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## Evading Post Thoracotomy Pain Functionally Assessed with Spirometer Using Regional Anesthetic Techniques; A Randomized Controlled Trial

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### Abstract

**Background:** Lung cancer has the highest incidence of all malignancies worldwide and accounts for approximately 13% of all cancer cases. **Aim:** To evaluate the impact of thoracic epidural compared to ultrasound (US) guided erector spinae plane block (ESPB) and to US guided serratus anterior plane block (SAPB) on controlling acute PTP functionally assessed with spirometer use and perioperative complications in patients undergoing operations for lung cancer through thoracotomy incision. **Patients and methods:** This single blinded randomized controlled trial was conducted on 111 patients scheduled for thoracic operations through lateral thoracotomy. They were randomly assigned into 3 equal groups (37 patients each). **Group 1:** thoracic epidural infusion group, **Group 2:** ESPB group and **Group 3:** SAPB group. The study was done at National Cancer Institute Cairo University from December 2021 to March 2023. **Results:** There was no statistical significance upon comparison of demographic data, lung procedures, and duration of surgery of the three groups (P value > 0.05). Spirometry use (Number of patients able to raise 2 balls) was insignificantly different among the three groups. also PONV, hypoxia, infection rate and LA toxicity. **Conclusion:** All three techniques (TEA, SAPB, and ESPB) are effective in PTP, as patients were able to use the spirometer after surgery, also in development of postoperative complications.

**Key words:** TEA, PTP, ESPB, SAPB

## Introduction

Lung cancer has the highest incidence of all malignancies worldwide and accounts for approximately 13% of all cancer cases (1). In addition to amputation and mastectomy, thoracotomy is considered the main etiology of severe acute and long-term chronic post-surgical pain syndromes (CPSPs)(2).

Regional analgesic techniques include thoracic epidural analgesia (TEA), which is considered by many as the gold standard analgesic technique for post-thoracotomy pain (3). Other regional analgesic techniques include paravertebral analgesia (PVB), erector spinae, intercostal nerve blocks and intrapleural analgesia. All of these techniques are invasive procedures that require a normal coagulation profile and no sepsis, and most of these strategies (TEA and PVB) are neuraxial techniques with their own risks (4).

Serratus anterior plane block (SAPB) was described as a procedure in which the local anesthetic (LA) is injected either superficially or deeply into the muscle. SAPB has been practiced more widely as a bed side, ultrasound (US) guided, simple technique for effective post-thoracotomy analgesia with easy sonoanatomy and higher success rate comparable to the standard techniques such as TEA and PVB, yet devoid of their hemodynamic and serious respiratory and neuro-axial sequelae (5).

The ultrasound-guided erector spinae plane (ESP) block is a novel technique for thoracic region analgesia that promises to be a relatively simple and safe alternative to more complex and invasive techniques of neural blockade. We have explored the application of the ESP block in the use of spirometry and report our preliminary experience to illustrate its therapeutic potential (6).

This study aimed to evaluate the impact of thoracic epidural compared to ultrasound (US) guided ESPB and to US guided serratus anterior plane block (SAPB) on use of spirometry as indicator of acute PTP in patients undergoing operations for lung cancer through thoracotomy incision.

## Patients and methods

This single blinded randomized controlled trial was conducted on 111 patients ASA II, III scheduled for thoracic operations through lateral thoracotomy under general anesthesia. Patients were randomly assigned into 3 equal comparable groups using computer generated random numbers in opaque closed envelopes. Group 1 thoracic epidural infusion group (n=37) patients received thoracic epidural preoperative, Group 2 (erector spinae plane block ESB) (n=37) patients received ultrasound guided erector spinae plane block preoperative with injection of 30 ml levobupivacaine 0.25% and insertion of catheter and Group 3 (Serratus Anterior Plane Block SAPB) (n=37) patients received ultrasound guided serratus anterior plane block preoperative with injection of 30 ml levobupivacaine 0.25%. Five patients dropped out in group 1 (n=32), 3 patients dropped out in group 2 (n=34) and 3 patients dropped out in group 3 (n=34). The study was done at National Cancer Institute Cairo University from December 2021 to march 2023

**Clinical trials no:** NCT05409144

### Ethical considerations:

Informed consent from patients after approval from the Ethical Committee from Faculty of Medicine, Cairo University. There are adequate provisions to maintain privacy of participants and confidentiality of the data.

