Indian Journal of Clinical Anaesthesia 2025;12(4):676–683

Content available at: https://www.ipinnovative.com/open-access-journals

Indian Journal of Clinical Anaesthesia

Journal homepage: www.ijca.in

Original Research Article

A prospective randomized interventional study comparing lateral sagittal and costoclavicular approaches for ultrasound-guided infraclavicular brachial plexus block

Abhijith Rao[1*], Sushil Bhati[1], Sonali Bhatia[1], Raman Deep[1]

[1]Dept. of Anaesthesiology, Sawai Man Singh Medical College, Jaipur, Rajasthan, India

Abstract

Background and Aim: Infraclavicular brachial plexus block is a reliable regional anesthesia technique for upper limb surgeries. Among the commonly used approaches, the costoclavicular (CC) and lateral sagittal (LS) techniques target the brachial plexus at distinct anatomical sites, each with specific advantages and limitations. This randomized controlled trial aimed to compare the CC and LS approaches in terms of onset times for sensory and motor block and overall time to readiness for surgery.

Materials and Methods: A total of 128 patients, aged 18–60 years with ASA physical status I or II, scheduled for upper limb surgery under regional anesthesia, were randomized into two groups: Group A (LS approach) and Group B (CC approach). Each patient received 25 mL of 0.5% ropivacaine. Sensory and motor block of the median, ulnar, radial, and musculocutaneous nerves were assessed using a verbal rating scale (0–5) and a qualitative scale (0–2), respectively, at regular intervals. The primary outcome was time to readiness for surgery; secondary outcomes included onset times for sensory and motor block, block performance time, and time to first rescue analgesia.

Results: The CC approach (Group B) demonstrated significantly faster onset of sensory block (7.5 min [IQR 6.25–8.75]) and motor block (5 min [IQR 5–5]) compared to the LS approach (Group A: sensory = 15 min [IQR 15–16.25]; motor = 10 min [IQR 5–10]) ($p<0.001$). Time to readiness for surgery was also significantly shorter in the CC group (7.5 min vs 15 min, $p<0.001$). No significant difference was observed in block performance time ($p = 0.593$) or time to first rescue analgesia ($p = 0.338$) between the groups.

Conclusion: The costoclavicular approach to infraclavicular brachial plexus block offers a faster onset of sensory and motor blockade and quicker readiness for surgery compared to the lateral sagittal approach, with comparable safety and performance profiles.

Keywords: Costoclavicular approach, Lateral sagittal approach, Infraclavicular block, Brachial plexus block.

Received: 30-06-2024; **Accepted:** 28-07-2025; **Available Online**: 31-10-2025

This is an Open Access (OA) journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: reprint@ipinnovative.com

1. Introduction

The brachial plexus block is a highly effective method for providing anaesthesia during procedures involving the upper limb. Patients who receive peripheral nerve blocks during surgery can avoid or decrease the amount of time they spend in the recovery area and be promptly discharged after outpatient surgery.

Infraclavicular block brachial plexus block (ICBPB) was developed to achieve brachial plexus anaesthesia without the adverse effects of supraclavicular block. It was among the first blocks to be depicted using ultrasonographic imaging.[1-3] ICBPB selectively blocks the brachial plexus at the cords, effectively producing anaesthesia and analgesia for surgical procedures involving the upper extremities.[4,5] In 2015, Karmakar et al. introduced the costoclavicular method for brachial plexus block as a substitute for the lateral sagittal (LS) route.[6]

In LS approach, the brachial plexus cords are positioned 4-6 cm deep,[7] away from one another, and may have

*Corresponding author: Abhijith Rao
Email: abhijithone@proton.me

https://doi.org/10.18231/j.ijca.22222.1761898004
© 2025 The Author(s), Published by Innovative Publications.

significant variability in position.[8,9] A single sagittal ultrasound scan seldom shows all three cords[9] and several injections may be necessary for successful brachial plexus block.[10] The costoclavicular (CC) approach has the potential to address certain limitations inherent in the LS approach. In the CC area, the cords of the brachial plexus are positioned lateral to the axillary artery,[0-0] maintaining a consistent anatomical relationship with each other and the axillary artery.[0,0,13] All three cords can be visualized in a single transverse ultrasound scan, allowing for successful brachial plexus block with a single injection of a relatively small volume of local anesthetic (20–25 mL).[0]

We hypothesized that the costoclavicular approach would lead to a more rapid onset of sensory and motor blockade compared to the lateral sagittal approach. Additionally, we aimed to compare the two techniques with respect to time to readiness for surgery, overall sensory and motor block scores, and the time to first rescue analgesia.

