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A randomized controlled study comparing thoracic paravertebral block to serratus anterior plane block in breast surgery

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ABSTRACT

Background: Breast surgeries cause severe acute pain and may result in chronic pain in 60% of cases. Thoracic paravertebral block (TPVB) is a reliable analgesic approach. The serratus anterior plane block (SAPB) is a recent block as the local anaesthetic is infiltrated at the fifth rib deep to the serratus anterior muscle (SAM) in the mid axillary line (MAL). This study compared the analgesic duration and efficacy of the SAPB versus that of the TPVB for postoperative pain management after mastectomy.

Patients and methods: This randomized controlled trial included 50 females undergoing breast surgery randomly allocated into two equal groups. Group I: 25 cases received TPVB and Group II: 25 cases received SAPB. Postoperatively, all cases were subjected to evaluation of the time of the first analgesic drug request, visual analogue score (VAS) and total morphine consumption. Heart rate and arterial blood pressure and postoperative nausea and vomiting (PONV) impact scale were recorded.

Results: The time for first analgesic request was significantly longer in the TPVB group than the SAPB group. There was a significant decrease in VAS results after 2 hours in the TPVB group 2 vs 2.72 in the SABP group with significant tachycardia in the intra-operative, immediate postoperative and 2 hours postoperative period. PONV between both groups had no significant difference.

Conclusion: The study favours TPVB regarding analgesic efficacy, delayed requirement for first rescue analgesia, extended analgesic duration and reduced morphine consumption. SAPB, on the other hand, provides a safe, easy application with good analgesic efficacy and fewer side effects.

Keywords: *TPVB, SAPB, breast surgery, VAS, analgesia*

INTRODUCTION

Chest wall surgeries are common procedures and are accompanied by considerable postoperative pain and discomfort. Breast carcinomas is the most frequent cancer afflicting women, with a percentage of 30.7% of new female's cancer cases [1]. Breast surgeries lead to severe acute pain and may advance to chronic pain states in 60% of cases [2]. Both epidural analgesia and thoracic paravertebral block

(TPVB) have become a considered analgesic approach in breast surgeries [3]. However, both may lead to hazardous side effects such as pneumothorax, inadvertent intravascular injection and total spinal anaesthesia. Many anaesthetists remain hesitant to perform thoracic paravertebral blocks for fear of complications. It is reported that the risk of such complication does not exceed 0.5%- 2% [4].

The revolution of ultrasound industry and increasing the capability to identify the pleura and other components in the paravertebral space gave attention to perform thoracic paravertebral analgesia [5].

Serratus anterior plane block (SAPB) is a plane block performed by infiltrating local anaesthesia at the fifth rib level deep to serratus anterior (SA) muscle in the mid axillary line (MAL). SAPB is a new block that Blanco et al. described as a progression on his prior work on the Pecs I and II blocks. Their aim was to provide an easier technique using a single injection and to lower the complication rate [6].

Therefore, in this randomized controlled study, a comparison between ultrasound guided thoracic paravertebral block (TPVB) and serratus anterior plane block (SAPB) was performed to determine their effectiveness of postoperative pain reduction after breast surgery.

PATIENTS AND METHODS

This randomized controlled trial was conducted in Kasr El-Ainy hospitals – Cairo University. The study protocol included 50 cases undergoing breast surgeries.

The study was declared for Ethical and Research approval by Anaesthesia department scientific and ethical committees, Kasr El-Ainy hospitals – Cairo University. Informed written consent as well as the objectives of the study was signed by all enrolled cases.

Inclusion criteria included female patients aged twenty to sixty years with ASA I ,II ,III undergoing breast surgery with or without axillary clearance.

Exclusion criteria included ASA IV, V cases, major breast surgeries including reconstruction operations and history of hypersensitivity reaction to local anaesthetics.

The cases were randomly allocated into two groups; Group I: Thoracic paravertebral block group (TPVB group n=25) and Group II: Serratus anterior plane block group (SAPB group n= 25). The randomization sequence was concealed in sealed envelopes.

All candidates were subjected to history and clinical examination. Chest X-ray, routine laboratory investigations and electrocardiogram [ECG] for cases above 40 years were done.

