

COMPARISON BETWEEN SUB CORACOID APPROACH AND COSTOCLAVICULAR APPROACH OF INFRA CLAVICULAR BRACHIAL PLEXUS BLOCK IN UPPER LIMB SURGERIES

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ABSTRACT

Background: Ultrasound-guided infraclavicular brachial plexus block provides effective anaesthesia for upper-limb surgery. The costoclavicular approach offers a compact anatomical target and potential technical advantages over the classical subcoracoid approach. This study compared the block characteristics and anatomical measurements in patients undergoing lower-arm and forearm surgery. **Materials and Methods:** This prospective randomised controlled study included 140 patients equally allocated to Groups A and B. Ultrasound-guided infraclavicular block was performed using an in-plane technique with standardised local anaesthetic administration. Sensory and motor responses, block onset, anatomical distances, vital parameters, nerve-sparing patterns, and vascular puncture were assessed perioperatively with serial observations after the blockade. **Result:** Age was comparable between groups A and B ($P=0.510$), as was sex distribution ($P=0.398$). Sensory and motor block onset were faster in Group A (both $P<0.0001$). Skin-to-plexus distance was 4.67 ± 4.93 vs. 6.62 ± 7.69 ($P=0.076$), while plexus-to-pleura distance was 2.83 ± 0.45 vs. 3.25 ± 0.68 ($P<0.0001$). Sensory scores differed significantly among the ulnar, musculocutaneous, and intercostobrachial distributions (all $P<0.0001$), whereas those of the axillary, median, and radial distributions were identical. Motor scores differed for axillary ($P=0.042$), ulnar, and musculocutaneous nerves (both $P<0.0001$) but not for median or radial distributions ($P=0.08$). Oxygen saturation, heart rate, and systolic and diastolic blood pressure remained comparable at all time points. No vascular punctures were observed in either group. **Conclusion:** The costoclavicular approach provided faster sensory and motor block onset with favourable anatomical characteristics and comparable perioperative stability, supporting its use for suitable distal upper-limb surgeries.

INTRODUCTION

Upper limb surgery requires effective anaesthesia and good postoperative analgesia to help patients recover and be comfortable. Regional anaesthesia, particularly brachial plexus blockade, can be an effective surgical anaesthetic, prolong postoperative analgesia, and decrease opioid use. This has been further enhanced by ultrasound guidance which provides real-time visualisation of the nerves, needle, and local anaesthetic spread, making the procedure safer and more accurate.^[1-3] It offers good distal coverage compared to more proximal approaches, with a reduced risk of phrenic nerve involvement and hemidiaphragmatic dysfunction. The cords can also

be identified around the axillary artery, allowing local anaesthetic to be deposited close to the neural structures. The ultrasound guidance also helps in locating the cords and the neighbouring vessels and enhances the accuracy of the block.^[1,4,5]

The classical subcoracoid approach involves the lateral, posterior, and medial cords around the axillary artery. These cords are generally separated on ultrasound, with the lateral cord anterior to the artery, the posterior cord posterior to the artery, and the medial cord either posterior or posterior-medial to the artery.^[6,7] Accurate identification and local anaesthetic deposition around each cord may be necessary if the cords are relatively separated. While this technique is standard and effective, these anatomical features could make the technique more

difficult technically and have sparked interest in alternative techniques.^[8-10]

The alternative infraclavicular approach is the costoclavicular approach, which is based on the position of the brachial plexus in the costoclavicular space. Therefore, the lateral, medial and posterior cords are typically grouped together lateral to the axillary artery, rather than spread apart as they are in the traditional infraclavicular area, and may give better coverage of all three cords with local anaesthetic in a smaller area, which could decrease needle handling.^[4,11] The method has therefore been proposed as a simpler method without compromise to the effectiveness of the sensorimotor blockade.^[11]

However, there is no evidence to confirm the superiority of the costoclavicular approach over the classical approach. Randomized studies have reported similar onset, procedure time, success, and complication rates, with some difference in the manipulation of the needle, but with possible preservation of diaphragmatic function.^[4,12] However, results are still variable, especially with regard to the onset of the block and technical efficiency, so the costoclavicular approach, although well supported by its anatomical basis, is not certain to yield better clinical performance than the already established subcoracoid approach.^[5,13,14] This is therefore a comparison between both techniques in patients undergoing surgery for the lower arm and forearm. Therefore, this study compared both techniques in patients who underwent surgery on the lower arm and forearm.

