Original Article

Comparison between ultrasound-guided subpectoral intercostal plane approach and pectoserratus plane approach for intercostobrachial nerve block in surgeries involving posterior and medial aspects of the arm – A randomised comparative trial

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ABSTRACT

Background and Aims: The intercostobrachial nerve (ICBN), along with the brachial plexus, supplies the medial and posterior aspects of the upper arm. This study hypothesised that ultrasound blockade of ICBN by subpectoral intercostal plane block may provide faster and complete blockade compared to the pectoserratus plane block. **Methods:** Sixty patients were randomised into two groups, and initially, an ultrasound-guided supraclavicular brachial plexus block was performed. After 10 min, Group A received a subpectoral intercostal plane block at the second rib. Group B received a pectoserratus plane block at the fourth rib. Anaesthesia over the posterior and medial aspects of the upper arm was assessed. The primary outcome was the time of onset of the blockade. The secondary outcome was the time taken to perform the block and the block failure rate. Student's *t*-test was used to compare the means. The categorical variables were compared using the Chi-squared test. Significance was defined by a *P* value of <0.05. **Results:** The time of onset of the block over the medial and posterior sides of the arm was significantly faster in Group A. Time taken for administering block in Group B was more than twice that of Group A ($P < 0.001$). The block was 100% successful in Group A, while in Group B, only 70% was successful. **Conclusion:** The subpectoral intercostal plane block at the second rib produces a faster and more complete blockade of ICBN in all patients compared to the pectoserratus plane block at the fourth rib.

Keywords: Brachial plexus block, intercostobrachial nerve, pectoserratus plane block, subpectoral intercostal plane block, ultrasonography

INTRODUCTION

Supraclavicular brachial plexus block does not guarantee surgical anaesthesia over the posterior and medial sides of the upper arm because of the communication between branches of the brachial plexus (medial cutaneous nerve of arm and posterior cutaneous nerve of arm) and intercostobrachial nerve (ICBN). So, along with the brachial plexus block, the ICBN block is also required to achieve complete anaesthesia of the entire upper limb.

The origin, branching, course and communications of ICBN are highly variable. In general, it originates as a lateral cutaneous branch of the second intercostal nerve with variable contribution from the first and third intercostal nerves. Contributions from T4 have

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also been reported. It penetrates the second space intercostal muscles and serratus anterior to reach the axillary fossa. Through its communication with branches of the brachial plexus, ICBN innervates the medial and posterior aspects of the upper arm.[1–3] Because of the variable anatomy, several methods have been proposed to block this nerve, such as simple landmark techniques,[4] ultrasound-guided selective ICBN block in the axilla,[5] various fascial plane blocks, namely Pectoral nerve block II (PEC-II)[6] serratus anterior plane block[7] and serratus–intercostal fascial plane block,[8] and paravertebral block.[9] Some of the methods listed above have high failure rates in terms of ICBN blockade.[4,5,10] Therefore, we have arrived at a simple, subpectoral intercostal plane block with a bony target, which is easy to visualise using ultrasound. In our institution, open reduction and internal fixation of the humerus via posterior incision and harvesting of skin graft from the medial side of the arm are frequently performed. We compared the technique we follow in our institution – subpectoral intercostal plane block at the second rib with the already established pectoserratus plane block at the fourth rib. The pectoserratus plane block at the fourth rib is the second component of Blanco's PEC-II block.[11]

The primary objective of our study was to evaluate the time of onset of sensory blockade of ICBN in Group A (subpectoral intercostal plane block) and Group B (pectoserratus plane block). The secondary objective was to compare the time taken to perform the ICBN block in both groups and to assess the block failure rate. We hypothesised that ultrasound blockade of ICBN by subpectoral intercostal plane block at the second rib may provide a faster onset of blockade with a high success rate, and the technique may be easier to perform compared to the pectoserratus plane block at the fourth rib.

METHODS

This randomised double-blind study was conducted between December 2023 and February 2024 after approval from the Institutional Ethical Committee (File No: EC/NEW/INST/2020/1084, dated 30 May 2023) was obtained and registration was done with Clinical Trials Registry-India (vide registration number CTRI/2023/12/060413, dated 1 December 2023, accessible at www.ctri.nic.in). The study was conducted using the principles of the Declaration of Helsinki, 2013 and Good Clinical Practice guidelines. Written informed consent was obtained from patients to participate in the trial and to use the patient data for research and educational purposes.

