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Ipsilateral -Thoracic Ultrasound-Guided Erector Spinae Plane Block Efficacy in Preventing Post-Thoracotomy Pain in Thoracic Cancer Surgeries

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Abstract:
Background: Post-thoracotomy pain is a significant issue in thoracic surgery. This work evaluated the effectiveness of ipsilateral thoracic ultrasound (US)-guided erector spinae plane block (ESPB) in controlling post-thoracotomy pain.
Methods: This retrospective study was conducted on 20 patients aged 18 to 60, classified as American Society of Anesthesiologists (ASA) physical status II and III, scheduled for thoracic surgery. Patients received ESPB using 15 ml of 0.25% bupivacaine under US guidance, followed by epidural anaesthesia. Postoperative pain management involved epidural infusion of 0.25% bupivacaine and rescue analgesia as needed.
Results: Heart rate measurements at 6 h and mean arterial blood pressure measurements at 2h, 6h and 24h were significantly lower than 1h ($P < 0.05$). Oxygen saturation measurements at 2, 6, 12 and 24 h were significantly elevated compared to 1h ($P < 0.05$). Visual analogue scale scores at 2h and 6h were significantly decreased compared to 1h ($P = 0.003$ and 0.002, respectively). The mean value (±SD) of intraoperative fentanyl dose was 202.5 (± 37.96) µg. The mean value (±SD) of time to 1st rescue analgesic was 6.9 (± 7.66) h. The total rescue analgesic doses' mean value (±SD) was 1.9 (± 0.75). The mean value (±SD) of the number of postoperative epidural bolus was 0.9 (± 0.72).
Conclusions: Ipsilateral thoracic US-guided ESPB effectively manages post-thoracotomy pain in thoracic cancer surgeries as it improves pain scores and maintains hemodynamic stability.upstream. Additionally, for all models, the material harvesting pit was moved downstream.
Keywords:Efficacy, Erector spinae plane block, Post-thoracotomy pain, Thoracic surgeries.

1. Introduction

Post-thoracotomy pain is a significant concern in thoracic cancer surgeries, as it results in prolonged hospital stays, increased morbidity, and a higher risk of chronic pain [1]. The current methods of post-thoracotomy pain management, such as epidural analgesia and thoracic paravertebral block, have limitations, including hypotension, motor blockade, and hematoma [2].

The erector spinae plane block (ESPB) has gained popularity as a promising alternative for postoperative analgesia due to its ease of performance, minimal sedation requirements, and potential for continuous infusion [3].

ESPB is a regional anaesthetic approach that targets the erector spinae (ES) plane between the ES muscles and the vertebrae's transverse processes (TP). By injecting local anaesthetic (LA) into this plane, ESPB blocks sensory nerves that innervate the thoracic wall, providing analgesia for the chest and abdomen [4].

Ipsilateral ESPB involves injecting LA into the ES plane on the same side as the surgical incision. The ipsilateral ESPB approach allows for targeted analgesia of the surgical site, reducing pain and discomfort [5].

The efficacy of ESPB in managing postoperative pain was reported in various surgical procedures, including thoracotomies [6], and lumbar fusions [8]. ESPB and thoracic paravertebral block provide the same analgesia [9]. ESPB has been used successfully in video-assisted thoracic surgeries [10] and minimally invasive thoracic surgeries [11]. Additionally, ESPB reduces opioid consumption and improves postoperative quality of recovery in thoracic surgeries [12].

Despite the widespread use of ESPB in thoracic surgeries, its efficacy in the management of post-thoracotomy pain, specifically in thoracic cancer surgeries, has not been extensively studied [13]. Thus, this work evaluated ipsilateral thoracic US-guided ESPB effectiveness in controlling post-thoracotomy pain.

Patients and Methods:

This retrospective study was performed on 20 patients aged 18 to 60, classified as American Society of Anesthesiologists (ASA) physical status II and III, scheduled for thoracic surgery. The research was conducted between April 2022 and October 2024 after authorization from Cairo University Hospitals Ethical Committee, Egypt. Patients gave informed written consent.

Participants were excluded if they exhibited infection at the injection site or coagulopathy, including hereditary disorders or acquired conditions. Additional exclusion criteria included unstable cardiovascular disease, psychiatric or cognitive disorders, and allergies to medications used.

Patients underwent a thorough history, physical examination, and routine laboratory tests. Electrocardiograms (ECGs) were performed for individuals over 40, and pulmonary function tests (PFTs) were conducted as needed for high-risk patients.