Aim: This study aimed to compare two approaches of infraclavicular brachial plexus block, regarding their ease and efficiency in lower arm and forearm surgeries.

MATERIALS AND METHODS

This prospective randomised controlled study was conducted in 140 patients attending Mahatma Gandhi Memorial Government Hospital, Trichy, under the Institute of Anaesthesiology for a period of one year. Ethical approval was obtained from the Institutional Ethical Committee (IEC NO: KAPV/IEC/2022/03/001), and written informed consent was obtained from the participants before study initiation.

A sample size of 70 patients in each group was calculated to achieve an 80% power with a type I error of 0.05. Patients were randomly divided into two groups: Group A and Group B.

Inclusion and Exclusion criteria

This study included patients of either sex aged 18-60 years, with ASA grades 1 and 2, weighing more than 50 kg, and undergoing lower-arm, elbow, forearm, wrist, and hand surgeries. Patients with ASA grades 3 and above, those receiving antiplatelet or anticoagulant drugs, those with severe respiratory diseases, neurological problems, local infections, allergy to local anaesthetics, pregnancy, or those who

refused nerve block or participation in the study were excluded.

Materials

The materials used in the study included a Sonosite M-Turbo ultrasound machine with a linear probe of frequency 5-16 Hz, a 23-gauge needle for infiltration, an 18-gauge needle for performing the block, 0.5% bupivacaine 15 cc, 2% lignocaine 10 cc, epinephrine 3 µg/ml, peripheral intravenous cannula, pulse oximeter, blood pressure monitor, and 5-lead electrocardiogram.

Methods

Patients were randomly allocated to Group A (n=70) or Group B (n=70). In Group A arm was abducted to 110°, externally rotated, and the elbow flexed to 90°. The ultrasound probe was placed at the apex of the deltopectoral groove, more proximally than in the classical approach, and the block was performed using an in-plane technique. This is the costoclavicular approach. In Group B, the classical subcoracoid approach was used, with the arm kept at the patient's side in a neutral position, and the block was performed using the in-plane technique.

Preoperative assessments were performed using standard protocols. A peripheral venous line was established, and pulse oximetry, blood pressure monitoring, and 5-lead electrocardiography were performed. Baseline values were also recorded.

After sterile preparation, a linear ultrasound probe was placed over the brachial plexus. In Group A, the axillary artery and vein were identified, followed by identification of the medial, lateral, and posterior cords. The skin-to-artery distance in the anteroposterior direction and cord positions relative to the artery and vein were recorded. The rib, pleura, or lung was also identified when possible, and the distance from the artery to these structures was measured. In Group B, the arms remained neutral. The probe was placed parasagittally at the distal deltopectoral groove, the coracoid process was identified, and the probe was moved slightly caudally until the axillary artery and vein were visualised. The three cords and their positions were recorded, and the same measurements were taken.

Skin and pectoral muscle infiltration were performed using a 23-gauge needle, whereas an 18-gauge needle was used for the block. The needle was introduced superior to the probe at 45° to the skin in the caudal direction using the in-plane technique. After negative aspiration for blood and air, 25 cc of local anaesthetic was injected, comprising 0.5% bupivacaine 15 cc and 2% lignocaine 10 cc with epinephrine 3 µg/ml. The drug spread around all three cords was observed in real time.

Block performance time, sensory and motor block onset, block quality, tourniquet pain, sparing, and other adverse events were also recorded. Sensory and motor responses were graded as 1 for baseline function, 2 for diminished response, and 3 for a response permitting painless surgical incision or complete motor paralysis.

Sensory testing was performed to assess the axillary, musculocutaneous, median, radial, ulnar, and intercostobrachial nerves. Motor testing was performed to assess the axillary, musculocutaneous, median, radial, and ulnar nerves. These assessments were performed before the block and at 5 and 20 min. The four Ps test and any surgical-field pain were also recorded for all patients.

