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ARTICLE

Ultrasound guided Thoracic Paravertebral block for postoperative analgesia after thoracotomy, single level or multiple levels, does it matter?

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ABSTRACT

Adequate postoperative pain control may help to minimize postoperative pulmonary complications by enabling earlier ambulation and improving the patient's ability to take deep breaths. Thoracic paravertebral block (TPVB) is a compartment block; success relies on spread of injected local anesthetic (LA) within the paravertebral space. This block anesthetizes spinal nerves.

Patients and methods; The patients were divided into two group, In Group I: T5 was defined using high frequency linear probe and the corresponding paravertebral space, a Total of 20 ml of Bupivacine 0.25% were injected. In Group II: T4, T5, T6 and T7 were confirmed and 5 ml of of Bupivacine 0.25% were injected in each. 1 ug/kg of fentanyl up to a total of 200 ug and Paracetamol 1 gm were given whenever there is a dramatic change in the hemodynamics with surgical stimulus. At the end, the Pain score were recorded as well as 6 hr, later and the analgesic given. no difference in the median for pain score among the patients 1(1.5) vs 1(1.3) for group I and II respectively), there was a significant reduction in the adjuvant analgesic in group II. 6 hr postoperatively, the median was 5(2.7) vs 2(1.9) only for group II, with a significant statistical reduction in the intensity of pain and the use of postoperative analgesic among the group II.

Conclusion; Multiple injection in paravertebral block is more efficient in controlling pain rather than single level injection.

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Thoracic; paravertebral; pain; single; multiple

It is important to establish Strategies to reduce the postoperative pain and the associated risk of postoperative pulmonary complications especially in high-risk patients. Postoperative pulmonary complications are common and are major causes of perioperative morbidity and mortality [1,2].

Adequate postoperative pain control may help to minimize postoperative pulmonary complications by enabling earlier ambulation and improving the patient's ability to take deep breaths. This is particularly important after thoracic and upper abdominal surgery. Studies on the effect of postoperative pain management on pulmonary complications have focused on the use of epidural analgesia and intercostal nerve blocks as alternatives to the traditional parenteral opioids.

Acute pain after thoracotomy isn't not only related to soft tissue trauma but due to multiple causes including osseous trauma (rib retraction, resection, or fracture), dislocation of costovertebral joints, intercostal nerve injury, and pleural injury as well as irritation by thoracotomy tubes [3].

chronic post-thoracotomy pain may be the sequel of inappropriate acute pain control as the Intense and prolonged noxious stimuli or tissue injury will cause central sensitization, hyperactivity of spinal cord dorsal horn neurons and other CNS neurons, through activation of N -methyl- D -aspartate (NMDA) receptors [4]. Central sensitization is especially important for the pain in the surrounding of the injury site (secondary hyperalgesia) [5].

Block of the thoracic wall innervation is a choice for the pain control, it includes but not limited to intercostal nerve blocks, thoracic paravertebral blocks (TPVB), and the inter-fascial blocks of the pectoral region. The indications for these nerve blocks have been extended from mere postoperative analgesia to anesthesia for surgeries including not only the chest wall but also the upper abdominal wall [1].

The thoracic paravertebral space is a channel-like cavity on both sides of the thoracic spine, filled with adipose tissue, the sympathetic trunk, and small vessels. The thoracic spinal nerves run through the space as they emerge from the intervertebral foramina to become intercostal nerves [2]. The Thoracic paravertebral block (TPVB) is a compartmental block that anesthetizes spinal nerves as they run in this space [1].

Thoracic paravertebral block (TPVB) can be performed using one or multiple injections and can be performed using anatomic landmarks and loss of resistance technique [6], nerve stimulator or ultrasound guidance [7].

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TPVB is as potent as the thoracic epidural anesthesia (TEA) with a lower risk of spinal hematoma, hypotension (unilateral sympathetic block), urinary retention, respiratory problems, and postoperative nausea and vomiting [3].

1. Aim of the work

The aim of the work is to test whether single level and multiple level injections in thoracic paravertebral space are equally efficient in controlling intraoperative and postoperative acute pain after thoracotomies.