2. Materials and Methods

This prospective, randomized controlled study was approved by the institutional ethics committee and registered with the Clinical Trials Registry of India (CTRI/2022/01/039525). A total of 128 patients aged 18 to 60 years, with American Society of Anesthesiologists (ASA) physical status I or II and a body mass index (BMI) ≤30 kg/m², scheduled for elective upper limb surgeries lasting less than four hours, were enrolled. Exclusion criteria included patient refusal, local infection at the site of block placement, coagulopathy, allergy to local anaesthetics, pre-existing peripheral neuropathy, or significant cardiac, pulmonary, hepatic, or renal dysfunction. Randomization was performed using a computerized random number table, with allocation concealment ensured. Patients were randomized into two groups: Group A (lateral sagittal approach) and Group B (costoclavicular approach). All blocks were performed by a senior anaesthesiologist with expertise in both techniques. Procedural data were recorded by the principal investigator. Sensory and motor block assessments were conducted by a nurse who was blinded to group allocation and not present during block placement. The same blinded nurse carried out postoperative assessments on the following day (**Figure 1**).

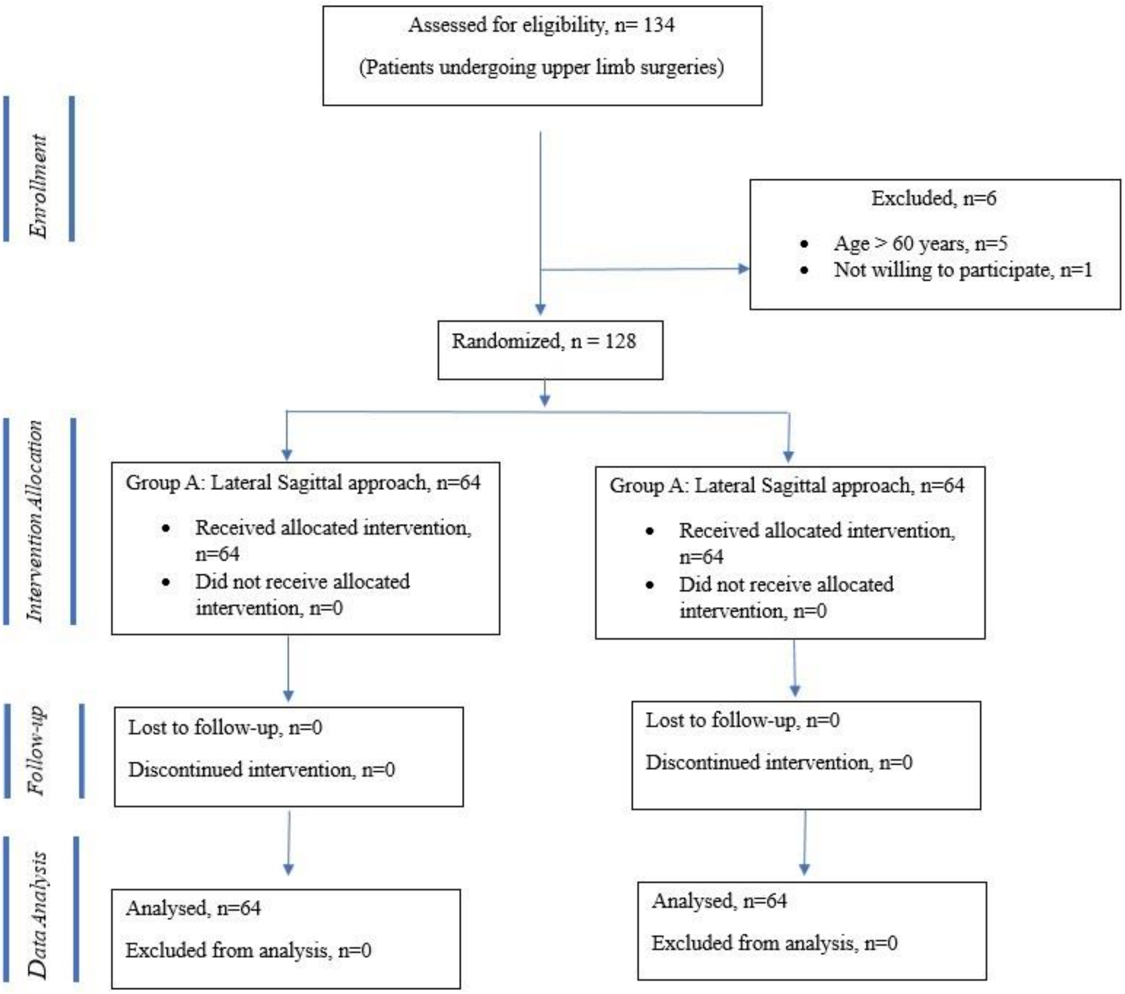
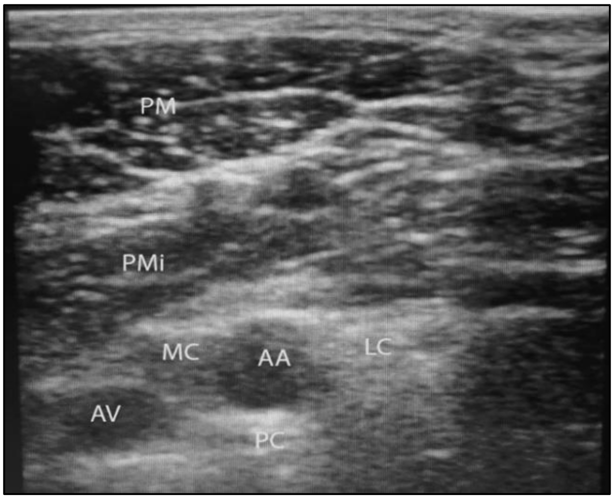