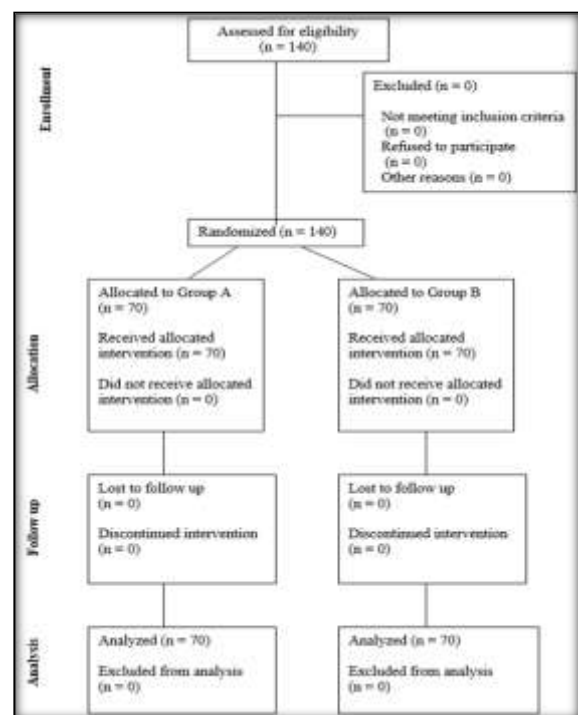


Figure 1: CONSORT Flowchart

Sensory onset was defined as the time from drug injection to a sensory score of three. The sensory duration was defined as the interval from the complete sensory block to the return of normal sensation. Motor onset was defined as the time from

completion of injection to complete paralysis, whereas motor duration was defined as the interval from complete paralysis to complete recovery. Tourniquet pain was recorded from inflation to removal of the tourniquet. The maximum application time was 90 min; if extension was required, the tourniquet was released for 10 min and reapplied. Pain was scored as 0 when absent and 1 when present, respectively. If pain occurred, 5 ml of 1% lignocaine was infiltrated subcutaneously below the axillary hairline. Postoperatively, motor and sensory recovery were monitored until complete recovery was documented.

Statistical analysis: Data were presented as mean, standard deviation, frequency and percentage. Continuous variables were compared using the independent sample t-test. Categorical variables were compared using the Pearson chi-square test. Significance was defined by P values less than 0.05 using a two-tailed test. Data analysis was performed using IBM-SPSS version 21.0 (IBM-SPSS Science Inc., Chicago, IL).

RESULTS

The mean age was similar in Groups A and B (27.51 ± 7.14 vs. 28.89 ± 5.93 years; $P = 0.51$). Of the patients, 31 (44.3%) and 36 (51.4%) were female, and 39 (55.7%) and 34 (48.6%) were male ($P = 0.398$). Sensory block onset was significantly faster in Group A than in Group B (13.84 ± 3.18 vs. 23.34 ± 3.36 min; $P < 0.0001$), as was motor block onset (18.84 ± 2.85 vs. 28.97 ± 2.26 min; $P < 0.0001$). The skin-to-plexus distance was lower in Group A (4.67 ± 4.93 vs. 6.62 ± 7.69 cm; $P = 0.076$), whereas the plexus-to-pleura distance was significantly lower (2.83 ± 0.45 vs. 3.25 ± 0.68 mm; $P < 0.0001$) [Table 1].

Table 1: Demographic characteristics, block onset, and anatomical measurements between Groups

		Mean $\pm$ SD		P value
		Group A (n=70)	Group B (n=70)	
Age		27.51 ± 7.14	28.89 ± 5.93	0.51
Sex, N (%)	Female	31 (44.3%)	36 (51.4%)	0.398
	Male	39 (55.7%)	34 (48.6%)	
Onset of sensory blockade (min)		13.84 ± 3.18	23.34 ± 3.36	<0.0001
Onset of motor blockade (min)		18.84 ± 2.85	28.97 ± 2.26	<0.0001
Distance from skin to plexus		4.67 ± 4.93	6.62 ± 7.69	0.076
Distance from plexus to pleura		2.83 ± 0.45	3.25 ± 0.68	<0.0001

Table 2: Distribution of sensory response scores between Groups

		N (%)		P value
		Group A	Group B	
Axillary	3	70 (100%)	70 (100%)	-
	3	70 (100%)	70 (100%)	
	3	70 (100%)	70 (100%)	
Ulnar	1	0	17 (24.3%)	<0.0001
	2	0	47 (67.1%)	
	3	70 (100%)	6 (8.6%)	
Musculocutaneous	1	0	4 (5.7%)	<0.0001
	2	15 (21.4%)	33 (47.1%)	
	3	55 (78.6%)	33 (47.1%)	
Intercostobrachial		42 (60%)	0	<0.0001

	2	21 (30%)	34 (48.6%)	
	3	7 (10%)	36 (51.4%)	

