



## Original Research Article

# Comparison of ultrasound guided costoclavicular brachial plexus block versus supraclavicular brachial plexus block for forearm and hand surgeries for surgical anaesthesia: A prospective randomised clinical study

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## ABSTRACT

**Background and Aims:** Successful brachial plexus blocks (BPB) rely on proper techniques of nerve localization, needle placement and local anesthetic injection. This study aimed at comparing the efficacy of costoclavicular brachial plexus block versus supraclavicular brachial plexus block for forearm and hand surgeries for providing surgical anesthesia by evaluating the time of onset of sensory and motor blockade, nerve sparing effect and duration of analgesia in both the groups.

**Materials and Methods:** Fifty patients with ASA physical status 1, 2 and 3 undergoing forearm and hand surgeries were recruited. Fifty patients in Group C (n=25) and Group S (n=25) received 20 ml 0.5% ropivacaine by ultrasound guided costoclavicular and supraclavicular BPB respectively. The primary outcome measure was the time of onset of sensory and motor blockade. Secondary outcome measures included nerve sparing effect and duration of analgesia. Statistical analysis was done with student-t test, unpaired t-test and Fisher exact test.

**Results:** In our study, onset of sensory blockade ( $8.20 \pm 0.58$  mins vs  $9.72 \pm 0.84$  mins) and onset of motor blockade ( $11.72 \pm 0.79$  mins vs  $12.56 \pm 0.92$  mins) were significantly shorter in group C when compared to group S. We did not find any nerve sparing effect in both the groups unlike other studies. Duration of analgesia ( $13.14 \pm 0.91$  hours vs  $12.84 \pm 0.93$  hours) and requirement of rescue analgesics were comparable in both the groups.

**Conclusion:** We conclude that ultrasound guided costoclavicular BPB has shorter procedural time and rapid onset of sensory-motor blockade compared to supraclavicular BPB.

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## 1. Introduction

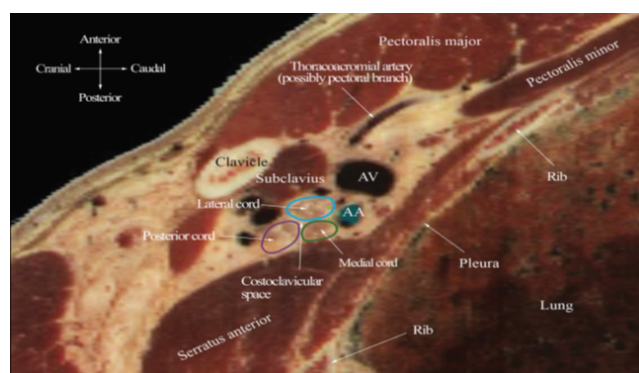
Costoclavicular approach of BPB is a modification of ultrasound-guided infraclavicular brachial plexus block. Its procedure<sup>1</sup> and cadaveric anatomical study<sup>2</sup> has been published by Sala Blanch et al.<sup>2</sup> in 2015. Under ultrasound guidance, the costoclavicular space (CCS) is visualized as a well-defined intermuscular space, lying deep and posterior to the mid-point of the clavicle. It is located between the clavicular head of the pectoralis major and subclavius muscle anteriorly and the upper slips of the

serratus anterior muscle and the second rib posteriorly. All 3 cords of the brachial plexus are visualized in a single transverse sonogram of the CCS as the cords are clustered together lateral to the axillary artery and exhibit a consistent triangular arrangement.<sup>3</sup> The block needle can be easily directed to the centre of the plexus with minimal discomfort to patient. Brachial plexus block would provide effective analgesia, safe surgical anesthesia without airway manipulation and hemodynamic swing, which is often seen in general anesthesia.

