is no significant difference between the two groups as regard analgesia consumption and Duration of hospital stay (**Table 4**).

There is no significant difference between the two groups as regards to the incidence of nausea and vomiting (*p*-value more than 0.05) (**Table 5**).

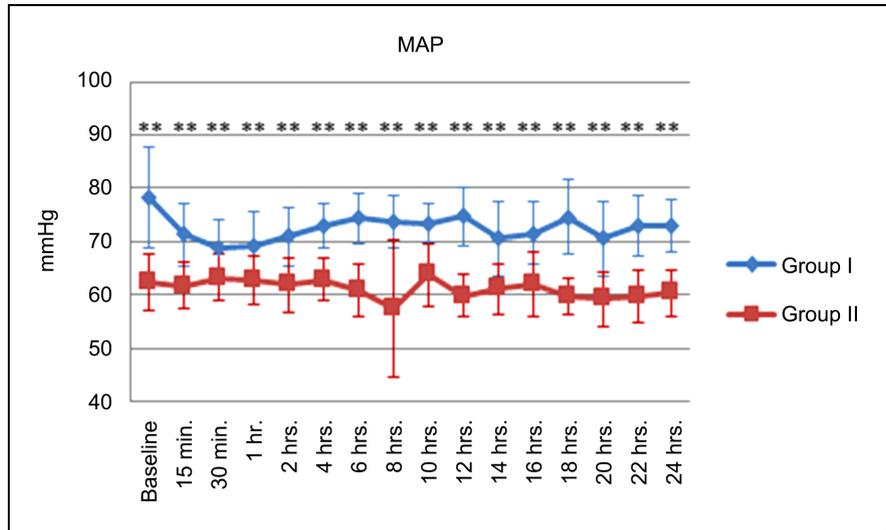


Figure 1. Mean arterial pressure.

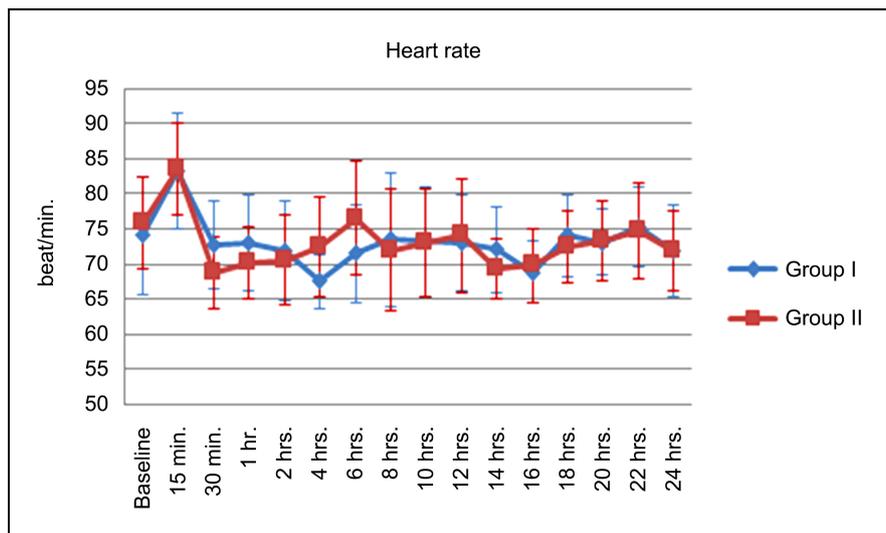


Figure 2. Heart rate.

Table 4. Analgesia consumption and Duration of hospital stay.

	Group I N = 20	Group II N = 20	p-value
analgesia consumption (mg)	10.2 ± 1.71	9.27 ± 0.60	0.07
Duration of hospital stays (Day)	2.5 ± 0.9	2.35 ± 0.82	0.58

Values are expressed when Mean ± SD.

Table 5. Postoperative complications.

	Group I	Group II	p-value
Nausea	2 (10%)	1 (5%)	0.548
Vomiting	1 (5%)	1 (5%)	1.000

4. Discussion

Pain after many surgical procedures has been treated with multimodal analgesia approach. These methods combine intravenous drug administration with regional anaesthesia procedures. These methods reduce the side effects of opioids in analgesic doses and improve patient comfort [11] [12].