In the preoperative holding area, patients underwent continuous monitoring of their vital signs. Intravenous (IV) cannulas were placed, and 0.02 mg/kg midazolam was administered. Additionally, Ringer's acetate solution was infused at a volume of 7-10 ml/kg 30 minutes before the surgical procedure.

Under strict aseptic settings, the skin was infiltrated with 2 ml lidocaine 1%. An 18-gauge Tuohy needle with a 20-gauge epidural catheter was inserted through the T6-T7 vertebral interspace, and the identification of the epidural space relied on applying the loss of resistance technique. The catheter was directed approximately 3 cm in a cephalad direction. A test dose of 3 ml lidocaine 1% containing epinephrine at a ratio of 1:200,000 was given to identify any unintentional intrathecal or IV injection. Then, 15 ml epidural bupivacaine 0.25% was injected.

Next, the US probe was positioned longitudinally, 2-3 cm lateral to the T4 spinous process, allowing visualization of the T4 TP in real-time US guidance. The ES muscle was identified above the T4 TP, and the needle was inserted in a cranial-to-caudal direction using an in-plane US-guided technique. A 5 mL normal saline bolus was injected into the interfascial plane between the ES muscle and the TP. After the hydro dissection, 15 mL of 0.25% bupivacaine was injected, and LA linear spread was observed within the interfascial plane. Dermatome evaluation using a cold test, and a successful block was defined as anaesthesia covering the C3-C5 to T4-T5 dermatomes.

Anaesthesia was induced using IV propofol at a dose of 2-3 mg/kg, fentanyl at 2 μg/kg, and rocuronium at 0.5-0.8 mg/kg. Maintenance of anaesthesia was achieved with isoflurane (1-2%) in a 50% air-oxygen mixture. Patients were intubated and mechanically ventilated using volume-controlled positive pressure ventilation, with a tidal volume of 6-8 mL/kg and an inspiratory to expiratory (I: E) ratio of 1:2, to maintain an end-tidal carbon dioxide tension around 35 mmHg.

Heart rate (HR) and mean arterial blood pressure (MAP) were monitored after the administration of LA and then every 5 minutes throughout the surgical procedure.

Postoperative analgesia was provided by a continuous epidural infusion of 0.25% bupivacaine at a rate of 0.1 mL/kg/h for 24 hours. Additionally, patients received scheduled doses of paracetamol 1 g every 8 hours. If patients reported severe thoracic pain, defined as a visual analogue scale (VAS) score of ≥3 at any assessment point, they received a supplemental 0.1 mL/kg bolus dose of 0.25% bupivacaine epidurally, and the infusion rate was increased.

Post-thoracotomy ipsilateral pain was assessed using the VAS. Patients reporting pain with a VAS score of ≥3 were administered 50 mg of IV tramadol as rescue analgesia. The time to first request rescue analgesia and the total number of rescue analgesic doses required over the 24-hour postoperative period were noticed.

Statistical analysis

Data analysis was performed using SPSS 26 (IBM Inc., Chicago, IL, USA). The normality of the data distribution was assessed using the Shapiro-Wilks test and visual inspection of histograms. Parametric data were presented as mean ± SD and compared using repeated measures ANOVA, while non-parametric data were presented as median (IQR) and compared using the Wilcoxon test. Qualitative variables were presented as frequency (%). A two-tailed p-value < 0.05 was considered statistically significant.

Results

The mean value (±SD) of age was 42.9 (± 13.15) years. Regarding sex, 9 (45%) patients were males. The mean value (±SD) of weight was 81.4 (± 11.6) kg. The mean value (±SD) of height was 1.68 (± 0.07) m. body mass index's mean value (±SD) was 28.9 (± 4.94) kg/m2. ASA physical status was I in 12 (60%) patients and II in 8 (40%) patients. The mean value (±SD) of the duration of surgery was 162.6 (± 26.83) min. The type of surgery was metastasectomy in 9 (45%) patients, pneumonectomy in 1 (5%) patient, pleuro-pneumonectomy in 5 (25%) patients and Lobectomy in 5 (25%) patients. Table 1

HR measurements at 2, 12, and 24 h were insignificantly different compared to 1h and significantly decreased at 6h compared to 1h (P =0.01). MAP measurements at 12 h were insignificantly different compared to 1h and significantly decreased at 2 h, 6 h and 24 h compared to 1h (P <0.05). Figure 1