Most frequent approach in infraclavicular brachial plexus block is lateral infraclavicular fossa (LICF) performed using a sagittal ultrasound scan where the local anesthetic is

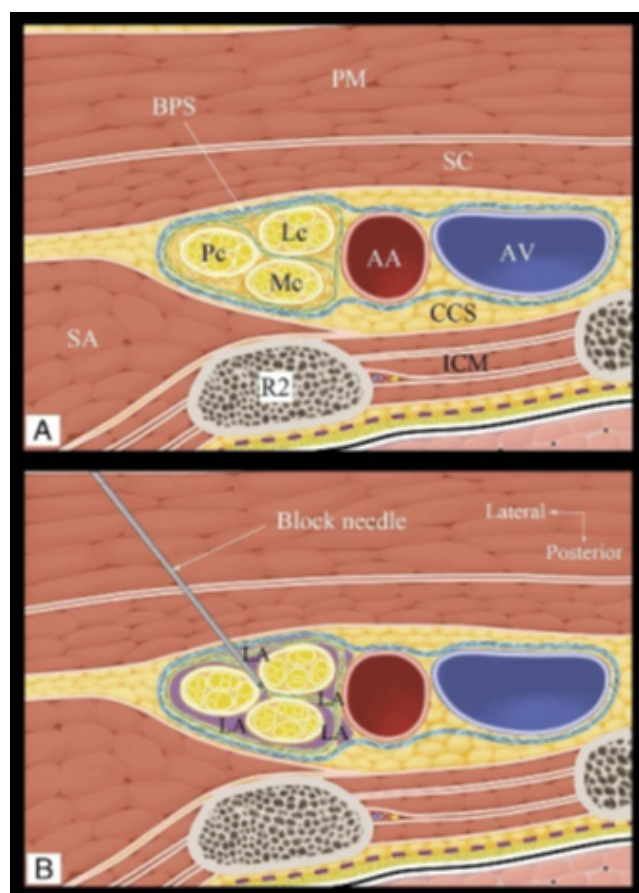
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**Fig. 1:** Anatomical image of costoclavicular space<sup>1</sup>

injected deep to the pectoral muscles and next to the second part of the axillary artery,<sup>4</sup> relatively large volumes of local anesthetic (up to 35–40 mL) and/or multiple injections are used to produce successful brachial plexus blockade during a lateral sagittal ICBPB.<sup>5</sup>



**Fig. 2:** Schematic representation of costoclavicular space in (A); Costoclavicular brachial plexus block approach in (B).<sup>3</sup>

Costoclavicular brachial plexus block varies from supraclavicular block as all the three cords of the

brachial plexus are clustered in the former and the low dose of local anesthetic and single injection provides effective analgesia and anesthesia. In the conventional supraclavicular approach, brachial plexus around the subclavian artery is blocked with higher risk of ulnar nerve sparing and vessel rupture. There is low risk of vessel rupture and pleural puncture in costoclavicular variant of infraclavicular brachial plexus block as the nerve cords are first approached before vessel and the pleura when compared with other approaches to infraclavicular brachial plexus block (ICBPB). We hypothesized that a single injection of local anesthetic at the center of the brachial plexus at the CCS, under USG guidance, will produce rapid onset of BPB producing surgical anesthesia. We undertook this study as there are no previous studies available which compared the efficacy of costoclavicular approach of brachial plexus block with the conventional supraclavicular block.

## 2. Materials and Methods

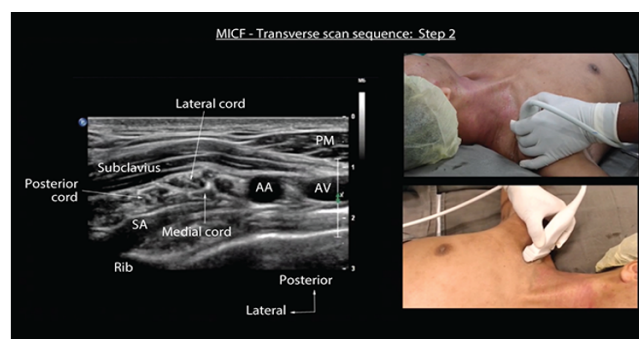
After obtaining the Institutions' Ethical committee approval, a single blinded (observer) randomized clinical study was carried out on patients aged between 18 to 80 years of ASA grade I, II and III scheduled for forearm and hand surgeries at our institution. The purpose, procedure and risks involved with the study were explained to the patient and a written informed consent was obtained. Patients with neuromuscular disease/nerve injury, prior surgery on the infraclavicular fossa, pregnant patients and with contraindications to peripheral nerve blocks were excluded from the study.

