Original Article

Ultrasound-Guided Pectoral Nerves Block Type II or Intercostobrachial Nerve Block as A Supplement to Supraclavicular Block in End-Stage Renal Disease Patients' Arteriovenous Access: A Randomized Controlled Trial

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Abstract

Background: Intercostobrachial nerve (ICBN) innervates the upper half of the medial aspect of the arm and axilla. We hypothesized to assessing either pectoral nerves block type II (PECS II) or ICBN block would improve the quality of block for proximal arm arteriovenous access surgery.

Materials and Methods: In the study, forty adult patients with the end-stage renal disease aged between 18 and 70 years received a combined supraclavicular block with 30 ml 0.25% bupivacaine, and either ICBN (Group A, n = 20) or PECS II block with 10 ml 0.25% bupivacaine (Group B, n = 20) for proximal arm arteriovenous access surgery. The primary outcome was whether patients required intraoperative local anesthetic supplementation. Secondary outcomes were the volume of local anesthetic supplementation, fentanyl administration, Pain scores 24 hours postoperatively, and time to first postoperative rescue analgesia.

Results: Local anesthetic (LA) supplementation was required in 4 patients in group A and 6 patients in group B, and the mean volume of LA was lower in group A than group B as the complete sensory block in the medial side of the upper arm was achieved in 80% of patients in group A and 70 % in group B. There was a statistically significant decrease in time taken for blocks in group B (PECS) compared to group A and, the insignificant difference between the two studied groups regarding fentanyl received and time to 1st postoperative rescue analgesia.

Conclusion: ICBN and PECS blocks are ideal supplements to supraclavicular brachial (SCB) with statistically insignificant fewer patients in ICBN required LA volume and supplementation than PECS II block.

Keywords: Arteriovenous fistula, Intercostobrachial nerve, Pectoral nerve block

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Introduction

Concerning patients with end-stage renal disease (ESRD), arteriovenous (AV) access creation for hemodialysis has been the most preferred choice (1).

As those patients are known to be at increased risk for perioperative and postoperative complications (2), general anesthesia (GA), associated with increased cardiorespiratory complications (3). Therefore, Regional anesthesia (RA) is considered the safer and preferred option as it avoids significant risks associated with GA in these patients (4,5). Furthermore, only RA produces an associated sympathetic nerve block, which increases the venous diameter and vessel flow intra-operatively and for several hours postoperatively (6,7). These effects can help prevent thrombosis and early fistula failure and are essential for fistula maturation (8).

Brachial plexus block (BPB) is usually utilized for proximal arm arteriovenous access creation. However, the medial upper arm and axilla are often inadequately anesthetized because the Intercostobrachial nerve (ICBN) (which provides sensory supply to the axilla, upper medial arm, and a tiny area at the upper lateral chest) is not a component of the brachial plexus. This requires repeated, intraoperative local anesthetic (LA) supplementation to convert into GA (9,10).

The ICBN can be identified by using ultrasound (US) guidance and blocked either alone by selective US-guided ICBN blockade (11) or with other nerves, such as the pectoral, intercostal, and long thoracic nerves in a recently described technique named pectoral nerves block type II (PECS II) (12,13).

In this study, we compared the utilization of the PECS II block and ICBN block as a supplement to supraclavicular brachial plexus block (SCB) for providing complete anesthesia of the upper arm for fistula creation surgery.

Methods

The study was approved by the institute's medical ethical committee and registered at ClinicalTrials.gov (NCT04988776). written consent was obtained from all patients. This manuscript is under the Declaration of Helsinki and adheres to the applicable CONSORT guidelines. Forty adult patients were randomly selected to participate in the study. End-stage renal disease (ESRD) patients aged 18 to 70 years old belonged to the American Society of Anesthesiologists (ASA) physical status II or III. They were scheduled for the creation of a proximal arm arteriovenous fistula.

Patients were excluded if they had a history of allergy to local anesthetics, Preexisting upper limb neurological disease at the side of the surgery, patients on anticoagulant therapy or with a history of coagulopathy, Previous surgery at or near the site of the study, and The presence of skin infection at the puncture site.