2. Patients and methods

2.1. Sample size and statistics

Sample size was calculated using CliniCal,com. setting the type-1 error (α) at 0.05, power (1-β) at 0.8 and confidence width level at 0.1. Calculation according to values of similar studies studies' thoracic paravertebral block after thoracotomy: comparison of three different approaches produced a **minimal** sample size of 22 cases.

The study is a double armed, double blinded clinical trial descriptive study that was conducted in Ain shams university hospital on 50 patients that were scheduled for thoracic surgeries after approval of the Research Ethics Committee of the Faculty of Medicine, Ain Shams University, and informed written consent from the patients in the period from April 2017 to August 2020.

The postoperative analgesic effect of injection at a single level in comparison to multiple levels in the thoracic paravertebral space after thoracotomies is the primary outcome from the study.

The secondary outcome is to decrease the use of opioid analgesics in the postoperative management of acute pain after thoracotomies.

2.1.1. Inclusion criteria

Both Gender

Age 21–70 years

Body weight, 50 Kg- 90 Kg

All procedures necessitating thoracotomies.

2.1.2. Exclusion criteria

Patients' refusal to participate in the study.

Patient refusing the block.

Known hypersensitivities to local anesthetics.

Patients with severe deformity of chest wall or vertebral column

Thoracic outlet syndrome or mediastinal syndrome

Patients on regular analgesics related to the current condition.

During a pre-operative visit, general examination was done, routine laboratory investigations (including complete blood picture, serum creatinine, Liver enzyme and coagulation profile) were checked and an informed written consent was signed by the patients.

Before the patients being transferred to the operating room, 0.02 mg/kg of Midazolam (Midathetic) was injected through 18 G peripheral Cannula.

In the operating room, the standard monitor was attached including ECG, NIBP, capnography and pulse oximeter and the process of anesthesia was started using Propofol (Diprivan) 2 mg/kg, Rocuronium (Esmeron) 0.5 mg/kg, Fentanyl 1ug/kg, the trachea was then intubated with a Left double lumen tube and the position was confirmed by auscultation as well as by fiberoptic.the maintenance of anesthesia was by sevoflurane 2% . the radial artery on the dependent arms was cannulated, 16 G venous cannula was inserted in non-dependent arms as well as the lower limbs and urinary catheter was inserted, the patients were then positioned in Lateral position and secured.

The patients were randomly grouped into group I and group II, 25 patients in each. Randomization was done by computer-generated number lists and using opaque sealed envelopes.

In Group I: the patients were scanned by high frequency linear probe (Sonosite) in a paramedian longitudinal position, T5 was confirmed and the corresponding paravertebral space and total of 20 ml of Bupivacine (Marcaine) 0.25% was injected and the spread of local anesthetic were monitored caudally as well as cephalad.

In Group II: the patients were scanned by high frequency linear probe in a paramedian longitudinal position (Sonosite), T4, T5, T6 and T7 were confirmed and 5 ml of of Bupivacine (Marcaine) 0.25% was injected in each space in the corresponding Paravertebral space.

The procedures were then started, and the vital data were recorded, whenever there was unexplained more than 20% increase in the heart rate and/or the blood pressure than the base line, Paracetamol (Perfalgan) 1 gm and NSAIDS (Ketorolac) 30 mg intravenous were given. If not controlled 1 ug/kg of intravenous fentanyl was given up to a total of 200 ug, the adjuvant analgesics were recorded.

At the end of the procedures, the patients were extubated but if extubation failed the patients were excluded and replaced by another, and the Pain score was recorded using Numerical rating scale and the patients were transferred to the intermediate care, 6 hr later the numerical rating scale was recorded again as well as the adjuvant analgesic given either opioids, NSAIDS or Paracetamol. During this 6 hrs., the nursing staff will apply the NRS to the patient and apply the pain management strategy and record it as well, all necessary

medication to control the pain will be given to the patients to control the pain.

The judgment for the patients' needs for Parenteral analgesics were guided by the patients NRS, unexplained hemodynamic changes and the patients' general conditions. The analgesics were given in a stepladder approach however if there was agonizing pain, narcotics was the drug of choice.

The pain control strategy postoperatively was Perfalgan 1 gm/kg on demand every 6 hrs., NSAIDs Ketorolac 30 mg/ml IV on demand every 6 hrs., if there was no decrease in the pain intensity or if the patients were complaining of pain with NRS>4 with unexplained tachycardia and agonizing pain, Pethidine 50 mg IV were given incrementally up to a total dose of 100 mg every 3 hrs. on demands. If the pain intensity is severe and persistent, thoracic epidural will be inserted after the patient approval and the patient will be excluded and replaced by another.

