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Ultrasound-guided thoracic paravertebral block vs pectoral nerve block for postoperative analgesia after modified radical mastectomy

Islam Gamal Hamed*, Ahmed Ali Fawaz, Amal Hamed Rabie, Abd El Aziz Abdallah Abd El Aziz and Tarek M. Ashoor

Abstract

Background: Thoracic paravertebral block may be used for analgesia after breast surgery. Ultrasound can be used during the whole technique of paravertebral block to increase success rate and decrease its complications. As well, pectoral nerve block is now used for pain relief after modified radical mastectomy with or without axillary clearance.

Objective: To compare thoracic paravertebral block and pectoral nerve block for postoperative analgesia after modified radical mastectomy

Methods: The study was performed over 30 female patients that were randomly divided into 2 groups with 15 patients in group A for thoracic paravertebral block (TPVB) and 15 in group B for pectoral nerve block (PECS) with injection of total 20 ml bupivacaine 0.25% in each block. Outcome measures of the study are postoperative analgesia duration (time to first rescue analgesia (0.5 mg/kg pethidine) after administration of block) and total analgesic dose in 24 h after surgery and postoperative pain which will be assessed using a visual analog scale (VAS, 0–10 as 0 = no pain and 10 = worst imaginable pain). The vital signs and pain score will be recorded at 0, 1, 2, 4, 6, 8, 12, 18, and 24 h after surgery.

Results: Our study showed decrease in systolic blood in PVB group immediately postoperative and in the first 6 h postoperative with p value < 0.05. Less time to perform the block in PECS group with p value < 0.001. Less VAS score in PECS group with statistically significant difference between groups at 1 h, 2 h, and 4 h. More time is needed for the 1st requested rescue analgesia in PECS group with p value < 0.05. Patients in the PECS group received less total dose of pethidine with a p value < 0.05

Conclusion: The PECS can be effectively and safely used, provides better relief of pain and less hemodynamic changes compared with the TPVB, and reduces postoperative analgesic consumption. Therefore, the PECS can be used safely for postoperative analgesia in patients undergoing breast surgeries with axillary dissection.

Keywords: Paravertebral block, Pectoral nerve block, Radical mastectomy

* Correspondence: islam.gamal2050@hotmail.com
Department of Anesthesiology, Intensive care and Pain Management, Faculty of Medicine, Ain-Shams University, Abbassia, Cairo 11591, Egypt

Introduction

Modified radical mastectomy, frequently done for the management of breast cancer, is associated with significant acute postoperative pain and limited shoulder movement. General anesthesia with postoperative NSAI D and opioids is a commonly used technique for postoperative analgesia after breast surgeries. Patients with radical mastectomy under general anesthesia commonly have pain in the axilla and upper limb that increases hospital stay, costs, and postoperative complications (Wahba and Kamal 2013).

Thoracic paravertebral block can be performed for analgesia after breast surgery. Ultrasound usage gave an accurate reading of the depth to the paravertebral space and can be used during the whole technique. Breast surgery is usually done with axillary dissection and can be done at single or multiple levels of thoracic paravertebral blocks (Terkawi et al. 2015).

Thoracic paravertebral block is associated with multiple complications such as hypotension, pneumothorax, sympathetic block, central spread of local anesthesia or failed block which may cause limitations in the technique. The use of ultrasound in anesthesia increases the success rate of the block and decreases the incidence of variable complications (Wu et al. 2015).

On the other hand, many interfascial plane blocks have been described. Pectoral nerve block (PECS) has been described as interfascial plane blocks and provide analgesic adjuvants for breast surgery with or without axillary dissection. The block was described as an injection of local anesthetic between the pectoralis major and minor muscles (PEC I) and between pectoralis minor and serratus anterior muscle (PEC 2) (Kumar et al. 2018). This injection blocks the lateral and medial pectoral nerves which supply the pectoralis muscles. Since then, local anesthetic injection to target the pectoral nerves and the thoracic dermatomal innervation is mainly to T2–T6. The exact site of injection of the local anesthetic is what will differentiate the PEC I and PEC II. Interfascial blocks are relatively easy and safe to be done under direct US guidance (Perez et al. 2013).

Aim of the study

The aim of this study is to compare thoracic paravertebral block versus pectoral nerve block for postoperative analgesia after modified radical mastectomy.