**Inclusion criteria:** Type of surgery; thoracic surgery through lateral thoracotomy, physical status ASA II, III, age (18-65) Years and body mass index (BMI): (20-40) kg/m<sup>2</sup>.

**Exclusion criteria:** Patient refusal, age <18 years or >65 years, BMI <20 kg/m<sup>2</sup> and >40 kg/m<sup>2</sup>, patients with known sensitivity or contraindication to drugs, contraindication to regional anesthesia, pre-existing peripheral neuropathies, coagulopathy, pregnancy, physical status ASA IV, chronic analgesic therapy, drug abuse history, neuropsychiatric diseases, chronic pain syndromes, thoracic surgery history, severe intra- or post-operative bleeding, postoperative mechanical ventilation, and thoracic spine disorders or deformity. The exclusion criteria included patients with a history of drug abuse, neuropsychiatric diseases, chronic pain syndromes, thoracic surgery history, and recurrent chest malignancies.

**Sample Size:** A randomized Controlled trial aiming to assess the development of postoperative pain affecting spirometer usage post thoracotomy surgery. Comparing the previously mentioned block with ratio 1:1, based on **David J Harris et al, (7) & Nadia Hernandez et al., (8)** (the proportion of patients with postoperative spirometer affection in epidural group was 0.62% while in serratus anterior plane block it

was 0.22, so we need to study 37 participant per group (total 111 participants) to be able to reject the null hypothesis that the population proportion in participant undergoing epidural infusion versus continuous serratus anterior plane block versus continuous Erector Spinae plane block are equal with probability (power) 0.95. The Type I error probability associated with test of this null hypothesis is 0.05. Sample size was calculated using PS program.

## Methods

**Epidural technique:** The epidural needle is inserted between vertebral spinous processes, and lidocaine is injected to reduce discomfort. The needle advances through the skin, subcutaneous tissue, supraspinous, and interspinous ligaments, then removes the stylet and the Loss of Resistance syringe. The needle advances while applying pressure to the plunger, piercing the ligamentum flavum, which is the epidural space. 5 to 10 cc of saline is injected to expand the space, reducing the risk of vascular injury. The epidural catheter is then advanced inside the needle, aiming to leave its tip 5 to 6 cm into the space. The catheter is then withdrawn, aiming to leave its tip 5 to 6 cm into the space. A 3 cm syringe is used to aspirate and rule out CSF leakage. If CSF is detected, the catheter may be in the intrathecal space and relocated. A test dose is performed to rule out the intravascular position of the catheter, using 3mL of 1.5% lidocaine with epinephrine (1 to 200000). An increase in HR of 20 to 30 bpm or 15 to 20 mmHg in systolic blood pressure may indicate intravascular injection (9).

### Erector spinae plane block Technique;

The block was performed with full aseptic precautions, with the block level at T5. An ultrasound probe was placed on the back to identify the tip of the T5 transverse process, which is recognizable as flat, squared-off acoustic shadows. The probe was rotated into a longitudinal orientation to produce a parasagittal view, showing layers such as skin and subcutaneous tissue, trapezius, erector spinae muscle, and T5 transverse process. A lidocaine solution was used to skin and subcutaneous fat. An echogenic block needle was inserted in-plane to the ultrasound beam until contact with the T5 transverse process. The needle tip was confirmed by injecting 0.5-1 ml normal saline, lifting the erector spinae muscle off the transverse process without distending the muscle. After aspiration to avoid intravascular injection, 30 ml levobupivacaine was performed and separation was seen (10).

### Serratus Anterior Plane Block Technique:

The patient underwent a block operation with full aseptic precautions, using an ultrasound probe placed on their midaxillary line. The patient's rib, pleural line, and overlying serratus anterior and latissimus dorsi muscles were visualized. 3ml lidocaine 1% was used for skin and subcutaneous fat, and a 38-mm 22-gauge regional block needle was advanced in-plane at an angle of 45 degrees towards the fifth rib. 30ml of levobupivacaine 0.25% was injected anteriorly to the rib and deep to the serratus anterior muscle. The needle was visualized at all times, and care was taken to avoid vessels while traversing soft tissue (11). In both blocks Fujifilm Sonosite M-Turbo Ultrasound system used.