All the patients were subjected to detailed pre-anesthetic evaluation. Routine investigations and specific investigations were done as per patient clinical evaluation. During the preoperative visit, patients were also instructed on the use of a visual analogue scale (VAS) for post-operative analgesia. Hemodynamic variables (BP, HR, and SPO<sub>2</sub>) were evaluated. All the patients were kept nil per oral 8 hours prior to surgery.

Patients were randomly divided into two groups of 25 patients each using computer random numbers using sealed envelope method into groups C (costoclavicular brachial plexus block) and group S (supraclavicular brachial plexus block).

On arrival to the operating room, intravenous access (20 G) was established on the contralateral hand or forearm and standard ASA monitors (electrocardiogram, noninvasive blood pressure and SpO<sub>2</sub>) were connected and intravenous fluids were started. Block was performed by an anaesthesiologist who was skilled in ultrasound guided block techniques. Outcome measures were observed by an independent observer after the performance of block by the anaesthesiologist.

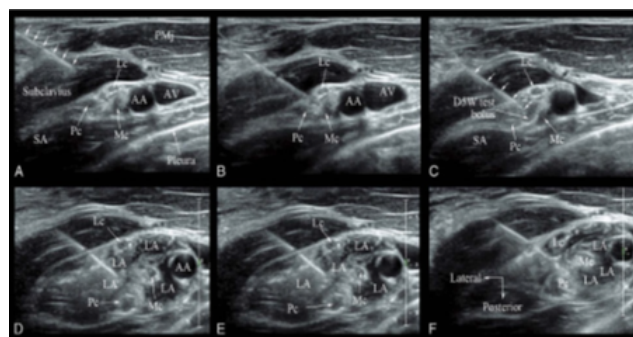
In Group C patients, under strict aseptic precautions, parts prepared and ultrasound scan was done using M-Turbo Sonosite® using high frequency linear array (5-12 MHz) transducer. Patients were positioned supine, with ipsilateral arm abducted for the scan and the head was turned slightly to the contralateral side for the BPB. The following anatomic landmarks were then identified and marked on the skin: clavicle, mid-point of the clavicle, and the tip of the coracoid process. A liberal amount of ultrasound gel was applied to the skin for acoustic coupling, and a transverse scan was performed over the medial infraclavicular fossa. The transducer was placed transversely directly over the mid-point of the clavicle in the transverse orientation with its orientation marker directed laterally (outward) and it was gently moved caudally until it reached the inferior border of the clavicle to visualize axillary artery (first part) and vein. Maintaining the same transducer position, it was gently tilted cephalad to direct toward the CCS, that is, the space between the posterior surface of the clavicle and the second rib. The ultrasound image was stabilized until all 3 cords of the brachial plexus were clearly visualized lateral Care was taken to avoid needle insertion to the cephalic vein or the thoracoacromial artery.



**Fig. 3:** Ultrasonography technique and image of costoclavicular space<sup>6</sup>

After skin was infiltrated with 2-3 ml of Inj. Lignocaine 2%, a 23 gauge spinal needle was inserted in-plane from a lateral to medial direction, cords of the brachial plexus are located and needle tip was placed at the center of the nerve cluster by advancing the needle through the gap between the lateral and posterior cord and advancing it toward the medial cord. After confirmation of the placement of needle via direct visualisation and saline dissection, a total volume of 20 mL of 0.5% Inj. Ropivacaine was injected in small aliquots and at a single site over 2 to 3 minutes.