VAS scores at 12 and 24 h were insignificantly different compared to 1h. VAS scores at 2 and 6 h were significantly decreased compared to 1h (P =0.003 and 0.002 respectively). Figure 2

The mean value (±SD) of intraoperative fentanyl dose was 202.5 (± 37.96) µg. The mean value (±SD) of time to 1st rescue analgesic was 6.9 (± 7.66) h. The total rescue analgesic doses' mean value (±SD) was 1.9 (± 0.75). The mean value (±SD) of the number of postoperative epidural bolus was 0.9 (± 0.72). Table 2

Table 1: Preoperative data of the studied patients

		N=20
Age (years)	42.9 ± 13.15	
Sex	Male	9 (45%)
	Female	11 (55%)
Weight (kg)	81.4 ± 11.6	
Height (m)	1.68 ± 0.07	
BMI (kg/m2)	28.9 ± 4.94	
ASA physical status	I	12 (60%)
	II	8 (40%)
Duration of surgery (min)	162.6 ± 26.83	

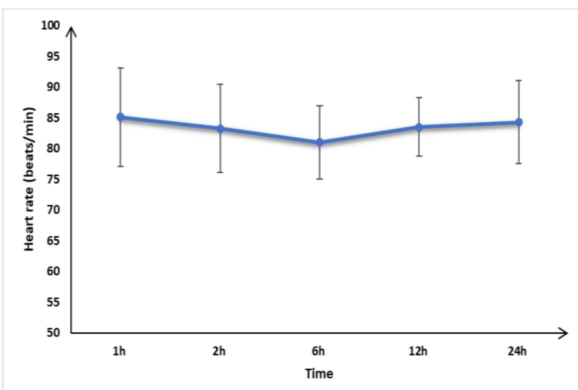
Type of surgery	Metastatectomy	9 (45%)
	Pneumonectomy	1 (5%)
	Pleuro-pneumonectomy	5 (25%)
	Lobectomy	5 (25%)

Data are presented as mean ±SD or frequency (%). ASA: The American Society of Anesthesiologists.

Table 2: Intraoperative and postoperative data of the studied patients

	N=20
Intraoperative fentanyl dose (µg)	202.5 ± 37.96
Time to 1st rescue analgesic (h)	6.9 ± 7.66
Total number of rescue analgesic doses	1.9 ± 0.75
Number of postoperative epidural bolus	0.9 ± 0.72

Data are presented as mean ±SD.



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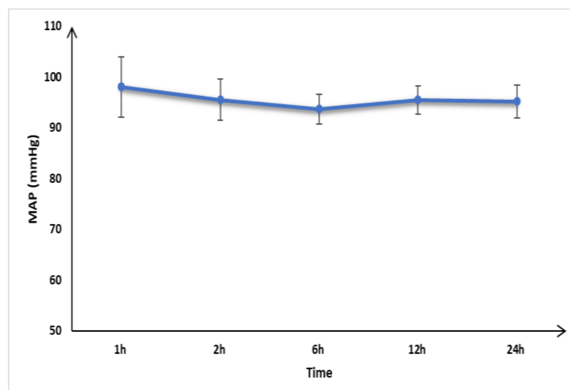

(B)

Figure 1: (A) heart rate and (B) mean arterial blood pressure measurements of the studied patients.