### Outcomes:

Spirometry use in 3 groups.

## Results

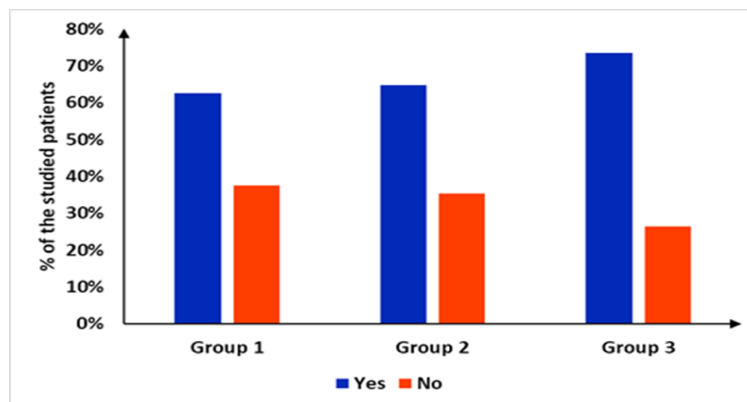
**Table (1):** Patients' characteristics and lung procedures and duration of surgery of the studied groups. Data were presented as: Mean  $\pm$  SD, (Range), patient number and (percentage) %

		Group 1 (n=32)	Group 2 (n=34)	Group 3 (n=34)	P value
Age (years)	Mean $\pm$ SD	52.8 $\pm$ 6.08	51.3 $\pm$ 5.93	51.3 $\pm$ 5.78	0.521
	Range	44 – 62	40 – 63	43 - 65	
Sex	Male	19 (59.38%)	22 (64.71%)	19 (55.88%)	0.756
	Female	13 (40.63%)	12 (35.29%)	15 (44.12%)	
Weight (kg)	Mean $\pm$ SD	75.6 $\pm$ 7.91	76.9 $\pm$ 13.07	73.8 $\pm$ 10.96	0.516
	Range	62 – 90	55 – 97	56 - 89	

Height (m)	Mean $\pm$ SD	1.68 $\pm$ 0.07	1.66 $\pm$ 0.07	1.66 $\pm$ 0.07	0.407
	Range	1.54 - 1.81	1.56 - 1.79	1.54 - 1.79	
BMI (kg/m <sup>2</sup> )	Mean $\pm$ SD	28.4 $\pm$ 8.66	27.8 $\pm$ 4.91	26.9 $\pm$ 4.43	0.612
	Range	21.3 - 71	21.2 - 36.5	21.7 - 37.1	
ASA physical status	II	19 (59.38%)	18 (52.94%)	16 (47.06%)	0.605
	III	13 (40.63%)	16 (47.06%)	18 (52.94%)	
Lung resection procedures	Wedge resection	4 (12.12%)	3 (8.82%)	2 (5.88%)	0.683
	Pleuro-pneumonectomy	6 (18.18%)	5 (14.71%)	4 (11.76%)	
	Lobectomy	13 (39.39%)	10 (29.41%)	15 (44.12%)	
	Pneumonectomy	9 (28.13%)	16 (47.06%)	13 (38.24%)	
Duration of surgery (min)	Mean $\pm$ SD	148 $\pm$ 17.64	150.9 $\pm$ 18.52	157.9 $\pm$ 18.55	0.085
	Range	120 - 185	120 - 180	125 - 185	