Patients with American Society of Anesthesiologists (ASA) physical status I/II, aged between 18 and 70 years, undergoing surgical fixation of humerus via posterior skin incision and harvesting skin graft from the medial side of the arm were enroled. Patients allergic to local anaesthetic, patients with body weight less than 50 kg, pregnant ladies, patients on anticoagulant therapy and patients having bleeding diathesis were excluded. After enrolment, the participants were randomised into two groups (n = 30) based on a computer-generated random number of samples [Randomizer (Research Randomizer {Version 4.0} Lancaster, PA, USA)]. To adhere to allocation concealment, we used a sealed opaque envelope technique. The investigator who assessed the outcomes and the participants were blinded to the technique and method of allocation concealment. The anaesthesiologist performing the blocks did not participate in the study or data analysis. Anaesthesiologists with experience in performing more than 100 such procedures performed both techniques.

Subjects were positioned in the supine position, standard ASA monitors were attached, and oxygen was administered via nasal cannula. Midazolam and pentazocine were titrated intravenously for patient comfort. After skin disinfection and draping, a linear high-frequency (5–13 MHz) ultrasound probe (Sonosite Edge II; Fujifilm Sonosite®, Inc, Bothell, WA, USA) was used to identify the targets. The skin puncture site was anaesthetised using lignocaine 2%. The local anaesthetic used was a mixture of 20 ml of 0.5% bupivacaine and 10 ml of 2% lignocaine diluted to 40 ml, taking care not to exceed the toxic doses. Both groups initially received a supraclavicular brachial plexus block with 20 ml of local anaesthetic mixture. After 10 min, both groups were assessed for supraclavicular brachial plexus blockade. In addition, the medial and posterior parts of the upper arm were tested for loss of sensation to pinprick. Only those patients who had brachial plexus blockade with sensory sparing along the medial and posterior aspects of the upper arm were included in the study.

After this, the ICBN block was performed in both groups by one of the two techniques proposed, using a 24-gauge 1.5″ needle, where 15 ml of local anaesthetic mixture was injected. In Group A, patients were

kept supine, the arm kept by the side and the linear transducer was kept in the oblique parasagittal plane just below the outer third of the clavicle medial to the coracoid process in such a way that the cranial end of the probe touched the clavicle [Figure 1]. Axillary vessels were identified, and the probe was moved medially [Figure 2]. At the point where the axillary vein starts disappearing, the second rib seems to rise up from below. The needle was inserted in the caudocranial direction, and 15 ml of the local anaesthetic mixture was injected after hitting the lower border of the second rib, taking care to avoid the possible complications of intravascular injection and pleural injury. The drug spreads over the intercostal muscle in between the ribs in the subpectoral plane and over the second and third ribs [Figure 3]. This figure shows the craniocaudal spread of the drug. (Refer supplementary video 1).

In Group B, patients were in the supine position with their arms abducted. The ultrasound linear transducer was placed at the midclavicular line and angled inferolateral to find the third and fourth ribs. Fifteen millilitres of local anaesthetic mixture was then administered between the pectoralis minor and serratus anterior muscles at the level of the fourth rib at the anterior axillary line – pectoserratus plane block.

In both groups, the onset of the sensory block was assessed by the absence of sensation to pinprick over the medial and posterior aspects of the upper arm. It was checked at 2-min intervals for 15 min, starting from the time at which the needle was withdrawn after drug administration, and the time taken to perform the block included the time taken to identify the sonoanatomical landmarks and the block execution time. The time taken to identify the sonoanatomical landmarks is the time taken to identify the target point of injection. The block execution time is from the time of needle insertion after identification of the sonoanatomical landmarks till needle withdrawal after completion of drug administration. After 15 min, if there was no sensory loss over the posteromedial part of the upper arm, they were grouped as block failure. These patients were given general anaesthesia with controlled ventilation. Regression of block could not be assessed in either group during the postoperative period due to surgical dressing. A blinded research associate gathered the above data.