Figure 1: Consort for the study

All patients underwent a thorough pre-anaesthetic evaluation and were advised to follow ASA fasting guidelines. Written informed consent was obtained after explaining the study objectives, procedure details, and potential risks. In the preoperative area, baseline vital signs were recorded, intravenous access was secured, and an infusion of Ringer's lactate or normal saline was initiated. Upon arrival in the operating theatre, standard monitoring was established, including electrocardiography, pulse oximetry, and non-invasive blood pressure. Intravenous midazolam (0.02 mg/kg) was administered to anxious patients.

Block procedures were conducted under strict aseptic precautions with the patient in the supine position, ipsilateral arm abducted to 90°, palm facing upward, and the head gently turned to the opposite side. A cushion was placed under the interscapular area for optimal positioning. A local anaesthetic skin wheal was created using 2–3 mL of 1% lidocaine. All blocks were performed under ultrasound guidance using a high-frequency linear probe (6–13 MHz; Sonosite, FUJIFILM Sonosite, Inc.) and a 21-gauge block needle. After confirming appropriate needle placement and negative aspiration for blood, 25 mL of 0.5% ropivacaine was injected incrementally under real-time ultrasound visualization.

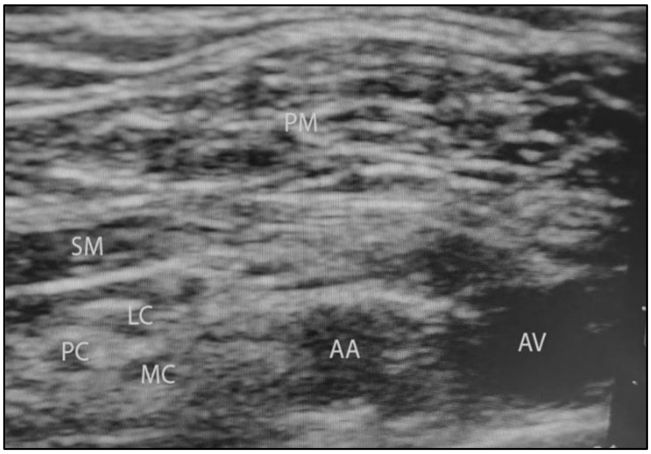
In Group A (lateral sagittal approach), a sagittal scan was performed medial to the coracoid process to obtain a transverse image of the second part of the axillary artery and the three cords of the brachial plexus (**Figure 2**). The needle was inserted in-plane from cephalad to caudad. Half of the local anaesthetic volume was administered at the 6 o'clock position, posterior to the axillary artery. The needle was then withdrawn and repositioned above the artery at the 9 o'clock position, where the remaining volume was injected.



PM: Pectoralis major muscle; PMi: Pectoralis minor muscle; MC: Medial cord; LC: Lateral cord; PC: Posterior cord; AA: Axillary artery; AV: Axillary vein

Figure 2: Ultrasound image showing brachial plexus at lateral sagittal area.

In Group B (costoclavicular approach), a transverse scan was performed just inferior to the midpoint of the clavicle, focusing on the medial infraclavicular fossa. The probe was angled cephalad to visualize the costoclavicular space and the three cords clustered lateral to the axillary artery (**Figure 3**). The needle was introduced in-plane from lateral to medial and advanced between the lateral and posterior cords to reach the center of the cord cluster. The entire volume of local anaesthetic was injected incrementally at this single site without repositioning the needle.



PM: Pectoralis major muscle; SM: Subclavius muscle; MC: Medial cord; LC: Lateral cord; PC: Posterior cord; AA: Axillary artery; AV: Axillary vein.

Figure 3: Ultrasound image showing brachial plexus at costoclavicular area.

Subsequently, patients were assessed at five-minute intervals to determine the onset of sensory and motor blockade. The point of needle withdrawal following the administration of local anaesthetic was considered as time zero (T = 0). Sensory and motor assessments were performed at predefined time points: 5, 10, 15, 20, 30, and 45 minutes post-block. The block performance time was defined as the interval from the start of local anaesthetic skin infiltration to the completion of drug injection. The Visual Analog Scale (VAS) was used to record patient-reported pain during the procedure.

Sensory block onset was evaluated using a Verbal Rating Scale (VRS) ranging from 0 to 5, where 5 indicated normal sensation and 0 represented complete sensory loss. Sensory testing focused on cold perception in the distribution areas of four nerves: the median nerve (lateral 3½ fingers on the palmar surface), radial nerve (dorsum of the hand), ulnar nerve (medial 1½ fingers on the palmar surface and hypothenar region), and musculocutaneous nerve (lateral forearm). Motor block was assessed using a 3-point qualitative scale (0 = paralysis, 1 = paresis, 2 = normal motor function). The motor assessment for the median nerve involved thumb-index finger opposition, for the ulnar nerve thumb-little finger opposition, for the musculocutaneous nerve elbow flexion, and for the radial nerve wrist extension.