Patients were evaluated, medically optimized before surgery, and were oriented with the technique of regional anesthesia, and the technique wont to assess the degree of sensory block. Patients were admitted to the operating theatre and applied standard monitoring. Intravenous access was secured, and all patients were monitored continuously for heart rate (three-leads Electrocardiogram), non-invasive arterial pressure, capnogram, and oxygen saturation. Patients were sedated using 0.05-0.1 mg/kg midazolam intravenously (IV). Oxygen via nasal cannula was applied to all patients at a rate of 5 liters/ minute.

Patients were positioned supine with the arm adducted, and therefore the head turned to the contralateral side. The supraclavicular block was carried out on all patients.

After sterile preparation of the neck with Povidone-Iodine 10%, with the patient in a 20-degrees head-up position, the brachial plexus trunks in the supraclavicular region imaged with a high-frequency linear ultrasound probe (FUJIFILM SonoSite M-Turbo, Bothell, WA, USA). Local anesthesia of the injection site was achieved with 2 ml 2% lidocaine. A sterile, insulated, 22-gauge, 88-mm needle (Spinocan; B. BRAUN. Melsungen AG, Germany) was introduced in-plane to the ultrasound beam, using a lateral to medial approach. After placing the needle tip near the intersection of the first rib and lateral aspect of the subclavian artery (‘corner pocket’), 15 ml 0.25% bupivacaine were injected with intermittent aspiration for blood and followed by redirection of the needle to the superior and middle trunks of the brachial plexus and administration of 15 ml 0.25% bupivacaine.