The sample size was calculated using G* Power software version 3.1.9.7 (Heinrich Heine Universität Düsseldorf, Düsseldorf, Germany) by *t*-test for the difference between two independent means. In a previous study by Moustafa and Kandeel,[4] the mean onset of sensory block was 8.75 min in the group that

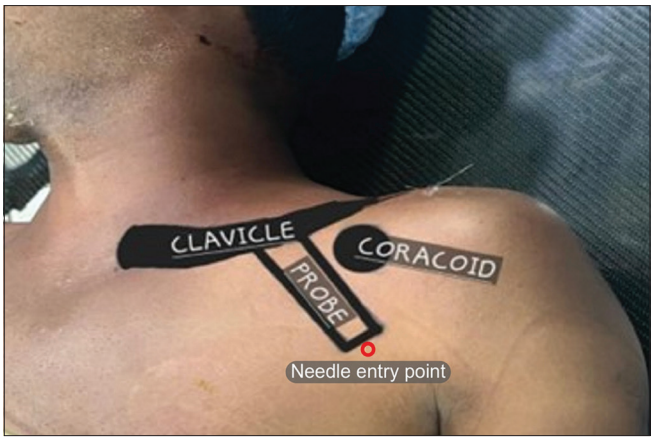

Figure 1: Anatomical landmarks for performing the subpectoral intercostal plane block

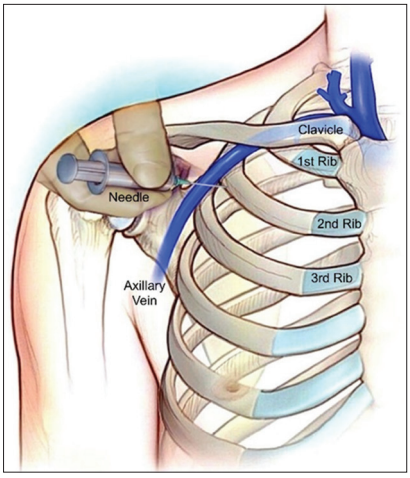

Figure 2: Schematic representation of needle position in the subpectoral intercostal plane block

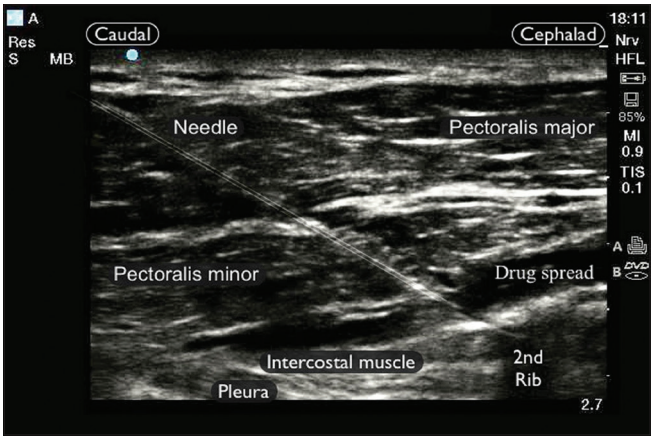

Figure 3: Sonoanatomy and drug spread in the subpectoral intercostal plane block. HFL = High Frequency Linear, MI = Mechanical Index, TIS = Thermal Index for Soft tissue, MB = Mode B

received proximal ICBN block and 10 min in the group that received distal ICBN block. For a confidence level of 95% and power of 80%, the calculated sample size was 28 for each arm. Accounting for dropouts, the sample size was rounded to 30 in each arm.

Data collected was presented as mean and standard deviation. Statistical analysis was done using Statistical Package for the Social Sciences statistics software version 21.0 (International Business Machines Corporation, Armonk, NY, USA). Student's *t*-test was used to compare the mean time taken for the ICBN block and the mean time taken for the complete block. The Chi-squared test was used to compare the count of patients requiring rescue analgesia. Significance was defined by a *P* value of <0.05.