An overall sensory and motor score was calculated for each patient by averaging the individual nerve scores at each time point. The onset time for each nerve was defined as the time taken to achieve a sensory VRS ≤2 and a motor score ≤1. The overall onset time for sensory and motor block was determined as the time taken for all four nerves to reach these thresholds. Time to readiness for surgery was defined as the time required to achieve a composite motor score ≤1 and sensory score ≤2 across all four nerves.

Postoperative pain was monitored using the VAS hourly until the patient requested rescue analgesia. The time to first rescue analgesia was recorded when the VAS exceeded 3. Patients were observed for any complications related to the block and monitored for adverse effects for up to 24 hours postoperatively.

The primary outcome variables were the overall onset times of sensory and motor block. Secondary outcome variables included time to readiness for surgery and time to first rescue analgesia.

The sample size was calculated using G*Power software (version 3.1.9.7). Based on a previous study involving 28 patients undergoing similar infraclavicular blocks, the reported median onset times were 10 minutes [IQR, 10–26.25] for the costoclavicular approach and 20 minutes [IQR, 15–30] for the lateral sagittal approach, using 25 mL of 0.5% ropivacaine.[15] Using these values, a minimum of 120 patients (60 per group) was required to detect a statistically significant difference in block onset times with a power of 80% (1-β), a significance level of 5% (α = 0.05), and a confidence level of 95%. To account for potential dropouts or protocol deviations, a total of 128 patients (64 per group) were enrolled in the study.

Statistical analysis was performed using SPSS software (version 22.0; SPSS Inc., Chicago, IL, USA). The Kolmogorov-Smirnov test was used to evaluate the normality of distribution for continuous variables. Data are presented as mean ± standard deviation (SD) for normally distributed variables, and as median with interquartile range (IQR) for non-normally distributed variables. Between-group comparisons were made using the independent-samples t test or Mann-Whitney U test for continuous variables, and the Pearson chi-square test or Fisher's exact test for categorical variables, as appropriate. A p-value <0.05 was considered statistically significant.

3. Results

The two study groups were comparable with respect to demographic data and baseline clinical characteristics (**Table 1** and **Table 2**). All 128 enrolled patients (64 in each group) successfully underwent infraclavicular brachial plexus block (ICBPB) and completed the study protocol without any dropouts.

The onset of sensory block was significantly faster in Group B (costoclavicular approach) with a median time of 7.50 minutes [IQR, 6.25–8.75] compared to Group A (lateral sagittal approach) with a median time of 15 minutes [IQR, 15–16.25] (p < 0.001) as shown in **Table 3**. Similarly, motor block onset occurred significantly earlier in Group B (5 minutes [IQR, 5–5]) compared to Group A (10 minutes [IQR, 5–10]) (p < 0.001). Motor block onset was approximately 7 minutes in Group A versus 5 minutes in Group B (**Table 4**).

The mean sensory scores for individual nerves were significantly lower at 5, 10, 15, 20, and 30 minutes post-block in Group B compared to Group A (**Figure 4** and **Figure 5**). Similarly, the mean motor scores of each nerve were significantly reduced at 5, 10, 15, and 20 minutes in Group B (**Table 5**). The time to readiness for surgery was significantly shorter in Group B, with a median of 7.50 minutes [IQR, 6.25–8.75], compared to 15 minutes [IQR, 15–16.25] in Group A (p < 0.001).

The time to first rescue analgesia was similar between groups, with Group A averaging 894.29 ± 77.24 minutes and Group B 881.56 ± 72.58 minutes (p = 0.338). Both approaches provided effective surgical anaesthesia in all patients, with no major technical difficulties or adverse events related to local anaesthetic administration reported.

The ICBPB proved effective for surgical anaesthesia in all patients, with no significant concerns regarding the technique or the administration of local anaesthetic in either group. Horner's syndrome was observed in 5/64 (7.8%) patients in Group B, and vascular puncture occurred in 2/64 (3.1%) in Group A and 3/64 (4.6%) in Group B. At the 24-hour follow-up, no patients exhibited persistent neurological symptoms or signs in the ipsilateral upper limb.