The SAP block is a new regional block technique for providing thoracic analgesia. The SAP block was initially proposed for breast surgery, but its applications have later been extended and are now often used in thoracic surgery. Various studies have established that postoperative pain scores and additional opioid requirements and related adverse effects can be reduced by supplementing a multimodal analgesic regimen with an SAP block [13]. TEA is an alternative method for relieving of post-thoracotomy pain, but it may be ineffective in some cases. This may be due to incorrect placement, secondary migration of catheter, sub-optimal doses of epidural drugs (volume or concentration) or patchy or unilateral effect of medications. Alternatives to TEA include paravertebral, intercostal, inter-pleural and Ultrasound-guided serratus anterior plane block [14].

This study aimed to assess the safety and efficacy of serratus anterior plane block (SAPB) compared to thoracic epidural analgesia (TEA) for relieving acute thoracotomy pain.

The visual analogue pain scores (VAS) were measured at rest and coughing every 6 hrs postoperative. There was no significant difference between both groups. These results agree with Semyonov *et al.* [15] that studied Ultrasound-guided serratus anterior plane block for analgesia after thoracic surgery.

Also, this current study goes with the research done by (Saad *et al.* [16]) who compared thoracic Paravertebral Block (TPVB) and Serratus Anterior Plane Block (SAPB) for perioperative analgesia in thoracotomy. Saad *et al.* compared the VAS score in TPVB and SAPB groups, and they found it significantly lower when compared to the control group up to 9 h postoperatively. Also, they recorded a lower consumption of total intraoperative fentanyl in TPVB and SAPB Groups when compared to the control group. The majority of TPVB Group cases did not need rescue morphine, while the majority of the control group required two doses ($P < 0.001$).

This current study disagrees with (Gupta *et al.* [17]) who studied the analgesic efficacy of ultrasound-guided paravertebral block versus serratus plane block for modified radical mastectomy. Results showed that the Duration of analgesia (mean \pm SD) was significantly longer in the PVB group compared to the SAPB group (346 ± 57 min vs 245.6 ± 58 min, $P < 0.001$). The post-operative 24 h morphine consumption (mean \pm SD) was significantly higher in the SAPB group (9.7 ± 2.1 mg) compared to PVB group (6.5 ± 1.5 mg) ($P < 0.001$).

As regard hemodynamic parameters (mean arterial blood pressure and heart rate), the present study showed a significant difference in MAP with a substantial decrease in MAP in group II (TEA group) than in group I (SAPB group) with no significant statistical difference between both groups as regard heart

rate.

The current study agrees with Khalil *et al.* [18] who compared the Ultrasound-guided serratus anterior plane block versus thoracic epidural analgesia for thoracotomy pain. They found that the mean arterial pressure in the SAPB group did not change significantly ($p = 0.181$), whereas it was significantly lower ($p = 0.006$) in the TEA group.

In addition, Biswas *et al.* [19] found that the incidence of hypotension and bradycardia in patients receiving thoracic epidural was significantly higher (23.3% and 6.67% respectively) as compared to TPVB.

Oktavia, [20] found that hypotension (80%) and bradycardia (40%) were more frequent in TE. Lahiri *et al.* [21] found that the incidence of hypotension was 13.3%, and bradycardia was 16.6% in the TE. Rajan *et al.* [22] reported that the incidence of hypotension was 26.6%, and bradycardia was 20% in the TE.

Biswas *et al.* [19] found that the incidence of nausea and vomiting was similar in epidural and paravertebral in thoracotomy patients. The use of opioid with LAs infusion might explain the similarity of the incidence. In addition, the result of the current study agrees with that of Gupta *et al.* [17], who reported that two patients in each group had Nausea and vomiting and there was no major complication.

5. Conclusion

Serratus anterior plane block provides adequate regional anaesthesia which is a safe alternative for postoperative analgesia after thoracotomy. Further studies are recommended to support this finding.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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