Patients and methods

This randomized prospective comparative clinical study was carried out in Ain Shams University Educational Hospitals after approval of Research Ethics Committee (REC) at Ain Shams University Hospitals and obtaining a written informed consent from the patient. A total of 30 ASA grade I–II female patients in the age group of 30–60 years and with body mass index (BMI) of 25–35 who were undergoing modified radical mastectomy under general anesthesia with average operation duration of 2–3 h between January 2018 and January 2019 were included.

Exclusion criteria are patient refusal, infection at site of block, and contraindications for procedures or drug used: coagulopathies (INR > 1.5 and platelets < 50,000) and allergy to any drug used in the procedure and any surgical, anesthetic complications, or blood transfusion.

Sampling method

Patients were randomly divided according to computer-generated sequence program into two equal groups, group A for thoracic paravertebral block (TPVB) and group B for PECS study.

Before induction of general anesthesia, patients were kept fasting for 8 h preoperative, a G18 IV cannula was inserted, and all patients were monitored with pulse oximetry, electrocardiogram, and non-invasive arterial blood pressure. Midazolam 1–2 mg IV was given to all patients.

Induction of general anesthesia was done with injection of fentanyl 1 μg kg^{-1} i.v. and propofol 1–2 mg kg^{-1} i.v. Atracurium 0.5 mg kg^{-1} i.v. was given before tracheal intubation. Maintenance of general anesthesia was done with isoflurane (minimal alveolar concentration 1–1.3%) and oxygen, and all patients were kept on controlled mechanical ventilation. A bolus dose of fentanyl 25 μg i.v. was given if the mean blood pressure (MBP) or heart rate exceeded 20% of the preoperative value.

After induction of general anesthesia and before surgery, patients in the TPVB group (group A) were placed in the lateral decubitus and tilted slightly forward with the side of surgery which is upward. Ultrasound device (S-Nerve Ultrasound System, Fujifilm Sonosite Inc., Bothell, WA) and linear transducer with a frequency of 10–12 MHz was used. At the level of T3, the ultrasound scanning started 5 cm lateral to the midline at the same side of surgery where the transverse process and parietal pleura were identified. After visualization of the superior costotransverse ligament, the needle was advanced with in-plane technique craniocaudally and after frequent aspiration to avoid intravascular or intrapleural injection. Bupivacaine 0.25% 20 ml was injected between the costotransverse ligament and the parietal pleura.

Patients in the PECS group (group B) were kept supine while the arm of the same side of surgery was abducted.

The axillary artery and vein were located by placing the linear ultrasound probe at midclavicular level below the clavicle at the same side of surgery and then the probe was moved laterally until pectoralis minor and serratus anterior muscles were identified. The needle entry point is 1 cm medial to the probe and was advanced in plane from medial to lateral direction obliquely until the needle entered the plane between the pectoralis major and minor muscles, and bupivacaine 0.25% 10 ml was injected. Then, the needle was advanced further until entering the plane between the pectoralis minor muscle and serratus anterior muscle, and bupivacaine 0.25% 10 ml was deposited in this space.

The primary outcome is time to first requested analgesia (pethidine 0.5 mg/kg given intramuscular) and secondary outcomes are total analgesic consumption in 24 h after surgery and postoperative pain which was assessed using a visual analog scale (VAS, 0–10 as 0 = no pain and 10 = worst imaginable pain). The vital signs (systolic and diastolic blood pressure and heart rate) and pain score were recorded at 0, 1, 2, 4, 6, 8, 12, 18, and 24 h after surgery while the patient was in resting position. Hypotension was treated with 250 ml of lactated ringer solution, and 6 mg of ephedrine IV was given as bolus doses if needed. Nausea or vomiting was treated with ondansetron 4 mg. Complications of PVB as pneumothorax or epidural spread of local anesthetic were monitored as sensory deficit on the contralateral side, difficulty of breathing, desaturation or diminished air entry, and CXR was requested after PVB.