Table 1: Baseline characteristics

Parameters	**Group A** **n = 64**	**Group B** ***n = 64***	**p-value**
Age (years)	30.14 (10.09)	32.39 (10.66)	0.222
Gender (male/female)	50/14	51/13	1.00
BMI (kg/m^2)	24.65 (3.14)	24.75 (3.08)	0.883
ASA (I/ II)	62/2	61/3	1.00

Table 2: Comparison of clinical parameters

Clinical parameters	Group A	Group B	p-value
Side of block (left/right)	28/36	32/32	0.595
Block performance time (minutes)	6.86	7.01	0.593
Overall procedural pain (VAS)	2.72	2.53	0.182
Duration of surgery (minutes)	48.36	51.90	0.460
Arm tourniquet used during surgery (yes/no)	25/39	22/42	0.714
Average tourniquet time (minutes)	49.40	55	0.249
Time to first rescue analgesia (minutes)	894.29	881.56	0.338

Table 3: Comparison of mean time of onset of sensory block (in minutes) in individual nerves among the two groups

Nerves	Group A		Group B		Result (p-value)
	Mean	SD	Mean	SD	
Median	16.02	2.03	7.81	2.80	p<0.001 (S)
Musculocutaneous	15.31	1.75	6.48	2.30	p<0.001 (S)
Radial	14.84	1.25	7.58	2.52	p<0.001 (S)
Ulnar	15.00	0.00	7.11	2.49	p<0.001 (S)

Table 4: Comparison of mean time of onset of motor block (in minutes) of individual nerves among the two groups

Nerves	Group A		Group B		Result (p-value)
	Mean	SD	Mean	SD	
Median	7.73	2.51	5.39	1.35	p<0.001 (S)
Musculocutaneous	7.73	2.51	5.39	1.35	p<0.001(S)
Radial	7.73	2.51	5.39	1.35	p<0.001(S)
Ulnar	7.73	2.51	5.39	1.35	p<0.001(S)

Table 5: Average motor score (0–2) of all four nerves tested

Time in minutes	Group A		Group B		Result (p-value)
	Mean	SD	Mean	SD	
5	1.55	0.50	1.06	0.30	p<0.001 (S)
10	0.98	0.13	0.80	0.41	0.0005 (S)
15	0.91	0.29	0.58	0.50	p<0.001 (S)
20	0.69	0.47	0.39	0.49	0.0006 (S)
30	0.28	0.45	0.19	0.39	0.213 (NS)
45	0.17	0.38	0.11	0.31	0.312 (NS)

Table 6: Adverse events

Complications	Group A	Group B	p-value
Vascular puncture (yes/no)	*2/62*	3/61	1
Horner syndrome (yes/no)	0/64	5/59	0.068
Paraesthesia (yes/no)	52/12	49/15	0.665

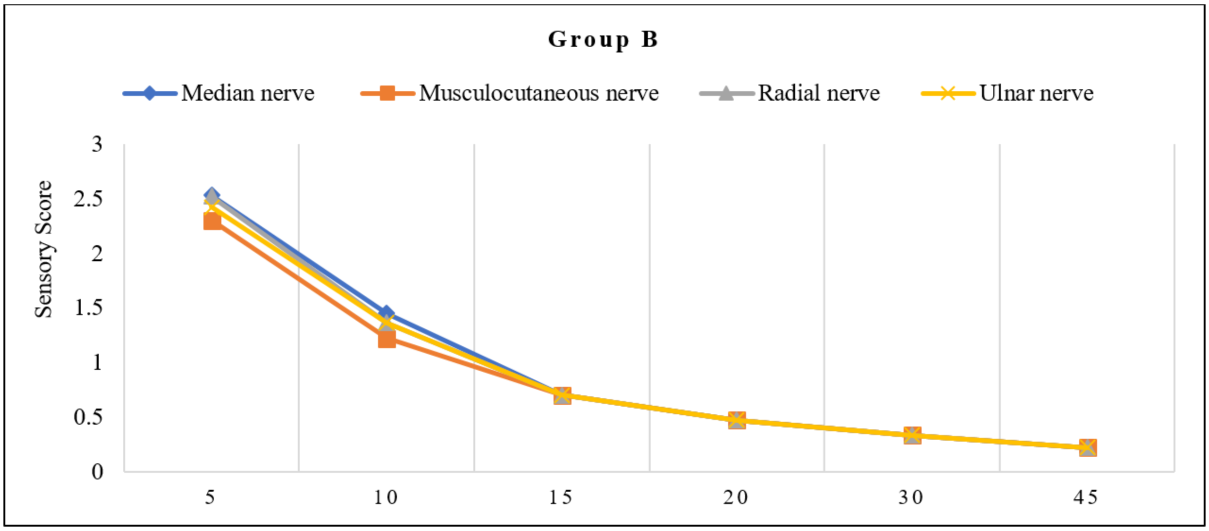


Figure 4: Comparison of mean of the average sensory score of individual nerves at various time intervals in Group B