Table 1. Descriptive of personal and medical characteristics.

		Group I (n=25) Mean±SD /N (%)	Group II (n=25) Mean±SD /N (%)		
Age (year)		35.50±13.69	38.4±13.77	0.07*	NS
Gender	Male	15 (60)	14(56)	0.09***	NS
	Female	10(40)	11(44)		
ASA	I	13 (52%)	11(44%)	0.494**	NS
	II	10(40%)	10(40%)		
	III	2(8%)	4(16%)		
	** Chi square test				

*student T test, ** Fisher exact test, *** chi square test, NS = non significant

3. Results

Mann Whitney and student t Tests were used to compare non-parametric and parametric continuous variables between the two study groups respectively. Chi square and Fisher's exact tests were used to examine the relationship between Categorical variables. P-value< 0.05 was considered statistically significant. All statistical procedures were carried out using SPSS version 20 for Windows (SPSS Inc, Chicago, IL, USA).

The demographic data in both groups were comparable including age and gender with non-significant statistical difference. There were no significant differences between the two groups regarding the ASA physical status (Table 1). The main procedures were Lobectomy and Pneumonectomy in both group (Figures 1,2).

Although the median for early postoperative pain was 1 (IQR = 1.5) and 1 (IQR = 1.3) for group I and II respectively with non -significant statistical difference (Table 2), but the intraoperative use of adjuvant analgesic was significantly less in group II compared with group I (Table 3).

There was a significant statistical difference for the pain score 6 hrs. postoperative where the median was 5 (IQR = 2.7) for group I vs 2 (IQR = 1.9) only for group II, and the pain score was mainly in the range 0-<4 in group II vs 7–10 for group I with a significant statistical reduction in the intensity of pain among group II. Table 4

There was a statistically significant decrease in the need for postoperative analgesic especially those recorded at 6 hrs. post-operative Table 3, where a highly significant decrease in the need for Opioid

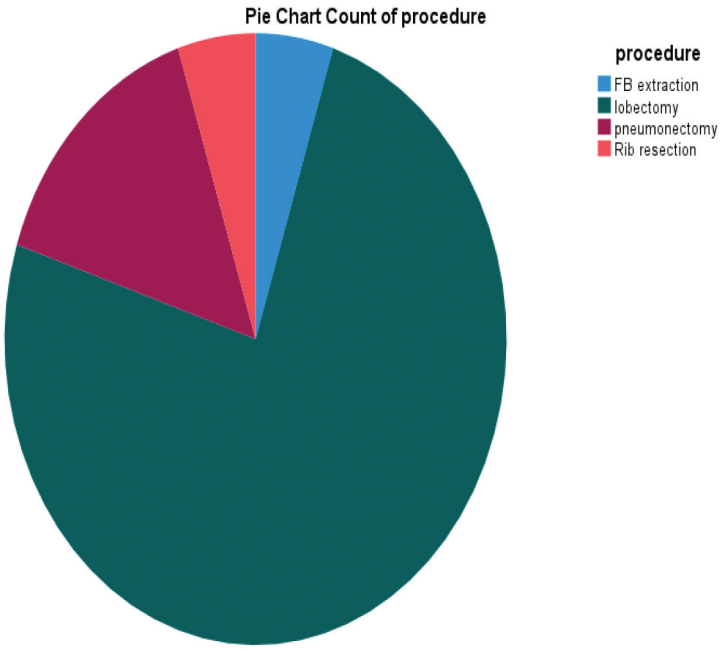

Figure 1. Types of procedures in group I.