Statistical analysis

Sample size was calculated using OpenEpi, Version 3 using a previous data from Wahba and Kamal (Wahba and Kamal 2013) who mentioned in his study that time to first analgesic (min) in PVB group was 137.5 ± 28.35 while in the PECS group 175.0 ± 32.13 and adjusting the confidence interval to 95%, the power of the test to 80% and the ratio between groups 1:1 and according to the previous data the total sample size needed for this study was found to be 22 patients divided into two equal groups each group (11 patients) with calculated effect size of 1.237664.

The data were collected, revised, coded, and entered to the Statistical Package for Social Science (SPSS) released 2011 (IBM SPSS Statistics for Windows, version 20.0. Armonk, NY: IBM Corp). The qualitative data were presented in the form of numbers and percentages and the comparison between groups were done by using Chi-square test, while quantitative data were normally checked using Kolmogorov-Smirnov test of normality. The quantitative data with normal distribution were presented as mean, standard deviations, and ranges; the comparison between groups were done using independent *t* test while with non-parametric distribution presented using median with inter-quartile range (IQR); and the comparison between groups were done by using Mann-Whitney test. The confidence interval was set to 95% and the margin of error accepted was set to 5%. So the *p* value was considered significant at the level of < 0.05 and highly significant at level of < 0.001.

Table 1 Demographic data

	Group A, PVB (***n*** = 15)	Group B, PECS (***n*** = 15)	***t***/χ^2#	***p*** value
Age (years)				
Range	30–60	30–60	0.454•	0.653
Mean ± SD	44.19 ± 5.76	45.24 ± 6.86		
ASA (No., %)				
I	8 (53.3)	9 (60.0)	0.039*	0.842
II	7 (46.7)	6 (40.0)		
Weight.				
Range	60–90	60–90	1.078•	0.290
Mean ± SD	79.15 ± 6.38	81.27 ± 4.16		
Height.				
Range	150–170	150–170	1.390•	0.176
Mean ± SD	155.80 ± 5.20	158.34 ± 4.8		
Duration of surgery (h)				
Range	1.5–2.5	1.5–2.5	0.299•	0.767
Mean ± SD	1.87 ± 0.55	1.92 ± 0.34		

•*t*, independent sample *t* test
*χ^2, chi-square test
p value < 0.05 = statistically significant

Table 2 Systolic blood pressure

		Group A, PVB No. = 15	Group B, PECS No. = 15	Test value	*p* value	Sig.
Preoperative	**Range**	**100–140**	**110–130**	**0.739**	**0.466**	**NS**
	Mean ± SD	**120.67 ± 11.63**	**118 ± 7.75**			
0 h (immediately postoperative)	**Range**	**90–120**	**100–130**	**− 4.010**	**0.000**	**HS**
	Mean ± SD	**100 ± 11.34**	**114 ± 7.37**			
1 h postoperative	**Range**	**90–120**	**100–130**	**− 2.798**	**0.009**	**HS**
	Mean ± SD	**104.67 ± 9.15**	**113 ± 7.02**			
2 h postoperative	**Range**	**100–130**	**100–130**	**− 0.111**	**0.913**	**NS**
	Mean ± SD	**114 ± 8.28**	**114.33 ± 8.21**			
4 h postoperative	**Range**	**110–140**	**100–140**	**2.135**	**0.042**	**S**
	Mean ± SD	**123.33 ± 7.24**	**116.33 ± 10.43**			
6 h postoperative	**Range**	**120–140**	**100–130**	**2.932**	**0.007**	**HS**
	Mean ± SD	**124.67 ± 6.4**	**116.33 ± 8.96**			
8 h postoperative	**Range**	**110–140**	**100–130**	**2.040**	**0.051**	**NS**
	Mean ± SD	**123.33 ± 7.24**	**117 ± 9.6**			
12 h postoperative	**Range**	**110–140**	**110–140**	**0.897**	**0.377**	**NS**
	Mean ± SD	**122 ± 8.62**	**119 ± 9.67**			
18 h postoperative	**Range**	**120–140**	**110–140**	**1.937**	**0.063**	**NS**
	Mean ± SD	**125.33 ± 6.4**	**119.67 ± 9.35**			
24 h postoperative	**Range**	**120–140**	**110–140**	**1.892**	**0.069**	**NS**
	Mean ± SD	**126 ± 6.32**	**120.33 ± 9.72**			