The axillary nerve had a motor score of 3 in 66 (94.3%) patients in Group A and 70 (100%) in Group B, while a score of 2 occurred in 4 (5.7%) and none, respectively ($P = 0.042$). For the median nerve, score 2 was observed in 3 (4.3%) versus none, and score 3 was observed in 67 (95.7%) versus 70 (100%) patients, respectively ($P = 0.08$). The radial nerve showed the same pattern, with a score of 2 in 3 (4.3%) versus none and a score of 3 in 67 (95.7%) versus 70

(100%) ($P = 0.08$). For the ulnar nerve, scores of 1, 2, and 3 were 2 (2.9%), 3 (4.3%), and 65 (92.9%) in Group A versus 8 (11.4%), 52 (74.3%), and 10 (14.3%) in Group B, respectively ($P < 0.0001$). For the musculocutaneous nerve, score 1 occurred in none versus 15 (21.4%), score 2 in 30 (42.9%) versus 33 (47.1%), and score 3 in 40 (57.1%) versus 22 (31.4%), respectively ($P < 0.0001$) [Table 3].

Table 3: Distribution of motor response scores between Groups

	Motor response score	N (%)		P value
		Group A	Group B	
Axillary	2	4 (5.7%)	0	0.042
	3	66 (94.3%)	70 (100%)	
Median	2	3 (4.3%)	0	0.08
	3	67 (95.7%)	70 (100%)	
Radial	2	3 (4.3%)	0	0.08
	3	67 (95.7%)	70 (100%)	
Ulnar	1	2 (2.9%)	8 (11.4%)	<0.0001
	2	3 (4.3%)	52 (74.3%)	
	3	65 (92.9%)	10 (14.3%)	
Musculocutaneous	1	0	15 (21.4%)	<0.0001
	2	30 (42.9%)	33 (47.1%)	
	3	40 (57.1%)	22 (31.4%)	

The mean oxygen saturation remained comparable between the groups throughout the study. Preoperatively, values were $99.03 \pm 0.76\%$ vs $99.21 \pm 0.68\%$ ($P = 0.130$). At 5, 10, 15, 30, 45, 60, and 90 min, values were $99.93 \pm 0.25\%$ vs $99.97 \pm 0.18\%$ ($P = 0.561$), $99.97 \pm 0.18\%$ vs $99.97 \pm 0.18\%$ ($P = 1.000$), $99.83 \pm 0.38\%$ vs $99.90 \pm 0.31\%$ ($P = 0.456$), $99.93 \pm 0.25\%$ vs $99.93 \pm 0.25\%$ ($P = 1.000$), $99.90 \pm 0.31\%$ vs $99.97 \pm 0.18\%$ ($P = 0.309$), $99.73 \pm 0.38\%$ vs $99.91 \pm 0.31\%$ ($P = 0.456$), and $99.10 \pm 0.73\%$ vs $99.33 \pm 0.76\%$ ($P = 0.070$), respectively [Figure 2].

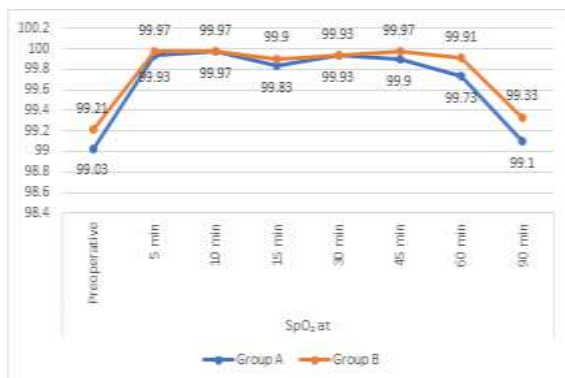


Figure 2: Comparison of mean oxygen saturation between Groups at different time points

The mean heart rate remained comparable between the groups. Preoperatively, the values were 83.50 ± 5.93 vs 84.44 ± 2.88 beats/min ($P = 0.234$). At 5, 10, 15, 30, 45, 60, and 90 min, values were 84.66 ± 5.24 vs 84.31 ± 3.36 ($P = 0.646$), 84.07 ± 4.41 vs 84.47 ± 2.90 ($P = 0.528$), 85.06 ± 4.09 vs 84.86 ± 2.63 ($P = 0.731$), 84.67 ± 3.48 vs 84.26 ± 2.68 ($P = 0.431$), 84.57 ± 2.42 vs 84.24 ± 2.64 ($P = 0.444$), 83.99 ± 2.42

vs 84.40 ± 2.53 ($P = 0.324$), and 86.33 ± 4.41 vs 85.14 ± 2.32 ($P = 0.292$), respectively [Figure 3].