TPVB

TPVB was performed under ultrasound guidance before induction of general anaesthesia at the level of the 4th thoracic vertebra while the patient was in the sitting position. Skin infiltration by local anaesthetics was done after visualization of the sono-anatomical marks including transverse processes, pleura and superior costo-transverse ligament then the block was performed using an 18-gauge Tuohy needle in a cephalic direction. A total volume of 20 cc of bupivacaine 0.25% was injected slowly.

SAPB

SAP block was performed under ultrasound guidance before induction of general anaesthesia while the patient was lying supine. The ultrasound was used to count the ribs down from the clavicle infero-laterally until confirmation of the 5th rib in the MAL. Using a 22G block needle, 20 cc of bupivacaine 0.25% was injected deep to SA muscle separating it from corresponding ribs.

Induction of anaesthesia in all groups was done after performing the block by propofol 2 mg/kg I.V., fentanyl 2 µg/kg and atracurium 0.5 mg/kg I.V. Anesthesia was maintained by isoflurane 1-1.5 %.

Time to first analgesic request, visual analogue scale (VAS) every two hours and total morphine consumption were recorded for twelve hours

postoperatively. Heart rate, arterial blood pressure and postoperative nausea and vomiting impact scale were recorded as well as the use of antiemetic drugs.

Sample size calculation

The sample size calculation was estimated using [PS Power and Sample Size Calculations soft-wares, Microsoft version 3.0.112 (William D. Dupont and Walton D. Vanderbilt, USA). The minimum number of cases for significance was calculated to be 25 participants in each group by setting of type-I error to 0.05 and power of 95%.

Statistical analysis

The data was collected then analyzed using SPSS® PC application version-26.0. The numerical variables were shown as mean ± standard deviation (SD), whereas categorical values were shown as median and range. Numerical variables comparison was done by student t test. Testing proportion independence was performed by chi-square test. Significance of the obtained results was considered at 0.05. P-value = the level of significance. p <0.05 was considered to be significant.

RESULTS

There was no significance in the demographic presentation of cases in both groups of the study. In the SAPB group, the mean age was 52.8 ± 10 yrs., in the TPVB group the mean age was 49 ± 11.1 yrs. Table 1

TABLE 1: Patients characteristics.

Variable		**SAP B**	**TPV B**	**P value**
Age (years)		52.8 ± 10	49 ± 11.1	.2
ASA	1	12(48%)	12(48%)	
	2	10(40%)	11(44%)	
	3	3(12%)	2(8%)	

Data were presented as mean ±SD or frequency (%), SAPB: Serratus Anterior Plane Block, TPVB: Thoracic Paravertebral Block, ASA: American Society of Anaesthesiologist

There was a significant difference in the time for first analgesic request between the groups; 306.4 ± 37.4 (mins) for the SAPB group and 336.8 ± 29.5 (mins) for the TPVB group. (p value 0.003). Table2

TABLE 2: First analgesic request and analgesic consumption.

	SAPB	**TPVB**	**P value**
First analgesia (min)	306.4 ± 37.4	336.8 ± 29.5	0.003*
Morphine consumption(mg)	3.7 ± 1.3	3.5 ± 1.1	0.5

Data was presented as mean ±SD. *: Statistically significant at $p \leq 0.05$. SAPB: Serratus Anterior Plane Block, TPVB: Thoracic Paravertebral Block. Asterisk = value of significance.

There was a significant reduction in the mean VAS at 2 hours in the TPVB group compared to the SABP group (2 vs 2.72), (p value = 0.001). There was significant reduction in VAS results after 4 hours in the SABP 2.56 vs 3.12 in the TPVB. p value = 0.04. There were low VAS results in 6, 8,10 ,12 hours with no statistical differences. Table 3