Table 3 Diastolic blood pressure

		Group A, PVB No. = 15	Group B, PECS No. = 15	Test value	*p* value	Sig.
Preoperative	**Range**	**60–90**	**50–80**	**1.876***	**0.071**	**NS**
	Mean ± SD	**70.67 ± 8.84**	**64 ± 10.56**			
0 h (immediately postoperative)	**Range**	**50–70**	**50–70**	**− 1.835***	**0.077**	**NS**
	Mean ± SD	**54.67 ± 7.43**	**60 ± 8.45**			
1 h postoperative	**Range**	**50–70**	**50–70**	**− 1.901***	**0.068**	**NS**
	Mean ± SD	**54 ± 7.37**	**59.33 ± 7.99**			
2 h postoperative	**Range**	**50–80**	**50–80**	**1.000***	**0.326**	**NS**
	Mean ± SD	**63.33 ± 9**	**60 ± 9.26**			
4 h postoperative	**Range**	**50–80**	**50–80**	**1.344***	**0.190**	**NS**
	Mean ± SD	**66 ± 8.28**	**61.33 ± 10.6**			
6 h postoperative	**Range**	**50–80**	**50–80**	**0.821***	**0.418**	**NS**
	Mean ± SD	**64.67 ± 7.43**	**62 ± 10.14**			
8 h postoperative	**Range**	**50–80**	**50–90**	**0.000***	**1.000**	**NS**
	Mean ± SD	**64 ± 7.37**	**64 ± 12.42**			
12 h postoperative	**Range**	**50–80**	**50–90**	**− 0.370***	**0.714**	**NS**
	Mean ± SD	**64 ± 7.37**	**65.33 ± 11.87**			
18 h postoperative	**Range**	**50–70**	**50–90**	**− 0.602***	**0.552**	**NS**
	Mean ± SD	**64 ± 6.32**	**66 ± 11.21**			
24 h postoperative	**Range**	**50–90**	**50–90**	**0.343***	**0.734**	**NS**
	Mean ± SD	**68 ± 10.14**	**66.67 ± 11.13**			

*t, independent sample *t* test
p value < 0.05 = statistically significant

Table 4 Heart rate

		Group A, PVB No. = 15	Group B, PECS No. = 15	Test value	*p* value	Sig.
Preoperative	**Range**	**60–90**	**60–90**	**− 0.256**	**0.800**	**NS**
	Mean ± SD	**74 ± 11.21**	**75 ± 10.18**			
0 h	**Range**	**70–100**	**70–100**	**− 0.325**	**0.748**	**NS**
	Mean ± SD	**84 ± 11.21**	**85.33 ± 11.25**			
1 h	**Range**	**70–100**	**70–100**	**0.367**	**0.716**	**NS**
	Mean ± SD	**80 ± 10.69**	**78.67 ± 9.15**			
2 h	**Range**	**70–100**	**70–95**	**0.400**	**0.692**	**NS**
	Mean ± SD	**81 ± 9.86**	**79.67 ± 8.34**			
4 h	**Range**	**65–95**	**65–95**	**0.093**	**0.926**	**NS**
	Mean ± SD	**77.67 ± 9.61**	**77.33 ± 9.98**			
6 h	**Range**	**65–95**	**65–95**	**0.409**	**0.686**	**NS**
	Mean ± SD	**77 ± 9.22**	**75.67 ± 8.63**			
8 h	**Range**	**65–95**	**65–85**	**0.710**	**0.484**	**NS**
	Mean ± SD	**76.33 ± 8.76**	**74.33 ± 6.51**			
12 h	**Range**	**65–90**	**65–90**	**0.501**	**0.620**	**NS**
	Mean ± SD	**75.67 ± 7.76**	**74.33 ± 6.78**			
18 h	**Range**	**65–90**	**65–90**	**0.270**	**0.789**	**NS**
	Mean ± SD	**74.67 ± 6.94**	**74 ± 6.6**			
24 h	**Range**	**65–90**	**65–85**	**0.290**	**0.774**	**NS**
	Mean ± SD	**73.67 ± 6.94**	**73 ± 5.61**			

t, independent sample *t* test
p value < 0.05 = statistically significant

Results

Table 1 shows no statistically significant difference between groups according to demographic data.