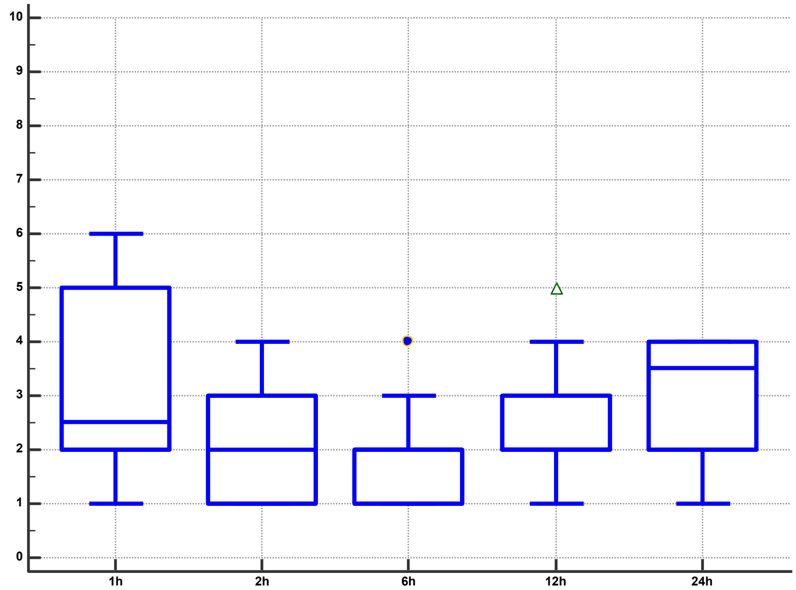

Figure 2: VAS score of the studied patients

Discussion

Thoracic pain following thoracotomy surgery is a significant problem that can lead to severe complications and even death [14]. One effective way to prevent these complications is to use preemptive analgesia, which involves administering pain relief medication before the procedure [15]. Research has shown that ultrasound (US)-guided regional interfascial nerve blocks are a simple and effective alternative to other pain management options [16]. These blocks target thorax and abdomen cutaneous nerves and are easier to perform than other regional block techniques, with a lower risk of injury [17].

ESPB is often effective and provides immediate pain relief for various thoracolumbar procedures. The addition of ultrasonographic guidance enhances the practical value of this block by allowing for targeted drug injection away from neurovascular structures and the pleura [18, 19]. Moreover, the TP acts as a sonographic landmark and backstop for needle insertion, making the procedure more efficient, safe, and easy to perform [20].

Several studies have used cadaveric and multislice CT imaging to illustrate the spread of injectate in ESPB [21, 22]. These studies have found that solutions of LA induce a sensory multidermatomal blockade across chest walls (posterior, lateral, and anterior) due to the blocking of spinal nerve roots ventral, dorsal, and lateral rami as the injectate diffuses through medial, lateral, and craniocaudal directions in the interfascial planes, through the costotransverse foramen, the intervertebral foramina, and into the paravertebral and epidural spaces [21, 22]. Additionally, ESPB may block the rami communicans of the sympathetic chain, which could explain the efficacy of ESPB in relieving somatic, visceral, neuropathic, and myofascial components of PTPS [23].

In our study, HR measurements were significantly lower at 6 hours than at 1 hour. MAP measurements were significantly improved at 2, 6, and 24 hours compared to 1 hour. Oxygen saturation measurements were significantly higher at 2, 6, 12, and 24 hours compared to 1 hour. VAS scores were significantly reduced at 2 and 6 h compared to 1 hour. The mean intraoperative fentanyl dose was 202.5 ± 37.96 µg, the time to the first rescue analgesic was 6.9 ± 7.66 hours, total number of rescue analgesic doses was 1.9 ± 0.75, and number of postoperative epidural bolus was 0.9 ± 0.72.

In agreement with our investigations, Soltan et al. [24] stated that pain scores were improved at 4, 7, 12, 18 and 24 hours compared to 1 hour. The time to the first rescue analgesic was 8 ± 0.5 h hours.

Also, Liang et al. [25] noted that ESPB improved post-thoracotomy pain scores. The median intraoperative opioid consumption was 199.7 (134.5-299.1) µg. Additionally, Fiorelli et al. [26] noted that ESPB improved post-mini-thoracotomy pain scores.

Abdelhaleem et al. [27] noted that study ESPB improved postoperative pain. The mean intraoperative opioid consumption was 224.7 ± 17.1 µg, and the time to the first rescue analgesic was 281.3 ± 31.3 min.

Ciftci et al. [28] showed that in the ESPB group, intra-operative fentanyl consumption was 96.66 ±105.57 µg. The difference in type of surgery and larger sample size can explain the lower intra-operative fentanyl consumption. Zubair et al. [29] showed that VAS scores improved at 1h, 6h, 12h and 24h postoperative.

This retrospective study was conducted with a small sample size, limiting the generalizability of the findings. Additionally, the absence of a control group prevents direct comparison and the determination of the superiority of ipsilateral thoracic US-guided ESPB over other techniques. Further studies with larger sample sizes are warranted to confirm the efficacy of ipsilateral thoracic US-guided ESPB in controlling post-thoracotomy pain. Additionally, investigating this technique's long-term outcomes and potential complications is crucial for establishing its safety and role in clinical practice.

Conclusions:

Ipsilateral thoracic US-guided ESPB is effective for managing post-thoracotomy pain in thoracic cancer surgeries as it improves pain scores and maintains hemodynamic stability.

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Conflict of Interest: Nil

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