RESULTS

A total of 66 patients were assessed for eligibility, of which six were excluded. Sixty patients were randomised into two groups [Figure 4]. The demographic variables in each group were comparable, and there was no significant difference between the groups [Table 1]. The time of onset of the sensory block over the medial and posterior sides of the upper arm was significantly shorter in Group A ($P < 0.001$). The time taken to perform the ICBN block in Group B was more than twice that of Group A ($P < 0.001$). Thirty per cent of cases in Group B had failure, necessitating rescue anaesthesia, while it was complete in all cases in Group A [Table 2].

DISCUSSION

Subpectoral intercostal plane block had a faster onset of ICBN blockade with less block performance time and a 100% success rate compared to pectoserratus plane block at the fourth rib. There were no complications in both groups.

On reviewing the various articles pertaining to the ICBN block technique broadly, there are two methods:

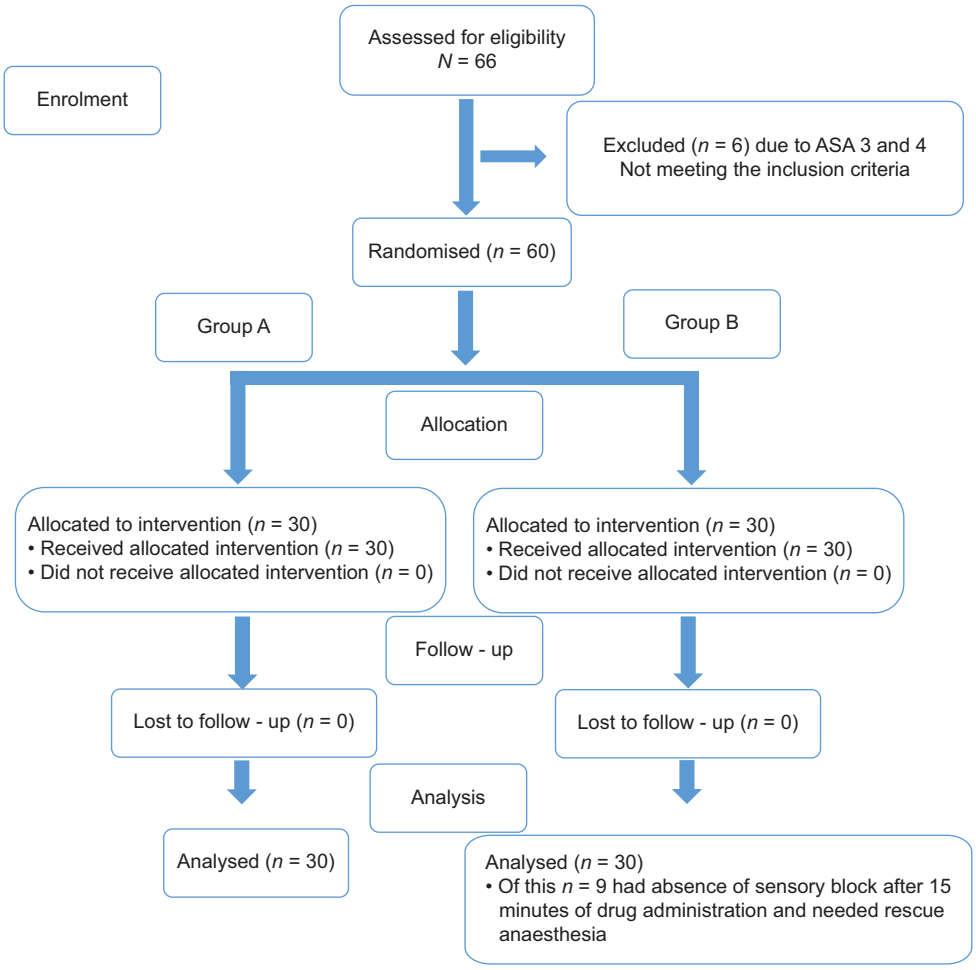

Figure 4: CONSORT flow diagram. Group A: subpectoral intercostal plane block. Group B: pectoserratus plane block. *n* = number of patients. ASA = American Society of Anesthesiologists, CONSORT = Consolidated Standards of Reporting Trials

distal and proximal. In the distal method, the drug is injected at the axilla or the medial side of the arm. Infiltration along the medial side of the arm at the level of insertion of the deltoid muscle is the common technique followed. In a study by Samerchua *et al.*,[5] the drug was injected over the latissimus dorsi, 2–4 cm caudal to the axillary artery. This technique failed in a significant number of cases as by the time the nerve reached the level of the latissimus dorsi, it had given off branches. So, we avoided the distal method to block ICBN.