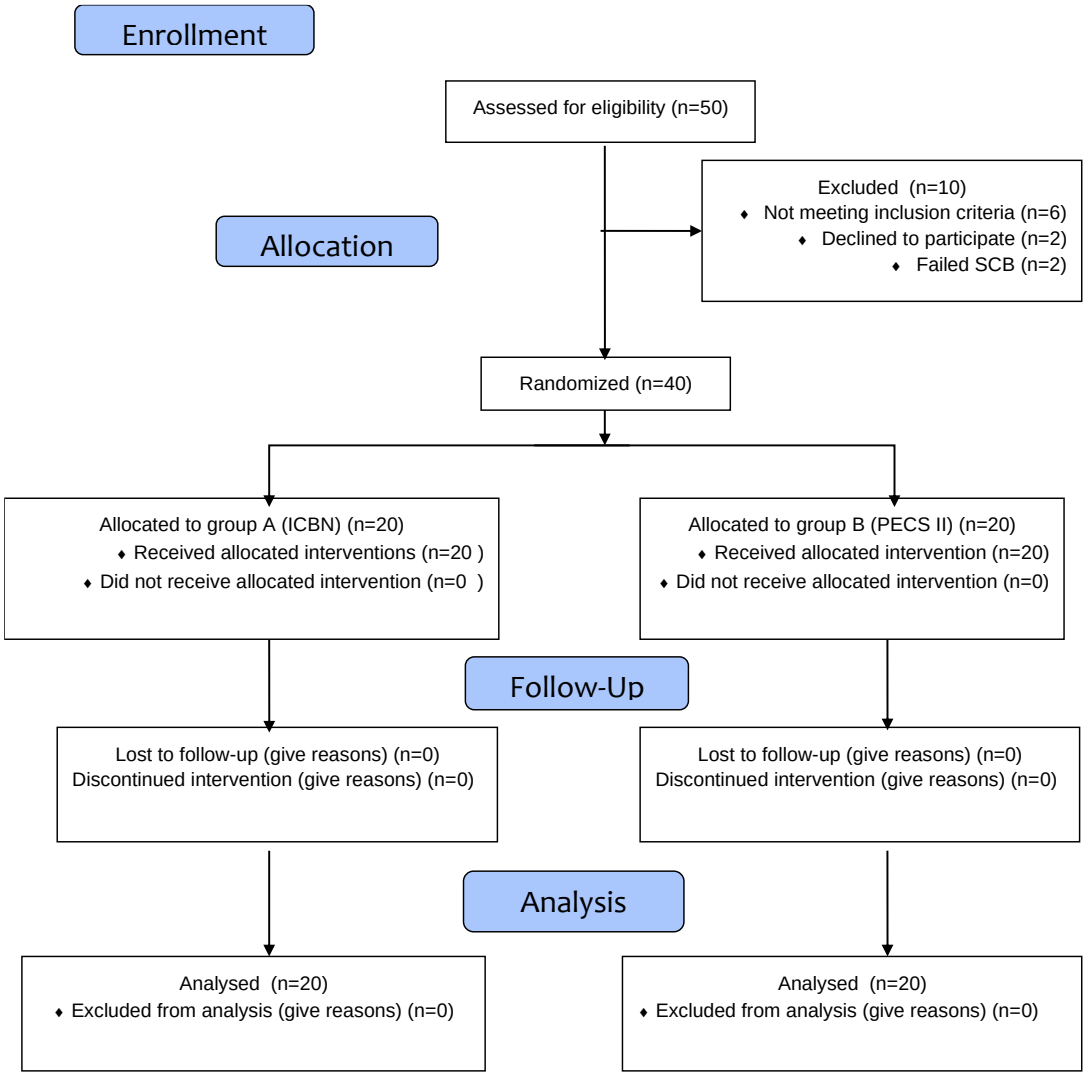

Figure 1. Study CONSORT flow chart.

After placing the needle tip near the intersection of the first rib and lateral aspect of the subclavian artery ('corner pocket'), 15 ml 0.25% bupivacaine were injected with intermittent aspiration for blood and followed by redirection of the needle to the superior and middle trunks of the brachial plexus and administration of 15 ml 0.25% bupivacaine. A total of 30 ml of 0.25% Bupivacaine were administered for the SCB.

The brachial plexus block was assessed at the sensory dermatomal distribution of the median, ulnar, radial, and musculocutaneous nerves. Patients with any sensory sparing within the distribution of those nerves were managed accordingly and were excluded from the study.

Patients were randomly allocated into two parallel groups by sealed closed envelopes were opened by another member not involved in the study. Each group included 20 patients who received either ICBNC or PECS II Block.

Group A (Intercostobrachial nerve block) (n= 20): The ICBN block was performed on the same side with the patient in the supine position. The arm was abducted and elevated above the head level. Using the US and the probe mentioned above, the probe was going to be positioned at the apex of the armpit to scan the axillary vein within the short axis view. The US probe slid proximally toward the base of the axilla at a distance of roughly 6 cm proximal to the medial aspect of the humeral head, and the axillary vein became

deeper on the US screen and inferior to the postero-lateral border of the pectoralis major muscle. The probe was then positioned slightly oblique for precise identification of the nerve in the cross-sectional view. The ICBNwill now appear as a hyper-echoic oval structure surrounded by a fascial split, superior and posterior to the axillary vein, midway on an imaginary line crossing the borders of the pectoralis major and latissimus dorsi muscles. After sterilization of the axillary area and sterile preparation of the US probe, blockade of the ICBN was performed with a sterile, insulated, 22-gauge, 88-mm needle (Spinocan; B. BRAUN. Melsungen AG, Germany) using an in-plain technique. After negative aspiration, 10 ml of bupivacaine 0.25% was injected under direct US visualization, and the local anesthetic that encircled the nerve was visualized.

Group B (Pectoral nerve block type II) (n=20): Following skin preparation with Povidone-Iodine 10%, the ultrasound probe was placed in a sagittal plane below the outer third of the clavicle to locate the axillary artery and vein. The probe was then directed inferolateral then medially until the pectoralis major, pectoralis minor, and serratus anterior muscles were identified at the level of the third rib.

After local infiltration of the skin with 2 ml 2% lidocaine, the block needle was introduced in-plane to the ultrasound beam during a cephalo-caudal direction, targeting the interfascial plane between the pectoralis minor and serratus anterior muscles at the second rib. Investigators took care was to avoid puncturing the axillary vessels, thoracoacromial artery, and pleura.

Once the needle-tip position was satisfactory, 10 ml 0.25% Bupivacaine was administered. If there were patients' perceived pain during surgery, the surgeon asked to provide further supplementation with 0.25% bupivacaine, keeping the total bupivacaine dose within safety limits of 3 mg/kg.

If the patient experienced discomfort, intravenous fentanyl in boluses of 1-2 µg/kg was given. General anesthesia was administered if the pain persisted despite local anesthetic supplementation and intravenous fentanyl, and the patient was excluded from the study.

All patients were followed up for twenty-four h after surgery. An assessor who was blinded to the studied groups recorded the study outcomes intraoperatively and postoperatively.