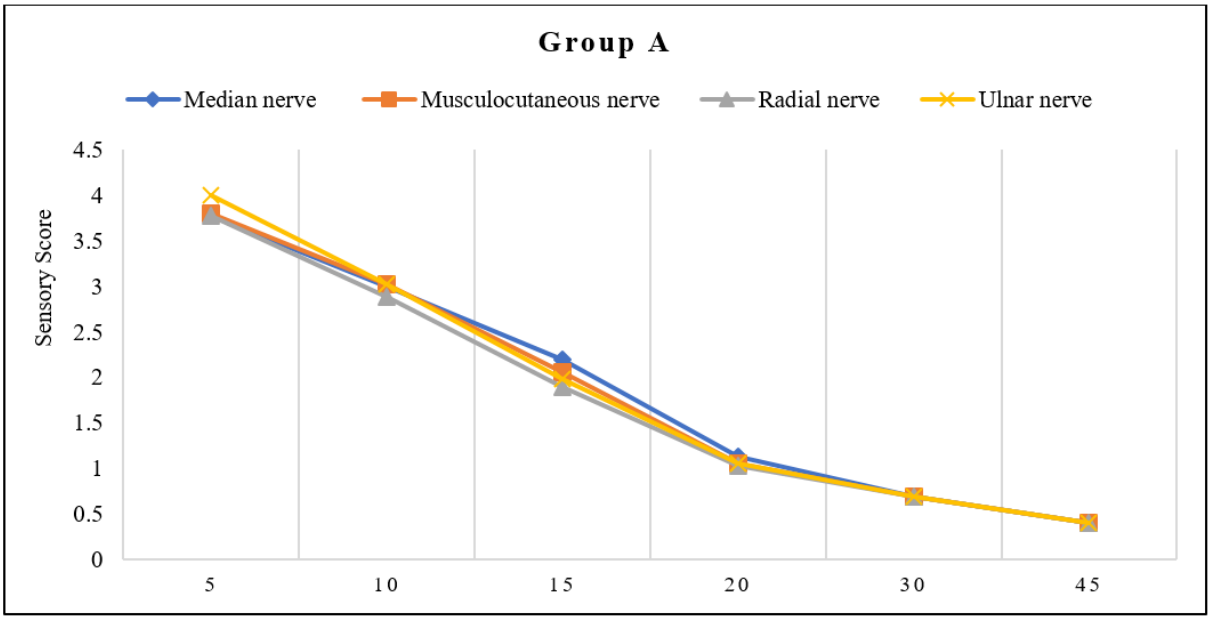


Figure 5: Comparison of mean of the average sensory score of individual nerves at various time intervals in Group A

4. Discussion

Infraclavicular brachial plexus block (ICBPB) is an effective alternative to supraclavicular and axillary blocks, providing comparable surgical anesthesia quality for procedures performed below the shoulder.[16] Evidence suggests that local anaesthetic distribution in the infraclavicular region posterior to axillary artery results in a complete brachial plexus block.[17] The infraclavicular area is an optimal location for catheter placement due to its deep position beneath the pectoral muscles, which effectively secures the catheter and minimizes the risk of displacement. The serratus anterior and subscapularis muscles create a protective boundary between the neurovascular bundle and the chest in the infraclavicular region with little anatomical variations.[18] Infraclavicular blocks are effective in providing optimal conditions for upper extremity surgery due to the anaesthesia of proximal arm muscles, especially the pectoralis and deltoid, resulting in good tourniquet tolerance as well.[18] A study utilizing cadavers confirmed that the dye disseminated in the costoclavicular area cephalad to the brachial plexus in the supraclavicular region, reliably reaching the suprascapular nerve without impacting the phrenic nerve.[19]

A comparable study conducted by Songthamwat B. et al. shown that the costoclavicular route resulted in a more rapid onset of sensory block and faster readiness for surgery compared to the lateral sagittal approach with a difference of 10 minutes.[15] The research conducted by Dost B. et al. also yielded comparable findings.[20] The study revealed a difference of 7.5 minutes for the onset of sensory block. Also, in our study, the costoclavicular (CC) approach resulted in a more rapid initiation of sensory and motor block compared to the lateral sagittal (LS) technique. The Group-B exhibited significantly lower overall sensory score, motor score, and mean value of onset of sensory and motor blockade in individual nerves (median, radial, musculocutaneous, and ulnar) compared to the Group-A. Moreover, we noted a substantial reduction in the average sensory and motor scores for specific nerves after five, 10, 15, 20, and 30 minutes in Group B.

Research indicates that in the CC area, the cords of the brachial plexus are closely clustered, potentially enhancing the diffusion of local anaesthetic when injected into the centre of the nerve group.[0] The shorter duration may possibly be due to the plexus sheath being anatomically denser and tightly surrounding the cords, more in the proximal area compared to the distal portion.[0,21] On the contrary, the cords are distinct from each other,[8] with changes in their position relative to the axillary artery in the lateral sagittal region.[8,9] We propose that the compact arrangement of the cords with sheath minimizes local anaesthetic dispersion, facilitating a more rapid blockade of sodium channels and resulting in a quicker onset of sensory and motor block.

Some studies showed significant difference in the block performance times which was absent in our study.[20,22] This finding may result from the use of the triple injection technique by them in contrast to our double injection technique. The duration of block performance demonstrated a statistically significant effect; however, it lacked meaningful therapeutic relevance in our routine practice. The intervention may lead to a modest reduction in operating room time, though its clinical significance remains uncertain.