Table 2 compares between the two groups according to systolic blood pressure and shows no statistically significant difference between the two groups according to preoperative systolic blood pressure with decrease in systolic blood in PVB group immediately postoperative and in the first 2 h postoperative with statistically significant difference (p value < 0.05)

Table 3 compares between the two groups according to diastolic blood pressure and shows decrease of diastolic blood pressure in both groups, more with PVB group but with no statistically significant difference in diastolic blood pressure between the 2 groups (p value > 0.05)

Table 4 shows no statistically significant difference in heart rate between the 2 groups (p value > 0.05)

Table 5 compares between the two groups according to time taken to perform the block and shows PVB needs more time to be performed with highly statistically significant difference between groups (p value < 0.001).

Table 6 compares between the two groups according to VAS score and shows that VAS score is lower in PECS with statistically significant difference between groups at 1 h, 2 h, and 4 h.

Table 7 compares between the two groups according to time to first request of analgesia and shows that patients in PECS group take more time till 1st requested rescue analgesia with statistically significant difference.

Table 8 shows patients in PVB group requested more total dose of pethidine when compared to PECS group with statistically significant difference.

Discussion

This randomized prospective comparative clinical study was performed on a total 30 female patients which were randomly divided into 2 groups with 15 patients in group A for TPVB and 15 in group B for PECS. Measuring postoperative time to first requested analgesia (pethidine 0.5 mg/kg given intramuscular) and total pethidine given in 24 h postoperative and postoperative pain which was assessed using a visual

Table 5 Time taken to perform the block

	Group A, PVB (***n*** = 15)	Group B, PECS (***n*** = 15)	***t***	***p*** value
Range (min)	10–20	5–9	8.297	< 0.001**
Mean ± SD	15.20 ± 3.5	7.34 ± 1.1		

Independent *t* test
**Highly significant

Table 6 VAS score

		Group A, PVB No. = 15	Group B, PECS No. = 15	Test value	*p* value	Sig.
0 h (immediate after recovery)	Median (IQR)	1 (0–1)	0 (0–1)	− 1.548	0.122	NS
1 h postoperatively	Median (IQR)	1 (0–1)	0 (0–1)	− 2.366	0.018	S
2 h postoperatively	Median (IQR)	1 (1–2)	1 (0–1)	− 1.822	0.069	NS
4 h postoperatively	Median (IQR)	2 (1–3)	1 (1–2)	− 1.958	0.050	S
6 h postoperatively	Median (IQR)	2 (1–3)	1 (1–2)	− 0.873	0.383	NS
8 h postoperatively	Median (IQR)	2 (1–3)	2 (1–3)	− 0.779	0.436	NS
12 h postoperatively	Median (IQR)	1 (1–4)	2 (1–3)	− 0.177	0.860	NS
18 h postoperatively	Median (IQR)	1 (0–1)	1 (1–3)	− 1.447	0.148	NS
24 h postoperatively	Median (IQR)	1 (1–2)	1 (0–1)	− 3.433	0.001	HS

Mann-Whitney test
Data are expressed median (25th–75th percentile)
p value < 0.05 = significant

analog scale (VAS, 0–10; 0 = no pain and 10 = worst imaginable pain). Blood pressure, heart rate, and pain score were monitored at 0, 1, 2, 4, 6, 8, 12, 18, and 24 h after surgery.

This study showed that PECS performed in patients before MRM resulted in significantly longer duration of postoperative analgesia and less postoperative pethidine consumption in the first 24 h with lower intensity of pain in the first 4 h and less hemodynamic changes in comparison with PVB.

The PECS anesthetize the pectoral, the intercostobrachial, the intercostals III and VI, and the long thoracic nerves which supply the breast and axilla (Purcell and Wu 2014). Blocking those nerves provides complete analgesia after breast surgery (Ueshima and Otake 2017).

Blanco et al. (Blanco et al. 2012) used the PECS in 50 patients and revealed adequate postoperative analgesia for 8 h after modified radical mastectomy. Bashandy and Abbas (Bashandy and Abbas 2015) compared patients receiving the PECS with general anesthesia with patients receiving only general anesthesia and reported lower VAS scores and decrease postoperative morphine dose used in patients receiving the PECS with general anesthesia.