Proximal blocks are interfascial chest wall blocks. The drug was injected near the chest wall at either the second, third or fourth intercostal space in between the pectoralis minor and serratus anterior fascial plane. PEC-II[6] and serratus anterior plane blocks[7] are the common blocks performed. They were developed as substitutes for the thoracic epidural and paravertebral blocks.[9]

Moustafa and Kandeel,[4] in their study, injected 6 ml of 0.25% bupivacaine at the level of the third rib in the anterior axillary line between the pectoralis minor and serratus anterior muscles. Of this, 14% had failure. This may be due to the inadequate volume of the drug used.

In a cadaveric study by Altinpulluk *et al.*,[12] 10 ml of methylene blue was injected over the surface of the second rib, and the spread of the dye was around both ICBN and the medial antebrachial cutaneous nerve. In a cadaveric study by Samerchua *et al.*,[5] 10 ml of the dye was injected medially into the medial border of serratus anterior over the inferior border of the second rib. However, the authors could not clearly identify the serrations of the serratus anterior muscle over the first and second ribs in all the specimens. Therefore, we aimed at a point at the lower border of the second rib just medial to the axillary vessels, which is easily visible.

We have drawn the following conclusions from the aforementioned review of the literature and our clinical experience: (1) ICBN typically develops as a lateral branch from the second intercostal nerve, with varying contributions from the first, third and fourth intercostal nerves. Therefore, enough local anaesthetic should be used to spread craniocaudally to the nearby intercostal spaces. (2) ICBN exits the chest wall at the lower border of the second rib near the midaxillary line. So, the target of injection should be at the lower border of the second rib close to the midaxillary line.

Based on the above observations, we selected the lower border of the second rib, just medial to the axillary vein, as the target of injection. The drug spread superficially to the intercostal muscle in the subpectoral plane and also over the ribs. In a few cases, it spread over the serratus anterior muscle in the pectoserratus plane. The lateral spread of the drug could not be visualised using ultrasound as the lateral aspect of the second rib is deep and underneath the axillary vessels.

The higher failure rate in Group B may be due to the target site at the fourth rib, and the drug may take a longer time to reach the second intercostal space. The time taken to perform the block in Group B was more than twice that of Group A ($P < 0.001$). In Group B, the identification and injection at the precise plane between pectoralis minor and serratus anterior may not be easier in all cases, hence the delay. However, in Group A, the injection target was a bony point, which is easily recognised as a hyperechoic structure on ultrasound.

Table 1: Demographic variables

Parameter	Group A (*n*=30) Mean (SD)	Group B (*n*=30) Mean (SD)
Age (years)	36.81 (1.8)	41.2 (12.6)
Gender:Male/female	22/8	117/13
Weight (kg)	61.1 (6.4)	64.3 (9.0)
Height (m)	1.6 (0.1)	1.6 (0.1)

Data presented as mean (SD) or number of patients. Group A – subpectoral intercostal plane block. Group B – pectoserratus plane block. SD=standard deviation

Table 2: Comparative assessment of study parameters

Parameter	Group A (*n*=30) Mean (SD)	Group B (*n*=30) Mean (SD)	*P*	Mean difference (95% CI)	Effect size
Time taken for ICBN block (min)	1.6 (0.7)	3.9 (0.8)	<0.001	2.3 (1.9, 2.7)	3.08
Time of complete block over the medial side of the arm (min)	2.1 (0.5)	9.1 (2.9) (*n*=21)[a]	<0.001	7.0 (5.8, 8.6)	3.45
Time of complete block over the posterior side of the arm (min)	2.3 (0.7)	10.1 (3.0) (*n*=21)[a]	<0.001	7.8 (6.4, 9.0)	3.84
Rescue anaesthesia, *n*	0	9	<0.001		