We observed horner syndrome (ptosis, miosis) in 5 patients who received costoclavicular block. We also found that 81% of patients in Group A and 76% in Group B experienced paraesthesia. Nevertheless, it was transient and self-limiting, and none of our patients reported persistent neurological symptoms or signs during the 24-hour follow-up after surgery. Although there have been isolated reports of pneumothorax and hemi diaphragmatic paralysis following the procedure, these complications occur less frequently with infraclavicular blocks compared to other approaches.[23,24] The utilization of ultrasound has demonstrated enhanced efficiency, higher success rates, and reduced likelihood of associated complications. An extensive, retrospective analysis of 1146 patients who underwent US-guided ICBPB demonstrated a success rate of 99.3%, without any documented instances of nerve damage, local anaesthetic toxicity or pneumothorax, also reduced incidence of hemi-diaphragmatic paralysis in the costoclavicular group.[25]

There are several limitations to our study. First, the patient population included only individuals with a body mass index (BMI) in the normal to overweight range, limiting the generalizability of our findings to obese patients. Future research should specifically examine differences in block characteristics between the costoclavicular and lateral sagittal approaches in this subgroup. Second, we did not employ specific assessments to detect hemi diaphragmatic paralysis following block administration, which may have underestimated this complication. Also in our study, postoperative neurological monitoring was limited to 24 hours, potentially missing mild or delayed neurological symptoms that may have developed beyond this timeframe

5. Conclusion

Both the lateral sagittal and costoclavicular approaches effectively achieve brachial plexus blockade. For time-sensitive procedures, the costoclavicular technique offers a faster onset of sensory and motor block with a comparable safety profile.

6. Source of Funding

None.

7. Conflict of Interest

None.

References

1. Raj PP, Montgomery SJ, Nettles D, Jenkins MT. Infraclavicular brachial plexus block—a new approach. *Anesth Analg*. 1973;52(6):897–904.
2. Ootaki C, Hayashi H, Amano M. Ultrasound-guided infraclavicular brachial plexus block: an alternative technique to anatomical landmark-guided approaches. *Reg Anesth Pain Med*. 2000;25(6):600–4. https://doi.org/10.1053/rapm.2000.18184.
3. Sandhu NS, Capan LM. Ultrasound-guided infraclavicular brachial plexus block. *Br J Anaesth*. 2002;89(2):254–9. https://doi.org/10.1093/bja/aef186.
4. Leurcharusmee P, Elgueta MF, Tiyaprasertkul W, et al. A randomized comparison between costoclavicular and paracoracoid ultrasound-guided infraclavicular block for upper limb surgery. *Can J Anaesth*. 2017;64(6):617–25. https://doi.org/10.1007/s12630-017-0842-z.
5. Tran DQH, Russo G, Muñoz L, Zaouter C, Finlayson RJ. A prospective, randomized comparison between ultrasound-guided supraclavicular, infraclavicular, and axillary brachial plexus blocks. *Reg Anesth Pain Med*. 2009;34(4):366–71. https://doi.org/10.1097/AAP.0b013e3181ac7d18.
6. Karmakar MK, Sala-Blanch X, Songthamwat B, Tsui BCH. Benefits of the costoclavicular space for ultrasound-guided infraclavicular brachial plexus block: description of a costoclavicular approach. *Reg Anesth Pain Med*. 2015;40(3):287–8. https://doi.org/10.1097/AAP.0000000000000232.
7. Bigeleisen P, Wilson M. A comparison of two techniques for ultrasound guided infraclavicular block. *Br J Anaesth*. 2006;96(4):502–7. https://doi.org/10.1093/bja/ael024.
8. Sauter AR, Smith H-J, Stubhaug A, Dodgson MS, Klaastad Ø. Use of magnetic resonance imaging to define the anatomical location closest to all three cords of the infraclavicular brachial plexus. *Anesth Analg*. 2006;103(6):1574–6. https://doi.org/10.1213/01.ane.0000242529.96675.fd.
9. Di Filippo A, Orando S, Luna A, Gianesello L, Boccaccini A, Campolo MC, De Gaudio AR. Ultrasound identification of nerve cords in the infraclavicular fossa: a clinical study. *Minerva Anestesiol*. 2012;78(4):450–5.
10. Gaertner E, Estebe JP, Zamfir A, Cuby C, Macaire P. Infraclavicular plexus block: multiple injection versus single injection. *Reg Anesth Pain Med.* 2002;27(6):590–4. https://doi.org/10.1053/rapm.2002.36456.