TABLE 3: VAS collected every two hours postoperatively

VAS Score		2	4	6	P value
Vas 2 hours	SAP B	16(64%)	9(36%)	0(0%)	.001*
	TPV B	25(100%)	0(0%)	0(0%)	
Vas 4 hours	SAP B	18(72%)	7(28%)	0(0%)	0.04*
	TPV B	11(44%)	14(56%)	0(0%)	
Vas 6 hours	SAP B	25(100%)	0(0%)	0(0%)	0.07
	TPV B	22(88%)	3(12%)	0(0%)	
Vas 8 hours	SAP B	25(100%)	0(0%)	0(0%)	
	TPV B	25(100%)	0(0%)	0(0%)	
Vas 10 hours	SAP B	25(100%)	0(0%)	0(0%)	
	TPV B	25(100%)	0(0%)	0(0%)	
Vas 12 hours	SAP B	25(100%)	0(0%)	0(0%)	
	TPV B	25(100%)	0(0%)	0(0%)	

Data were presented as frequency (%). VAS: visual analogue score. SAPB: Serratus Anterior Plane Block, TPVB: Thoracic Paravertebral Block. Asterisk = value of significance.

The mean haemodynamic values during different period of the operation in both groups were illustrated in Table (4).

TABLE 4: Mean Haemodynamic values in SAPB and TPVP group

	SAPB group			TPVP group		
	SBP (mmHg)	DBP (mmHg)	Pulse (beat/min)	SBP (mmHg)	DBP (mmHg)	Pulse (beat/min)
Preoperative	130.6 ±15.8	80.2± 9.1	87.4 ± 10.6	128.6 ±13.1	81.2± 7.4	83.6 ± 9.9
Intraoperative	112.8 ± 10.5	71.4 ±8	78.4 ± 9.3	110 ± 11.2	69.2 ± 7.3	70.3 ± 7.5
Postoperative	133.2 ± 11.5	85.2 ±7.8	92.2 ± 7.3	129.6 ± 11	82.8 ±6.9	86.6 ± 5.3
2 hours Postoperative	122.8 ± 12.1	77± 4.8	83.6 ± 7.6	120 ± 10	77 ± 7.5	76.8 ± 6.1
4 hours Postoperative	123 ± 12.6	75.8± 4.7	82.6 ± 8.2	121.8 ± 10.6	79.4 ± 7	79.2 ±7.5
6 hours Postoperative	122.4 ± 13.9	75.6± 5.3	75.8 ± 7.6	122.2 ± 8.8	76.2 ± 6.2	76.6 ±5.5
8 hours Postoperative	123 ± 14.6	75.2± 5.5	75.6 ± 6	120 ± 10.3	74.6 ± 6.9	74.2 ±5.3
10 hours Postoperative	121.8 ± 13.8	74.4± 6	74.8± 6.5	119.6 ± 10.4	75 ± 6.3	73.2 ±5.6
12 hours Postoperative	121.8 ± 13.7	74.4± 6	74.4± 6.5	120.6 ± 9.8	73.8 ± 6.2	73 ±5.6

Data was presented as mean ±SD. SAPB: Serratus Anterior Plane Block, TPVB: Thoracic Paravertebral Block

There was significant tachycardia in the SAPB in the intraoperative, immediate postoperative and 2 hours postoperative period. p value; 0.001, 0.004 and 0.001 respectively. There was no significant difference regarding PONV between both groups.

TABLE 5: Heart Rate and PONV between both groups

		SAP B	TPV B	P value
Heart Rate (beat/min)	Intra- operative	78.4 ± 9.3	70.3 ± 7.5	.001*
	Post-operative	92.2 ± 7.3	86.6 ± 5.3	.004*
	2 hours postoperative	83.6 ± 7.6	76.8 ± 6.1	.001*
PONV	NO	21(84%)	18(72%)	0.4
	Nausea	4(16%)	6(24%)	
	Vomiting	0(12%)	1(4%)	

Data was presented as mean ±SD. TPVB: Thoracic Paravertebral Block, SAPB: Serratus Anterior Plane Block, PONV: Postoperative nausea and vomiting.

DISCUSSION

This controlled study compared US-guided TPVB with US-guided SAPB for analgesia after breast surgery with or without axillary clearance. The results of our study found that TVPB provided longer duration of analgesia than SAPB. Morphine consumption was reduced in both groups.

TPVB is a common technique used for peri-operative pain control as well as chronic pain [7]. It is the block of local anaesthetics injection near the thoracic spinal nerves going out the intervertebral foramen resulting in sympathetic and sensory block.[8]

Ultrasound technology broadened the understanding of the paravertebral space anatomy allowing the recognition of the tissues, the blocking needle, and injectate spread [4].