Data presented as mean (SD), 95% CI=confidence interval (lower limit, upper limit). Group A – subpectoral intercostal plane block; Group B – pectoserratus plane block[a] Patients whose sensory block was absent after 15 min of drug administration were excluded from calculating these parameters. CI=confidence interval, ICBN=intercostobrachial nerve, SD=standard deviation, *n*=number of patients

The concern regarding the safety of our technique was the possibility of pleural injury, which is close to the point of injection, and accidental intravascular injection. There was no need to manipulate and position the fractured limb to perform the block in Group A. We waited for only 10 min after performing supraclavicular brachial plexus block in both groups to reduce the operation theatre utilisation time in total. This could be a study limitation as a complete blockade of the supraclavicular brachial plexus may take a longer time. Further cadaveric studies need to be done to prove the exact plane of the spread of the drug in the subpectoral intercostal plane block.

CONCLUSION

The subpectoral intercostal plane block at the second rib produces a faster and more complete blockade of intercostobrachial nerve in all patients compared to the pectoserratus plane block at the fourth rib.

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Study data availability

De-identified data may be requested with reasonable justification from the authors (email to the corresponding author) and shall be shared after approval as per the authors' institution policy.

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Conflicts of interest

There are no conflicts of interest.

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REFERENCES

1. Drake RL, Vogl W, Mitchell AWM. Gray's Anatomy for Students. 4th ed. Philadelphia: Elsevier; 2020.
2. Xaviour R. Uncommon configuration of intercostobrachial nerves, lateral roots, and absent medial cutaneous nerve of the arm in a cadaveric study. Anat Cell Biol 2023;56:570–4.
3. Cirocchi R, Matteucci M, Randolph J, Duro F, Properzi L, Avenia S, *et al*. Anatomical variants of the intercostobrachial nerve and its preservation during surgery, a systematic review and meta-analysis. World J Surg Oncol 2024;22:92. doi: 10.1186/s12957-024-03374-w
4. Moustafa MA, Kandeel AA. Randomized comparative study between two different techniques of intercostobrachial nerve block together with brachial plexus block during superficialization of arteriovenous fistula. J Anesth 2018;32:725–30.
5. Samerchua A, Leurcharusmee P, Panjasawatwong K, Pansuan K, Mahakkanukrauh P. Cadaveric study identifying clinical sonoanatomy for proximal and distal approaches of ultrasound-guided intercostobrachial nerve block. Reg Anesth Pain Med 2020;45:853–9.
6. Yadav M, Dixit A, Rathiya AK, Agrawal SK. Role of pectoral nerve block (PECS II) in post-operative pain management for breast surgeries. Asian J Med Sci 2022;13:59–65.
7. Biswas A, Castanov V, Li Z, Perlas A, Kruisselbrink R, Agur A, *et al*. Serratus plane block: a cadaveric study to evaluate optimal injectate spread. Reg Anesth Pain Med 2018;43:854-8.
8. Kaur U, Shamshery C, Agarwal A, Prakash N, Valiveru RC, Mishra P. Evaluation of postoperative pain in patients undergoing modified radical mastectomy with pectoralis or serratus-intercostal fascial plane blocks. Korean J Anesthesiol 2020;73:425-33.
9. Ardon AE, Lee J, Franco CD, Riutort KT, Greengrass RA. Paravertebral block: Anatomy and relevant safety issues. Korean J Anesthesiol 2020;73:394–400.
10. Makkar J, Dahiya D, Jain D, Kuber A, Kajal K, Singh N. Effect of balanced anaesthesia with and without modified pectoralis nerve block on postoperative analgesia after breast surgeries: A randomised controlled trial. Indian J Anaesth 2021;65(Suppl 3):S110-4.
11. El-Boghdadly K, Wolmarans M, Stengel AD, Albrecht E, Chin KJ, Elsharkawy H, *et al*. Standardizing nomenclature in regional anesthesia: An ASRA-ESRA Delphi consensus study of abdominal wall, paraspinal, and chest wall blocks. Reg Anesth Pain Med 2021;46:571–80.
12. Altinpulluk EY, Galluccio F, Salazar C, Simón DG, Espinoza K, Olea MS, *et al*. New approach for blocking intercostobrachial and medial brachial cutaneous nerve in the axillary area: Response to Varela. Reg Anesth Pain Med 2020;45:841-2.