The primary outcome of interest was whether patients required intraoperative local anesthetic supplementation or not. This was a measure for the success of the regional anesthesia technique in accomplishing the complete loss of sensations from C5-T3 dermatomes. Secondary outcomes were:

- The volume of intraoperative local anesthetic supplementation
- additional analgesia required intraoperatively
- Time to first postoperative rescue analgesia
- Postoperative pain scores at 6, 12, and 24 h postoperatively
- Hemodynamics measures (HR and MAP) in preoperative, intraoperative, and postoperative periods

Statistical Analysis

This study was designed to be a randomized controlled prospective clinical trial. Initial trials might require a total sample size from 20 up to 80 participants. The formula used was:

$$n = \left(\frac{r+1}{r}\right)\frac{(\bar{p})(1-\bar{p})(Z_{\beta}+Z_{\alpha/2})^2}{(p_1-p_2)^2}$$

Where n is the sample size, Z is the statistic corresponding to the confidence level, and P is the expected prevalence. The required sample size was 40 cases, with a level of significance of 95% and a power of 80%.

Statistical Package for Social Sciences (SPSS/version 21) software was used for the statistical study analysis. The Chi-squared or Fisher Exact tests were used as appropriate for categorized parameters. For normally distributed data, Student's *t*-test was used while the Mann-Whitney U test was used for abnormally distributed data analysis. The level of significance was 0.05.

Results

Fifty patients were screened for recruitment. 6 patients did not meet the inclusion criteria, two refused to participate, and two had incomplete Supraclavicular block (Fig.1). Forty patients were included and divided equally into groups A and B. There were no differences

Table 1: Demographic data, ASA, and duration of surgery among the two studied groups.

		Group A (ICBN) (n = 20)		Group B (PECS) (n = 20)		Test value	P-value
		n	%	n	%		
Age (years)	**Mean± SD**	54.55± 8.51		50.95± 11.43		T= 1.13	0.266
Gender	**Male**	15	75.0%	16	80.0%	X^2= 0.143	FET 1.00
	Female	5	25.0%	4	20.0%		
weight (Kg)	**Mean± SD**	70.95±7.47		71.70±7.60		T=0.315	0.755
ASA	**II**	8	40 %	7	35 %	X^2=0.107	0.744
	III	12	60 %	13	65 %		
Duration of Surgery (minutes)	**Mean± SD**	96.25± 15.12		93.50± 16.07		T=0.557	0.581

Group A(ICBN): Intercostobrachial nerve block, Group B(PECS II): Pectoral nerve block Type II n=number of patients. P≤0.05 is considered statistically significant. Comparison between groups done by Independent Samples Student T-test, Chi-Square orFET= Fischer Exact Test and Mann- Whitney U test

Table 2: Block characteristics among the two studied groups.

		Group A (ICBN) (n = 20)		Group B (PECS) (n = 20)		Test value	P-value
		n	%	n	%		
Time taken for blocks (minutes)	**Mean± SD**	15.3± 3.0		11.3± 2.8		U= 63.5	**<0.001***
Loss of cold sensation at C5-T1 dermatomes	**No**	0	0.0%	0	0.0%	X^2= 0.0	-
	Yes	20	100.0%	20	100.0%		
Presence of upper limb motor blocks	**No**	0	0.0%	0	0.0%	X^2= 0.0	-
	Yes	20	100.0%	20	100.0%		
Loss of cold sensation at T2-T3 dermatomes	**partial**	4	20.0%	6	30.0%	X^2= 0.533	0.465
	complete	16	80.0%	14	70.0%		

Group A(ICBN): Intercostobrachial nerve block, Group B(PECS II): Pectoral nerve block Type II n=number of patients. P≤0.05 is considered statistically significant. Comparison between groups done by Chi-Square test and Mann- Whitney U test

between the two groups regarding the demographic data, ASA Score, and duration of surgery (Table 1). The time taken for the block was faster in group B than group A (11.3±2.8 versus 15.3±3 min) (Table 2). Group A displayed a higher proportion of patients with a complete sensory block at T2-T3 dermatomes than group B (80% versus 70%) (Table 2). A partial sensory block of the proximal arm was observed in 4 patients in group A and six patients in group B (Table 2).

While all patients in groups A& B completed the surgical procedure under the regional anesthetic technique. There were minimal differences between

Table 3: Intraoperative Outcomes among the two studied groups.