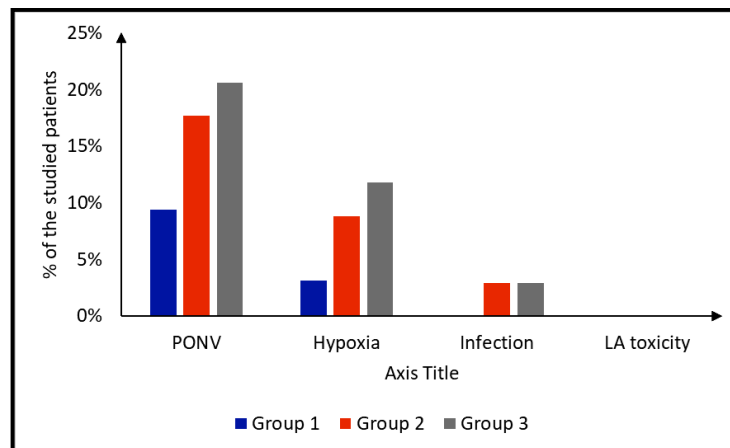
\*p value is insignificant  $\geq 0.05$

There was no statistical significance upon comparison of demographic data, lung procedures, and duration of surgery of the three groups (P value > 0.05) (Table 1).



**Figure 1:** Spirometry use (Number of patients able to raise 2 balls) of the studied groups.

Spirometry use (Number of patients able to raise 2 balls) was insignificantly different among the three groups (Figure 1).



**Figure (2):** Side effects of the studied groups

PONV, hypoxia and infection were insignificantly different among the three groups. LA toxicity did not occur in any patient in the three groups p value is insignificant  $\geq 0.05$  (Figure 3).

## Discussion

Thoracotomy is a very painful incision, with significant trauma and distraction forces involving several muscles and fascial layers, ribs, neurovascular bundles and pleura that are exaggerated with continuous movement during patient breathing (12).

Acute post-thoracotomy pain (PTP) is one of the most severe, debilitating pains and occurs as a result of skin incision, rib retraction, intercostal nerve injury, and intercostal and serratus anterior muscle damage. Acute PTP may result in some serious complications such as pulmonary complications, due to ineffective coughing, which leads to retention of secretion, in the short term; and chronic PTP in the long term (13).

There are several methods to control PTP. Systemic opioids have many side effects, such as respiratory depression, constipation, and increased risk of postoperative nausea and vomiting. Weaker analgesics, such as nonsteroidal anti-inflammatory analgesics, are not sufficient to treat the severe pain that accompanies thoracotomy and these also have many side effects, such as risk of peptic ulcers, gastrointestinal bleeding, and renal impairment. Similarly, opioids with intermediate potency (e.g., tramadol) do not manage PTP adequately in most of the cases (14).

Locoregional techniques are various of them. 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% (3).

Serratus anterior plane block (SAPB) is one of the interfascial plane blocks that acts by diffusion of local anesthetics (LA) between fascial planes to reach the lateral cutaneous branches of the intercostal nerves. Unlike TEA, SAPB does not block the autonomic nervous system or lead to adverse events such as epidural hematoma and spinal cord injury. Moreover, identification of SAPB sonoanatomy is not difficult, especially with the shallow needle angle allowing easy administration of the block (11).

Erector spinae plane block (ESPB) was reported as a treatment for thoracic neuropathic pain. Erector spinae plane block is a relatively simple technique with easily identified sonographic landmarks, and a catheter is easily inserted into the plane after distention induced by the injection. In addition, the ESPB has the potential to provide both somatic and visceral sensory blockade. It is a novel, relatively safe, and simple technique. It usually provides effective and immediate analgesia for many thoracolumbar procedures (10). This study showed that there was no statistical significance upon comparison of demographic data, lung procedures, and duration of surgery of the three groups (P value  $> 0.05$ ). Spirometry use (Number of patients able to raise 2 balls) was insignificantly different among the three groups.

**Nagaraja et al., (15)** performed a study on 50 patients who divided into two groups, TEA group (n = 25) patients received bolus dose of 0.25% plain bupivacaine 15 ml was administered. ESPB group (n = 25) received bolus dose of 0.25% bupivacaine 15 ml. They noticed that Intraoperative fentanyl and Spirometry use were insignificantly different between TEA group and ESP group.

In the current study, PONV, hypoxia and infection were insignificantly different among the three groups. LA toxicity did not occur in any patient in the three groups.

Similarly, **Taha et al., (16)** and **Ekinci et al., (17)** noticed that PONV was insignificantly different between ESPB group and SAPB group.

## Conclusion

All three techniques (TEA, SAPB, and ESPB) are effective in PTPS, as patients were able to use the spirometer after surgery, and considered safe techniques regard postoperative complications.

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