Figure 3: Comparison of mean heart rate between Groups at different time points

The mean systolic blood pressure remained comparable between the groups. Preoperative values were 121.34 ± 8.59 vs 120.43 ± 7.95 mmHg ($P = 0.589$). At 5, 10, 15, 30, 45, 60, and 90 min, values were 116.21 ± 7.73 vs 117.34 ± 7.14 ($P = 0.371$), 114.69 ± 5.92 vs 115.84 ± 7.30 ($P = 0.305$), 117.71 ± 7.11 vs 116.90 ± 7.46 ($P = 0.510$), 114.94 ± 7.01 vs 113.80 ± 6.71 ($P = 0.602$), 115.21 ± 6.16 vs 115.30 ± 6.62 ($P = 0.964$), 114.70 ± 5.68 vs 113.28 ± 6.29 ($P = 0.458$), and 115.29 ± 6.36 vs 117.17 ± 6.13 ($P = 0.076$), respectively [Figure 4].

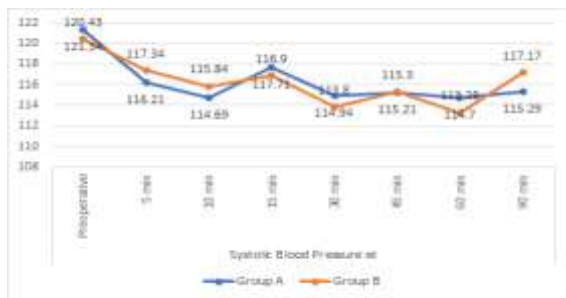


Figure 4: Comparison of mean systolic blood pressure between Groups at different time points

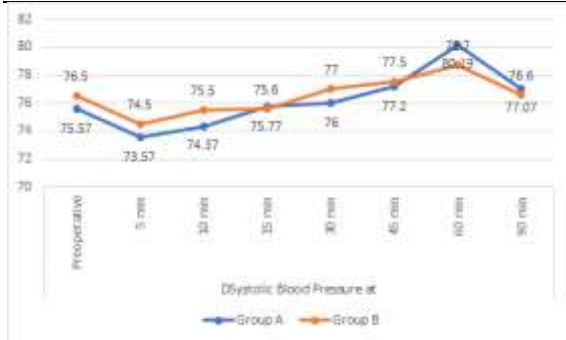


Figure 5: Comparison of mean diastolic blood pressure between Groups at different time points

The mean diastolic blood pressure remained comparable between the groups. Preoperatively, the values were 75.57 ± 18.65 vs. 76.50 ± 6.21 mmHg ($P = 0.315$). At 5, 10, 15, 30, 45, 60, and 90 min, values were 73.57 ± 5.26 vs 74.50 ± 6.00 ($P = 0.605$), 74.37 ± 11.20 vs 75.50 ± 4.64 ($P = 0.679$), 75.77 ± 8.65 vs 75.60 ± 4.38 ($P = 0.738$), 76.00 ± 6.22 vs 77.00 ± 3.87 ($P = 0.545$), 77.20 ± 5.27 vs 77.50 ± 3.62 ($P = 0.834$), 80.19 ± 6.91 vs 78.70 ± 4.20 ($P = 0.415$), and 77.07 ± 8.87 vs 76.60 ± 4.41 ($P = 0.076$), respectively [Figure 5].

No vascular puncture occurred; 70 (100%) patients in each group had no vascular puncture [Table 4].

Table 4: Distribution of vascular puncture between Groups

		N (%)	
		Group A	Group B
Vascular puncture	No	70 (100%)	70 (100%)
	Yes	0	0

DISCUSSION

This study compared the subcoracoid and costoclavicular techniques for infraclavicular brachial plexus block in surgeries on the lower arm and forearm. There were significant differences in block onset and nerve-specific responses. The plexus-to-pleura distance also differed significantly between the groups, whereas the difference in skin-to-plexus distance was not statistically significant. There were no differences between the two groups in terms of age or sex. The age groups were different in the studies, but the current groups were well balanced with Leurcharumsee et al. studying 90 adults and 45 patients in each group, Dost et al. studying 100 patients aged 18-65 undergoing forearm or hand surgery, and Yayik et al. studying 60 children aged 5-15 undergoing surgery at or distal to the elbow.^[4,12,15] The costoclavicular approach resulted in an earlier onset of sensory block than the subcoracoid approach. Brown et al. reported a similar finding, with sensory onset of 18.7 ± 4.4 min with paracoracoid versus 22.2 ± 6.2 min with costoclavicular ($P = 0.045$).¹⁶ In contrast, Leurcharumsee et al. found similar onset times of 16.0 ± 7.5 versus 16.8 ± 6.2 min ($P = 0.61$), with a mean difference of 0.8 min (95% CI, -2.3 to 3.8).⁴ Amaral et al., in five randomised trials involving 374 patients, also found no significant pooled difference, with a mean difference of -0.39 min (95% CI, -2.46 to 1.68; $P = 0.71$).^[17] Dost et al. compared costoclavicular with lateral-sagittal block and reported faster sensory onset with costoclavicular