		Group A (ICBN) (n = 20)		Group B (PECS) (n = 20)		Test value	P-value
		n	%	n	%		
Surgical LA supplementation required	**No**	16	80.0%	14	70.0%	X^2= 0.533	0.465
	Yes	4	20.0%	6	30.0%		
Volume of LA supplemented (ml)	**0 ml**	16	80.0%	14	70.0%	X^2= 1.13	0.769
	5 ml	1	5.0%	3	15.0%		
	8 ml	1	5.0%	1	5.0%		
	10 ml	2	10.0%	2	10.0%		
Total Volume of LA supplemented (ml)		1.65±3.5		2.15±3.6		U=183	0.653
Additional analgesic required	**No**	12	60.0%	14	70.0%	X^2= 0.44	0.507
	Yes	8	40.0%	6	30.0%		
Fentanyl received (µg)	**0 µg**	12	60.0%	14	70.0%	X^2= 1.96	0.580
	50 µg	3	15.0%	4	20.0%		
	100 µg	4	20.0%	2	10.0%		
	150 µg	1	5.0%	0	0.0%		
Total fentanyl received (µg)	**Mean± SD**	35±48.94		20±34		U=172	0.459
Time to 1st post-operative rescue analgesic (hrs.)	**Mean± SD**	9.3± 3.5		11.5± 5.1		t= -1.591	0.12

Group A(ICBN): Intercostobrachial nerve block, Group B(PECS II): Pectoral nerve block Type II n=number of patients. P≤0.05 is considered statistically significant. Comparison between groups done by Independent Samples Student T-test, Chi-Square and Mann-Whitney U test

the two groups in terms of the percentage of patients who required LA supplementation with surgical incision (20% in group A versus 30% in group B), and the volume of LA administered was higher in group A than in group B with an insignificant statistical difference (Table 3). Also, the difference in analgesic (fentanyl) requirement was statistically negligible between the two groups (Table 3).

There was a statistically significant difference between the two studied groups regarding VAS in either 12 hrs. and 24 hrs postoperatively, as shown in (table 4). There was no statistically significant difference between the two studied groups regarding hemodynamics heart rate and mean arterial pressure (HR and MAP) (Table 5).

Discussion

Many previous studies have demonstrated the advantages of creating arteriovenous fistulas (AVFs) under regional anesthesia. This is presumably thanks to the avoidance of hemodynamic instability and stress response of general anesthesia. The sympathectomy associated with brachial plexus blockade improves regional vascular flow and early graft outcomes (5). Since vein diameter is the major limiting factor for primary AVFs creation and maturation (14,15),

Table 4: Comparison between the two studied groups as regards Visual analog scale (VAS).

			Group A (ICBN) (n = 20)	Group B (PECS) (n = 20)	Test value	P-value
Visual analogue scale (VAS)	**Intraoperative**	**Mean± SD**	0.2± 0.4	0.8± 1.2	U= 161.0	0.149
	6 hrs. Postoperative	**Mean± SD**	1.5± 1.7	1.5± 2.0	U= 197.5	0.942
	12 hrs. Postoperative	**Mean± SD**	3.1± 2.1	4.5± 1.5	U= 126.0	0.042
	24 hrs. Postoperative	**Mean± SD**	3.9± 2.0	5.7± 1.6	U= 103.0	0.008

Group A(ICBN): Intercostobrachial nerve block, Group B(PECS II): Pectoral nerve block Type II n=number of patients. P≤0.05 is considered statistically significant. Comparison between groups done by Mann- Whitney U test

Table 5: Comparison between the two studied groups as regards HR and MAP

			Group A (ICBN) (n = 20)	Group B (PECS) (n = 20)	Test value	P-value
HR	**Preoperative**	**Mean± SD**	81.3± 9.0	80.0± 8.8	T=0.462	0.647
	15 min. after block	**Mean± SD**	74.4± 7.8	74.1± 7.7	T=0.122	0.903
	Postoperative	**Mean± SD**	71.1± 7.2	73.5± 8.1	T=0.99	0.328
MAB	**Preoperative**	**Mean± SD**	105.75±14.0	101.5±12.3	T=1.02	0.314
	15 min. after block	**Mean± SD**	103.65±13.2	98.8±10.1	T=1.305	0.2
	Postoperative	**Mean± SD**	93.3±13.4	90.05±8.6	T=0.913	0.367