11. Demondion X, Herbinet P, Boutry N, Fontaine C, Francke JP, Cotten A. Sonographic mapping of the normal brachial plexus. *AJNR Am J Neuroradiol.* 2003;24(7):1303–9.
12. Sala-Blanch X, Reina MA, Pangthipampai P, Karmakar MK. Anatomic basis for brachial plexus block at the costoclavicular space: A cadaver anatomic study. *Reg Anesth Pain Med*. 2016;41(3):387-91. https://doi.org/10.1097/AAP.0000000000000393.
    Li JW, Songthamwat B, Samy W, Sala-Blanch X, Karmakar MK. Ultrasound-Guided Costoclavicular Brachial Plexus Block: Sonoanatomy, Technique, and Block Dynamics. *Reg Anesth Pain Med.* 2017;42(2):233–40. https://doi.org/10.1097/AAP.0000000000000566.
13. Moayeri N, Renes S, van Geffen GJ, Groen GJ. Vertical infraclavicular brachial plexus block: needle redirection after elicitation of elbow flexion. *Reg Anesth Pain Med*. 2009;34(3):236–41. https://doi.org/10.1097/AAP.0b013e31819a8a92.
14. Faul F, Erdfelder E, Lang A-G, Buchner A. G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behav Res Methods*. 2007;39(2):175–91. https://doi.org/10.3758/bf03193146.
15. Songthamwat B, Karmakar MK, Li JW, Samy W, Mok LYH. Ultrasound-Guided Infraclavicular Brachial Plexus Block: Prospective Randomized Comparison of the Lateral Sagittal and Costoclavicular Approach. *Reg Anesth Pain Med.* 2018;43(8):825–31.
16. Stav A, Reytman L, Stav MY, Portnoy I, Kantarovsky A, Galili O, et al. Comparison of the Supraclavicular, Infraclavicular and Axillary Approaches for Ultrasound-Guided Brachial Plexus Block for Surgical Anesthesia. *Rambam Maimonides Med J*. 2016;7(2):e0013. https://doi.org/10.5041/RMMJ.10240.
17. Johnson RL, Kopp SL, Kessler J, Gray AT. Peripheral nerve blocks and ultrasound guidance for regional anesthesia. In: Gropper MA, editor. *Miller's Anesthesia*. 9th ed. Philadelphia: Elsevier; 2020. p. 1462.
18. Chin KJ, Alakkad H, Adhikary SD, Singh M. Infraclavicular brachial plexus block for regional anaesthesia of the lower arm. *Cochrane Database Syst Rev*. 2013;2013(8):CD005487. https://doi.org/10.1002/14651858.CD005487.pub3.
19. Koyyalamudi V, Langley NR, Harbell MW, Kraus MB, Craner RC, Seamans DP. Evaluating the spread of costoclavicular brachial plexus block: an anatomical study. *Reg Anesth Pain Med*. 2021;46(1):31–4. https://doi.org/10.1136/rapm-2020-101585.
20. Dost B, Kaya C, Ustun YB, Turunc E, Baris S. Lateral sagittal versus costoclavicular approaches for ultrasound-guided infraclavicular brachial plexus block: a comparison of block dynamics through a randomized clinical trial. *Cureus.* 2021;13(3):e14129. https://doi.org/10.7759/cureus.14129.
    Brenner D, Mahon P, Iohom G, Cronin M, O'Flynn C, Shorten G. Fascial layers influence the spread of injectate during ultrasound-guided infraclavicular brachial plexus block: a cadaver study. *Br J Anaesth.* 2018;121(4):876–82. https://doi.org/10.1016/j.bja.2018.04.043.
21. Reina MA, Sala-Blanch X. Cross-sectional microscopic anatomy of the brachial plexus and paraneural sheaths. In: Reina M, De Andrés J, Hadzic A, Prats-Galino A, Sala-Blanch X, van Zundert A, editors. Atlas of Functional Anatomy for Regional Anesthesia and Pain Medicine. Cham: Springer International Publishing; 2015. p.161–88.
22. Yayik AM, Cesur S, Ozturk F, Celik EC, Naldan ME, Ahiskalioglu A. Comparison of the lateral sagittal and costoclavicular approaches for ultrasound-guided infraclavicular block in pediatric patients: a prospective randomized study. *Braz J Anesthesiol.* 2024;74(5):744178. https://doi.org/10.1016/j.bjane.2021.05.005.
23. Crews JC, Gerancher JC, Weller RS. Pneumothorax after coracoid infraclavicular brachial plexus block. *Anesth Analg*. 2007;105(1):275–7. https://doi.org/10.1213/01.ane.0000266492.65813.10.
24. Yang CW, Jung SM, Kwon HU, Kang PS, Cho CK, Choi HJ. Transient hemidiaphragmatic paresis after ultrasound-guided lateral sagittal infraclavicular block. *J Clin Anesth.* 2013;25(6):496–8. https://doi.org/10.1016/j.jclinane.2013.04.012.
25. Oh C, Noh C, Eom H, Lee S, Park S, Lee S, et al. Costoclavicular brachial plexus block reduces hemidiaphragmatic paralysis more than supraclavicular brachial plexus block: retrospective, propensity score matched cohort study. *Korean J Pain.* 2020;33(2):144-52. https://doi.org/10.3344/kjp.2020.33.2.144.

Cite this article: Rao A, Bhati S, Bhatia S, Deep R. A prospective randomized interventional study comparing lateral sagittal and costoclavicular approaches for ultrasound-guided infraclavicular brachial plexus block. *Indian J Clin Anaesth*. 2025;12(4):676–683.