block 4 min (IQR 3.8-6) versus 5 min (IQR 4.4-6), $P = 0.022$. The complete sensory block at 5 min was 30% versus 12% ($P = 0.027$) and at 10 min 66% versus 26% ($P < 0.001$).^[15] These differences may be related to the local-anaesthetic volume and concentration, injection technique, assessment timing, and block definitions. Leurcharumsee et al. used 35 mL of a lidocaine-bupivacaine mixture, while Brown et al. used 35 mL of 0.5% ropivacaine.^[4,16]

In our study, motor block onset was also significantly faster with the costoclavicular approach than with the subcoracoid approach. Studies have similarly failed to demonstrate a significant difference between the onset of overall motor symptoms for the costoclavicular and paracoracoid approaches.⁴ Brown et al. did not show a clear motor-onset advantage. Amaral et al. reported no significant pooled difference, with a mean difference of -0.34 min (95% CI, -0.90 to 0.22; $P = 0.23$).^[16] Differences in motor scoring, assessment intervals, drug concentration, and individual nerve responses could be the reasons for these varying results.

This study showed a lower skin-to-plexus distance with the costoclavicular approach, although the difference was not statistically significant. Brown et al. described the costoclavicular cords as a compact cluster compared with the more separated paracoracoid cords.¹⁶ Dost et al. reported shorter costoclavicular performance time, 2 minutes (IQR 1.5-2.3) versus 3 minutes (IQR 2.5-3.3), $P < 0.001$, and fewer needle redirections, 2 (IQR 1-2) versus 3 (IQR 2.7-4), $P < 0.001$.^[15] This suggests that target

configuration may be more important than depth alone. Our study also showed a significant difference in the distance between the plexus and pleura. Leurcharusmee et al. ($P > 0.99$) and Amaral et al. (RR 0.60, 95% CI 0.20–1.84; $P = 0.37$) reported no significant difference in hemidiaphragmatic paralysis.^[4,17]

Our study showed significant nerve-specific differences, especially in the ulnar, musculocutaneous, and intercostobrachial nerves. Janardhaniyengar et al. reported no nerve-sparing effect was seen in either group, but individual nerve frequencies were not provided.^[18] Nalini et al. reported successful blockade in all 50 patients, with one patient in the axillary group needing rescue for the radial nerve. Some differences in motor responses were found, mainly in the ulnar and musculocutaneous territories.^[19] Amaral et al. found no significant difference in motor onset (-0.34 minutes, 95% CI -0.90 to 0.22; $P = 0.23$) or block failure (RR 1.59, 95% CI 0.63–3.39; $P = 0.63$).^[17] These nerve-specific differences may be due to the anatomical arrangement of the brachial plexus at the respective injection sites and variations in local anaesthetic spread around individual nerve components.

In our study, oxygen saturation, heart rate, and blood pressure were similar in both groups. No vascular punctures were observed in either group. Brown et al. found no significant difference in vascular or pleural and procedure-related complications.¹⁶ Leurcharusmee et al. reported comparable safety with no significant difference in hemidiaphragmatic paralysis ($P > 0.99$).^[4] Amaral et al. similarly reported no significant difference in overall complications (RR 0.60, 95% CI 0.20–1.84; $P = 0.37$).^[17] Both approaches provided comparable haemodynamic stability and a low incidence of vascular and procedure-related complications.

CONCLUSION

The costoclavicular approach was found to be more rapid in sensory and motor block than the classical subcoracoid approach in patients undergoing surgery of the lower arm/forearm distal to the mid-humerus. Both methods maintained oxygen saturation within the normal range, and HR, SBP, and DBP were stable between the two methods and did not change over time. No vascular punctures were observed in either group. If the arm position is appropriate and the surgery is distal to the mid-humerus, the costoclavicular approach can be considered an alternative, especially for its rapid onset of sensory and motor block and favourable anatomy.

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