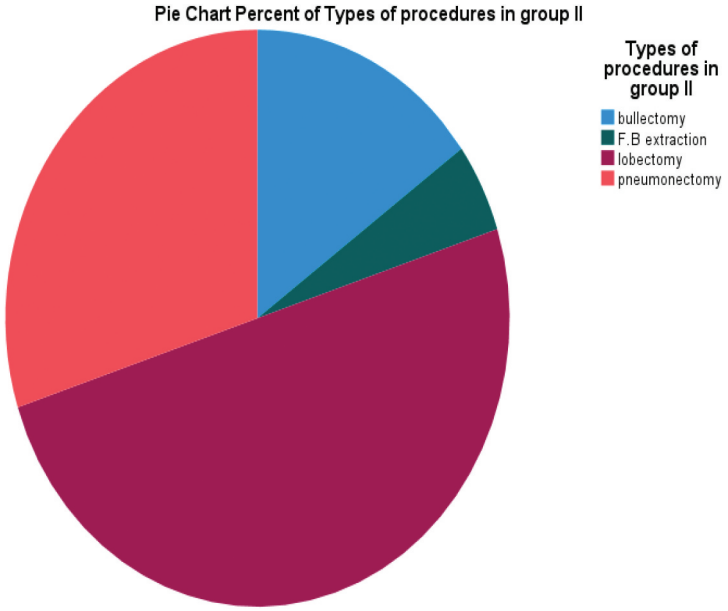

Figure 2. Types of procedure in group II.

Table 2. Analysis of pain score early postoperative and 6 hr later.

	Group I(n = 25) Median (IQR)	MIN	Max	Group II(n = 25) Median (IQR)	Min	Max	P	Sig
Early postoperative Pain	1(1.5)	1	10	1(1.3)	0	6	0.25*	NS
6 hr postoperative pain	5 (2.7)	0	7	2 (1.9)	0	4	0.0005*	HS

*Mann Whitney test

Table 3. Number of patients received adjuvant analgesics Intra operative and 6 hr postoperatively.

		Group I (n = 25)		Group II (n = 25)			
	No. of Patients	Yes	No	yes	No	P value	Sig.
Intraoperative adjuvant	25	11	15	0	25	**0.027***	S
Postoperative adjuvant	25	20	5	12	13	0.043**	S

*Fisher exact test ** Chi square test

Table 4. 6 hr Numerical rating scale analysis among the two groups.

Pain Score	Total no.	No. of patients	Total no.	No. of patients	P value	Sig.
0-<4	25	6	25	16	0.006**	HS
4-<7		9		7		
7–10		10		2		

** student t test
HS = highly significant

and increase in the use of NSAIDS and paracetamol in Group II as compared to group I (Figure 3). where only five patients used opioid narcotics vs 17 patients in group I (Table 5).

4. Discussion

The aims of Perioperative pain management are to relieve suffering, achieve early mobilization, reduce length of hospital stay, achieve patient satisfaction [8]. and establish the concept of preventive analgesia which can be accomplished by treatment given at any time in the perioperative period [9,10].

Multimodal therapy is the optimal strategy for perioperative pain control to minimize the need for opioids. The overuse of opioids has reached a critical level worldwide [1], and may be the trigger for long-term opioid use in many patients [11,12].

Multimodal analgesia targets different pathways in the perception of pain by using different agents rather than the traditional concept of targeting central mechanism involved in the perception of the pain [8].

Synergism between opioid and non-opioid analgesics reduces both the opioid dose and the unwanted side effects. Not only by medication, but multimodal analgesia can also be achieved by combination with regional anesthesia.

The multiple level injection in the current study significantly lowered the need of Opioid and accordingly the opioid related side effects in the perioperative time where the need for adjuvant opioid was 20% in group II vs 68% in group I

TPVB results in somatic and sympathetic nerve block, as which would be achieved with epidural blockade.