Group A(ICBN): Intercostobrachial nerve block, Group B(PECS II): Pectoral nerve block Type II n=number of patients. P≤0.05 is considered statistically significant, SD= standard deviation, comparison between groups done by Independent Samples Student T-test

brachial plexus block (BPB) is often utilized for proximal arm arteriovenous access creation. However, the medial upper arm and axilla are usually insufficiently anesthetized because the Intercostobrachial nerve (which provides sensory supply to the axilla, upper medial arm, and a small area at the upper lateral chest) is not a component of the brachial plexus. This requires repeated, intraoperative local anesthetic (LA) supplementation to convert into GA (16). Our study is the first clinical trial comparing the use of the ultrasound-guided PECS II block and ICBN block as a supplement to supraclavicular brachial plexus block for providing complete anesthesia of the upper arm fistula creation surgery. The most recent recommendations come in the increased use of ultrasound guidance for regional anesthesia (17).

The present study results showed a higher success rate (complete sensory block), less volume of LA supplementation, better postoperative analgesia, and prolonged block time in ICBN than in PECS with hemodynamic stability in both groups.

As regards the success rate, our results are consistent with Magazzeni et al. (18), who compared the conventional and the ultrasound-guided approach of distal ICBN block in addition to the medial brachial

cutaneous nerve and found the success rate with the use of ultrasound reached 90%. Also, another study combined axillary brachial plexus block with subcutaneous infiltration of 2 ml 1% lidocaine just over the axillary artery and demonstrated a late but complete sensory block within the whole medial surface of the arm; however, the study patients were undergoing forearm and hand surgery. Hence, the medial compartment of the arm was not truly examined by surgical stimulation, and the axilla was not concerned with sensory anesthesia (19).

In contrast to our study, Mostafa et al. (14), who studied two different methods of Intercostobrachial nerve block combined with brachial plexus block during superficialization of arteriovenous fistula and found that the success rate in distal intercostobrachial nerve versus proximal Intercostobrachial nerve (PECS) was 51% and 84% respectively, as a result of the different technique and LA volume they were used in ICBN. Another study by y Maria et al. (20) reported that axillary brachial plexus block is enough to cover tourniquet pain, and the additional intercostobrachial nerve block is not required. However, superficialization of the arteriovenous fistula involves extending the surgical incision to the apex of the axilla, which is not the case during tourniquet application. Indeed, Purcell and Wu (21) had combined supraclavicular brachial plexus block and pectoral nerves block (PECS II) for upper arm fistula with apparent good results as they reported that these patients had complete anesthesia at the surgical site and did not require any additional LA supplementation by the surgeon, which is contrary with the results of our study. In our study, complete anesthesia was not obtained in all patients in the PECS II group can be explained by anatomical variations, and a small number of patients underwent their report.

Intercostobrachial nerve block took a long time to achieve blocks than pectoral nerves block type II. Although small nerves can be visualized using the US, that successful blockade is feasible. Still, the operator should rely on prominent anatomical sono-landmarks described by Thallaj et al. (11), so making a selective block to ICBN took much time. We included both males and females with some difficulties in determining landmarks (22).

The study of Moustafa et al. (15) reported a more extended period in the Intercostobrachial nerve block than pectoral nerves block, which is similar to our study. Also, in the study of Quek et al. (9), they also reported time to achieve PECS block (8–14 min).

Regarding the postoperative Visual analog scale, patients who received ICBN block experienced less pain than others who received PECS block. Also, Quek et al. found an insignificant difference between PECS and SCB. Furthermore, Wisotzky et al. (23) reported axillary pain relief after ICBN perineural injection following breast cancer surgery.

Limitations of the study include a small number of patients, so more extensive studies are recommended to enable detection of complications associated with the need for repeated local anesthetic infiltration, additional systemic analgesia, sedation, or even general anesthesia, if not performing an auxiliary block. These studies will enable anesthesiologists to determine if the benefits of the extra-regional block outweigh its risks. Also, we recommend Dose-comparison studies aiming to characterize the optimal volume and concentration required of LA for PECS II and ICBN blocks.

Conclusion

This study suggests that the ICBNB or PECS II block are effective adjuncts to a supraclavicular brachial plexus block for renal failure patients undergoing proximal arm arteriovenous access surgery with a higher success rate (complete sensory block), less volume of LA supplementation, better postoperative analgesia, and prolonged block time in ICBNB than in PECSB.

Acknowledgment

None.

Conflicts of Interest

The authors declare that they have no conflict of interest.

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