In Group S patients, with the patient in the supine position with head end elevation of 15°, the skin was disinfected and the transducer was positioned in the transverse plane immediately proximal to the clavicle at its midpoint. The transducer was tilted caudally to obtain a cross-sectional view of the subclavian artery. The brachial plexus was seen as a collection of hypoechoic



**Fig. 4:** Series of ultrasound images showing costoclavicular approach of brachial plexus block<sup>3</sup>

oval structures superficial to the artery posteriorly. Proper needle placement was confirmed with saline dissection. When the injection displaced the brachial plexus away from the needle, an additional advancement of the needle 1–2 mm closer to the plexus was done accomplish adequate local anesthetic spread. A total amount of Inj. Ropivacaine 0.5% 20ml was given around the subclavian artery.

After LA injection through the block needle, measurements of onset of sensory and motor blockade were done by an independent observer who was blinded to the technique. Sensory blockade was graded according to a 3-point scale using a cold test using spirit swab as follows: 0, no block; 1, analgesia (patient can feel touch, not cold); and 2, anesthesia (patient cannot feel touch).<sup>5,7,8</sup> Sensory blockade of the musculocutaneous, median, radial, and ulnar nerves were assessed on the lateral aspect of the forearm, the volar aspect of the thumb, the lateral aspect of the dorsum of the hand, and the volar aspect of the fifth finger, respectively.<sup>5,7,8</sup> Motor blockade was also graded on a 3-point scale: 0, no block; 1, paresis; and 2, paralysis.<sup>5,7,8</sup> Motor blockade of the musculocutaneous, radial, median, and ulnar nerves were evaluated by elbow flexion, thumb abduction, thumb opposition, and thumb adduction, respectively.<sup>5,7,8</sup> Overall, the maximal composite score was 16 points. We considered the patient ready for surgery, when a minimal composite score of 14 points was achieved, provided the sensory block score was equal or superior to 7 out of 8 points. This scale has been used in previous studies.<sup>5,7,8</sup> Duration of onset of surgical anaesthesia was noted by sensory assessment at regular intervals in both the groups. Postoperatively VAS score was assessed to elicit duration of post-operative analgesia at predetermined time intervals 0,1,2,4,6,12,24<sup>th</sup> hour. Once the VAS score was  $\geq 4$ , patients were started on Inj. Paracetamol 1g i.v 8<sup>th</sup> hourly.

In cases of brachial plexus block failure in either of the approaches, supplemental analgesia with Inj. Fentanyl in graded doses or conversion into general anaesthesia was planned. Complications, if any were documented and

treated accordingly.

### 2.1. Statistical analysis

Data was collected and entered in MS Excel using SPSS version 24.0 for analysis. A pilot study was conducted on 10 patients and mean difference of 25% was obtained between two groups for onset of sensory and motor blockade. With standard deviation of 0.8, 90% statistical power and 5% level of significance, a sample size of 42 with 21 patients in each group was adequate. To avoid errors and attrition a sample size of 50 with 25 patients in each group was considered. Descriptive statistics was used for assessing demographic variables. Hemodynamic variables were assessed by student t test. Unpaired t test was used for statistical analysis of onset of block, duration of sensory and motor block and postoperative analgesia. Fisher Exact test was used for categorical variables. P-value of <0.05 was considered statistically significant.

## 3. Results

Demographic variables including age, weight, height, BMI, hemodynamic variables and ASA grading was comparable in both the groups.(Table 1)

As per our observation, onset of sensory blockade ( $8.20 \pm 0.58$  min vs  $9.72 \pm 0.84$  min) and onset of motor blockade ( $11.72 \pm 0.79$  min vs  $12.56 \pm 0.92$  min) were shorter in group C when compared to group S (p- value <0.0001 and p-value 0.0016 respectively). However, duration of sensory and motor blockade was comparable between both the groups and was statistically insignificant.(Table 2)

Duration of block performance was significantly shorter in costoclavicular approach of brachial plexus block when compared to supraclavicular approach. However, the duration of analgesia was comparable in both the groups. Requirement of rescue analgesics was also comparable between the two groups as it had almost similar duration of postoperative analgesia.