Blanco et al. [6] suggested Serratus anterior plane block as an alternative to thoracic paravertebral block for breast operations and other chest wall procedures. SAPB is considered an easy learning and performing block since the SA muscle is an easily identifiable radiological landmark [6].

In this study, the two groups were comparable regarding the demographic data with no statistical difference between the two groups.

The two blocks were done before induction of anesthesia. All the other studies performed the blocks before induction of anaesthesia except Amin et al, [9] who preferred performing blocks by the end of the surgery.

In previous studies, thoracic paravertebral block was performed by single injection at the level of the fifth dorsal vertebra [10]. Another study by Buckenmaier et al [11] concluded that adequate anaesthesia for breast surgery with axillary clearance is provided by block level from T1 to T6 dermatomes. Therefore, in the current study we decide performing single shot thoracic paravertebral block (TPVB) at the level of the fourth space that is the middle of the region of the aimed block.

In the current study, we considered that doses based on body weight were probably not appropriate because the paravertebral space size and longitudinal spread are not related to body mass. Therefore, we used 20 ml bupivacaine 0.25% to supplement general anesthesia. Boezaart et al., reported that 20 ml of bupivacaine administered in 5 mL incremental injections at the T4 thoracic paravertebral space was enough for postoperative pain relieve when combined with general anaesthesia. [12]

Kunigo et al. [13] studied the best volume for SAPB block comparing 20 ml to 40 ml of 0.375% ropivacaine. They found that larger volumes extend the dermatomal analgesia, however the the first analgesic demand time with 40ml was comparable to that with 20 ml. Smaller volumes of injection are safer and avoid local anesthetic systemic toxicity, whereas 20 mL could be sufficient for serratus plane block analgesia. [13]

Another debatable point is the site of injection for SAPB either superficial or deep to SA muscle. Many studies preferred deep SAPB rather than superficial block due to better distribution, longer duration of action and easier application of injectate. Superficial SAPB may block the long

thoracic nerve but this does not occur in deep SAPB which preserving scapula function. The correct deep SAPB will have an immediate linear spread of local anaesthetic that will separate the rib from the SA muscle. [14]

We noted that TPVB and SAPB before surgical incision provided adequate analgesia for the first 12 h after mastectomy with or without axillary clearance. There was significant difference in the first time of analgesic request between groups, 336.8 ± 29.5 min in TPVB and 306.4 ± 37.4 min in SAPB and P value= 0.003. The need for morphine was higher in the SAPB 3.7 ± 1.3 mg in comparison to 3.5 ± 1.1 mg in the TVPB.

Gupta et al. [15] in a study performed on 50 women undergoing radical mastectomy comparing TPVB to SAPB, reported TPVB group had a significantly longer duration of analgesia than that of the SAPB group (346 ± 57 min vs. 245.6 ± 58 min, P < 0.001). VAS scores postoperatively were comparable in the two groups, also postoperative morphine consumption in the 24 hrs was significantly higher in the SAPB group vs the TPVB group [9.7 ± 2.1 mg vs 6.5 ± 1.5, P < 0.001,]. Mahran et al, [16] compared ultrasound guided continuous SAPB and continuous TPVB for pain relief following MRM with axillary dissection. They found that the time for the first analgesic drug request was significantly increased in TPVB 368 ± 36.0 min vs 270.2 ± 37.7 for SAPB p < 0.001. There was no significant difference when comparing VAS results between groups throughout the duration of the study.

Saad FS. et al. [17] studied perioperative analgesia in thoracotomy by ultrasound-guided SAPB versus TPVB on 90 cases with lung cancer scheduled for lung lobectomy. Both the TPVB and the SAPB achieve adequate analgesia throughout study duration. VAS scores were significantly lower in patients of the TPVB and SAPB groups than patients in the control group up to nine hrs after the surgery. Whereas, VAS scores in the TPVB group were significantly decreased versus the SAPB and control groups at 12 and 24 hrs postoperative.