On the other hand, many studies have described better pain relief when TPVB was used as adjuvant to general anesthesia with significant reduction in opioid dose used, patients receiving TPVB frequently describe pain in the axilla and upper limb at the same side of surgery, as the TPVB does not anesthetize the medial and lateral pectoral nerves as effectively as the long thoracic and thoracodorsal nerves, leading to inadequate analgesia of the axillary region (Blackshaw et al. 2018), while the PECS gives better analgesia as it blocks the medial and lateral pectoral nerves together with the long thoracic and thoracodorsal nerves (Bashandy and Abbas 2015).

Cowie et al. (Cowie et al. 2010) reported one complication of TPVB which is spreading of the dye from paravertebral space into the epidural space in 40% of cadavers after injection. Purcell-Jones et al. (1989) also showed that up to 70% of volume of injected in pravertebral space spread into the epidural space.

This study revealed that patients in PECS group had a significantly prolonged duration of postoperative analgesia as the request for 1st dose of analgesics was significantly delayed with significant reduction in total pethidine consumption in the PECS group in contrast with the TPVB group during the first postoperative 24 h. In another study, Wahba and Kamal (Wahba and Kamal 2013) used different volume of local anesthetic used in each group; however, they reported more postoperative morphine consumption with longer time for 1st requested analgesia in patients receiving pectoral nerve block compared with thoracic paravertebral block. Sidiropoulou et al. (Sidiropoulou et al. 2008) used continuous ropivacaine infusion and reported less pain intensity at 16 h and 24 h in PECS group in comparison with PVB. The present study used single injection technique to compare the outcome between the two groups.

Table 7 Time to first request of analgesia (h)

	Group A, PVB	Group B, PECS	*t* test	*p* value
Number of patients	***N* = 10**	***N* = 8**		
Mean ± SD	8.30 ± 4.76	14.00 ± 4.54	6.637	0.020*
Range	1–18	8–18		

Independent sample *t* test
p value > 0.05 NS; **p* value < 0.05 S

Table 8 Total dose of postoperative pethidine (mg)

	Group A, PVB (No. = 10)	Group B, PECS (No. = 8)	*t* test	*p* value
Mean ± SD	75.66 ± 10.82	37.15 ± 4.73	− 9.335	< 0.001
Range (mg)	40–90	30–40		

Independent sample *t* test; *p* value < 0.05 S

The VAS scores were significantly lower in patients receiving the PECS at 2, 4, and 6 h postoperatively compared with the patients receiving TPVB. Wahba and Kamal (Wahba and Kamal 2013) also reported lower pain scores at 1, 6, and 12 h in the PECS group compared with the TPVB group. On the other hand, Sopena-Zubiria et al. (Sopena-Zubiria et al. 2012) combined the pectoral nerve block together with TPVB and revealed more significant decrease in pain scores after breast surgery.

The main limitation of this study is that the patient and the anesthetist performing the block were not blinded to the group assignment. Also, we cannot use continuous injection with catheter insertion as our study was designed to compare between the two groups after single injection only.

Conclusion

The PECS is a more effective technique, provides better pain relief for longer time in contrast with the TPVB, and reduces postoperative opioid consumption with less hemodynamic changes. Accordingly, the PECS is more effective and safe when combined with general anesthesia for postoperative analgesia after modified radical mastectomy with axillary dissection.

Recommendations

Further studies are required to assess the efficacy of catheter insertion for continuous injection for better and more prolonged postoperative analgesia and its effect on chronic post mastectomy pain.

Abbreviations

ASA: American Society of Anesthesiologists; BMI: Body mass index; CXR: Chest x-ray; MRM: Modified radical mastectomy; PECS: Pectoral nerve block; REC: Research Ethics Committee; TPVB: Thoracic paravertebral block; VAS: Visual analog score

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Authors' contributions

Islam Gamal Hamed designed the study, revised literature, followed the patients and critically reviewed the manuscript. Ahmed Ali Fawaz designed the study, analyzed the data, and wrote and critically revised the manuscript. Tarek M Ashoor, Amal Hamed Rabie, and Abd El Aziz Abdallah Abd El Aziz revised literature, followed the patients, collected the data, performed the analysis, and wrote the manuscript. All authors approved the final version of the manuscript.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

Approval of research ethical committee of Faculty of Medicine, Ain-Shams University, was obtained (code number FMASU M D 49/2018) and informed consent was obtained from patients.

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

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