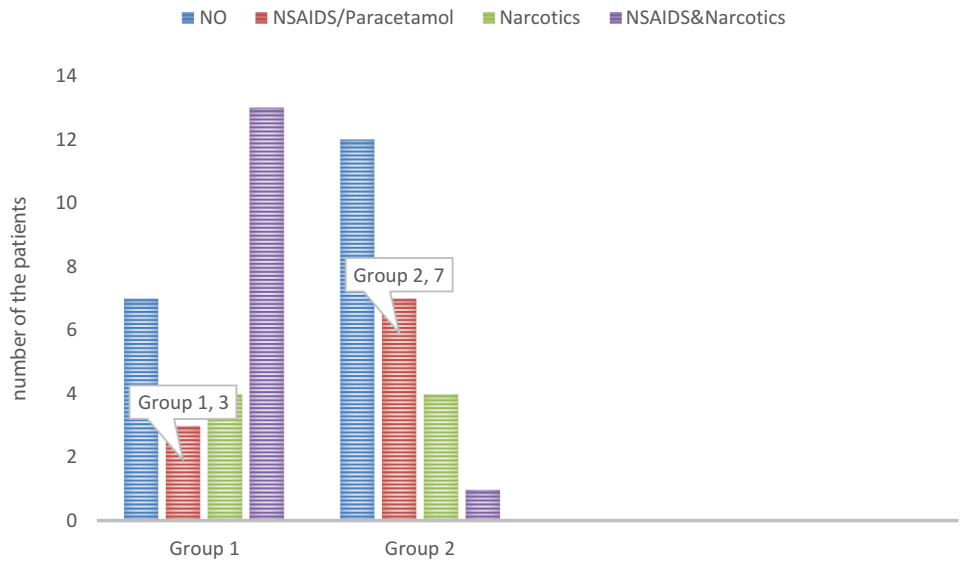

Figure 3. 6 hr Postoperative Analgesic requirement among the two groups.

Table 5. Analgesics used in the 6 hrs postoperative time.

Group I (n = 25)	Group II (n = 25)
3	7
4	4
13	1

**Chi square test

Thoracic Paravertebral block is used most to provide anesthesia and/or analgesia for mastectomy, cosmetic and other breast surgeries, thoracic surgery, nephrectomy and rib fractures.

SQM T et al; stated that "If only one to four dermatomes need to be blocked, a single level PVB at or below the mid-dermatomal level is usually sufficient (e.g., for simple mastectomy; T3 or T4 is an appropriate level. For open cholecystectomy, T6 or T7 should be selected)". If spread greater than four dermatomes are required, then multiple injections will block the area more reliably (e.g., for mastectomy and axillary dissection, a block from at least T1–T6 will be required. Therefore, blocks should be performed at each level or at T1, T3, and T5) [13].

This result is coinciding with the outcome of the current study where the severity of pain was significantly higher in single injection as well as the supplementation of analgesics intraoperatively. however, our study was conducted in thoracic surgeries, this made the conclusion that multiple level injection was more efficient in controlling the perioperative pain rather than single injection.

These results were also supported with a recommendation that based on clinical experience, cadaveric, and radiographic studies, where a single injection of 15 ml of local anesthetic produces a somatic block over a median of three dermatomes and a sympathetic block over eight dermatomes. They concluded that to ensure reliable and widespread cover, multiple injections of 3–5 ml at each thoracic vertebra are required or to block alternate level [13–15].

However, *Naja et al & Kaya et al stated that, if* TPVB is performed as the sole anesthetic for a surgical procedure, multiple injections may be more effective and preferable. while a single injection may be as effective and adequate when the block is used primarily for postoperative analgesia [16,17] .

Single-injection TPVB at T4 level is an alternative to general anesthesia for breast surgery [8,9] and has been described as a sole method of anesthesia for video-assisted thoracoscopic surgery [10]. Numerous studies have reported improved postoperative pain scores and reduced analgesic consumption after paravertebral block for breast surgery [14,15]. Several studies, though not all, have also reported a reduction in the incidence or severity of chronic pain after breast surgery [9–11].

In the past, there were no published data comparing the distribution of anesthesia after a single-site *versus* a multiple-site percutaneous thoracic paravertebral injection. Evidence at that time suggests that a single-site injection of 0.375–0.5% bupivacaine, 15–20 ml or 0.3 ml/kg [6,14,15]. is as effective as a multiple-site injection of 0.5% bupivacaine, 3–4 ml per site in producing unilateral anesthesia over four to five thoracic dermatomes. Therefore, if a wide unilateral thoracic block (*i.e.*, ≥ 5 dermatomes) is desired, it may be preferable to inject at multiple contiguous sites [14,18,19] or at two separate sites several dermatomes apart [6].

It is concluded that multiple level injections in the thoracic paravertebral block is superior to single level injection in the regards of decreasing the pain severity in the early postoperative period as well as 6 hrs. later. Moreover, multiple level injections were associated with a lower need for opioid analgesics.

5. Limitation of the study

The current study is limited by the six hours post-operative monitoring for pain. although the procedures in both groups were similar however no data was recorded regarding the duration of the procedure.

Disclosure of potential conflicts of interest

No potential conflict of interest was reported by the author(s).

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