Baytar et al. [18] studied analgesia for video-assisted thoracoscopic surgery and found no significant difference in first analgesic request 2.45 ± 1.57 hrs in the TPVB vs 2.12 ± 1.46 h in the SAPB group, (p = 0.651). Tramadol usage for the 24 hours postoperatively was significantly decreased in the TPVB (18.5 mg tramadol) versus that of the SAPB. (31.1 mg tramadol). (p = 0.026)

The discrepancy between these results and ours may be explained by the differences in the study design, type of operation, the patient population and the duration of procedure.

On the other hand, Amin et al. [9] reported that SAPB group showed longer duration of analgesia (20±3 h) in comparison to the TPVB group (15±4 h) p value = 0.007. In addition, the SAPB group showed lower total opioid consumption 5±2 mg versus 9±2 mg in the TPVB group. (p value = 0.01)

The differences between Amin et al, [9] study and ours may be due to the volume of local anaesthetics as they used 0.4 ml/kg while we used fixed 20 cc for each block and the addition of epinephrine 5 μg/ml, which may have led to prolongation of the block analgesic effect.

Amin et al, [9] also performed the blocks at the end of the surgery. However, in our study we perform the blocks before induction of general anaesthesia.

The VAS scores were generally low in both groups during the study time line (12 hours). There was a significant reduction in VAS in the TPVB after 2 hours, p value = 0.001. However, at 4 hours postoperatively there was a significant increase in the VAS score in the TPVB group compared to the SAPB group 3.12 vs 2.56 (p value = 0.04). There was no significant difference in the VAS scores between both groups at 6, 8, 10 and 12 hours postoperatively. This was explained that at 2 hours postoperatively cases in the TPVB did not demand rescue analgesics although cases in the SAPB were less comfortable demanding rescue analgesics. Whereas at 4 hours postoperatively cases in TPVB started feeling of pain and requesting rescue analgesia. After 6 hours, all cases were comfortable and pain free until the end of the study timeline.

The TPVB group mainly complained of pain related to the pectoralis major muscle especially with abduction of the arm and in few cases pain in the axilla. On the other hand, SAPB cases complained of discomfort in the axilla and a sharp pain in the medial side of the wound especially if the wound extended to the midline. Both groups complained slight burning pain in sub-clavicular region if the surgeon did upper flap release up to the clavicle because this area is supplied by superficial cervical plexus through the supraclavicular nerves.

This difference in the dermatomal distribution with each block technique is due to the anatomical complexity of the nerve supply of the anterior thoracic wall. SAPB targets only the lateral cutaneous branches of the intercostal nerves (T2–T4) sparing the anterior cutaneous branches and supraclavicular nerves. In addition, SAPB may not fulfill adequate somatic and sympathetic blockade in the axilla. Single shot TPVB may or may not reach T1 and T2 dermatomes leading to inadequate analgesia in the axilla. In addition, pectoralis major muscle is supplied by pectoral nerves which are branches from brachial plexus not thoracic nerves explaining the pain with abduction of the arm. [16, 19]

There was significant tachycardia in the SAPB group in the intraoperative, immediately postoperative and 2 hours postoperative with p value 0.001, 0.004 and 0.001 respectively.

This may be due to the sympathetic block of the TPVB which in not included in SAPB. This is consistent with the findings of a prior research by Chong et al. [20] They found that performing paravertebral block in combination with general anaesthesia provides a better hemodynamic stability in intra and post-operative periods compared to general anaesthesia alone.[20]

Our research has a few drawbacks. To assure safety, a bigger sample size is necessary. In addition, we must extend the duration of the trial and conduct patient follow-up to determine the long-term benefits of the block on chronic post-mastectomy pain reduction. Future research is needed with a bigger volume, a different concentration, or the use of a local anaesthetic adjuvant in order to extend the length and intensity of analgesia of the blocks, as well as the use of a catheter for continuous block.

CONCLUSION

The results of this study showed that preemptive TPVB and SAPB provide adequate analgesia for breast surgeries in conjunction with GA. This study found that TPVB had superior analgesic effectiveness, delayed the need for the first rescue analgesic, lower morphine intake, and a longer duration of analgesia. Furthermore, SAPB proved to be easier in application with good analgesic effect and relatively safer due to the lower incidence of adverse events.

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Nil

CONFLICT OF INTEREST

Nil

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