Studies have shown nerve sparing effect predominantly posterior cord, ulnar nerve in supraclavicular approach, however, our study did not show any nerve sparing effect in both the groups. Adverse effects such as nausea, vomiting, sedation and respiratory depression was not seen in both the groups.

## 4. Discussion

In this prospective randomized, observer blinded study, we compared costoclavicular and supraclavicular approach of brachial plexus block using ultrasound guidance. The CCS was visualized as a well-defined intermuscular space lying deep to the mid-point of the clavicle posteriorly. Costoclavicular space can be analyzed by infraclavicular approach which allows the visualization of the posterior, medial, and lateral nerve cords of the brachial plexus in a

triangular arrangement which is maintained in the proximal part of the retropectoralis minor space. In the CCS, cords of the brachial plexus lie lateral to the axillary artery. The cords appeared as hypoechoic clusters and exhibited a consistent anatomic arrangement relative to one another and to the axillary artery which are comparable with the study conducted by Demondion et al.<sup>9</sup> This consistent anatomic arrangement of the brachial plexus may explain the high success rate of this approach.

In our study we observed that onset of sensory and motor blockade was slightly earlier in group C than group S (Table 2). In a study conducted by Abhinaya et al.<sup>10</sup> where infraclavicular block was compared with supraclavicular block, results showed early onset of sensory blockade ( $6.43 \pm 2.61$  min) in Group I than Group S ( $8.45 \pm 2.87$  min,  $P = 0.006$ ). The onset of motor blockade was early in Group I ( $7.32 \pm 2.90$  min) than Group S ( $8.68 \pm 3.50$  min,  $P = 0.121$ ).

A study conducted by Li et al.<sup>3</sup> aimed at describing the anatomy, technique and block dynamics of an ultrasound guided costoclavicular brachial plexus block. In this study, costoclavicular brachial plexus block was successfully performed using 20ml of 0.5% Inj. Ropivacaine on 30 patients, it produced rapid onset of sensory-motor blockade with a median time to readiness for surgery as 10 (5-20 min) and it was effective as surgical anaesthesia in 97% patients.

The costoclavicular brachial plexus block was a single point injection lateral to axillary artery, whereas supraclavicular approach required multiple point injections around the subclavian artery. The block performance time was comparatively shorter in costoclavicular approach of brachial plexus block. (Table 2) This observation is comparable with the previous study conducted by Abhinaya et al.<sup>10</sup> where the block performance time was relatively quicker in Group I ( $9.57 \pm 3.19$  min) than Group S ( $11.53 \pm 2.90$  min) ( $P = 0.015$ ).

Similarly, a study by Koscielniak-Nielsen ZJ et al.<sup>11</sup> showed the mean block performance time of 5.7 min in the supraclavicular group and 5.0 min in the infraclavicular group. In our study, postoperative analgesia in both the groups is comparable and statistically insignificant which is comparable with study conducted by Abhinaya et al.<sup>10</sup> (Table 2)

As per our observation, costoclavicular approach of brachial plexus block is comparable to conventional supraclavicular approach of brachial plexus block, however the former shows early onset of sensory and motor blockade and comparatively shorter block performance time. Hence costoclavicular approach can be used as sole anaesthetic procedure for forearm and hand surgeries as an alternative to supraclavicular approach. No adverse effects were observed in both the group as the block was performed by trained anaesthesiologist and no supplemental analgesia was given intraoperatively. Other studies on supraclavicular approach

**Table 1:** Comparison of demographic variables between two groups

	Group C (Mean±SD)	Group S (Mean±SD)	P- value
Age in years	50.52±19.33	50.16±17.69	0.93
Weight in kgs	64.8±14.19	60.84±14.62	0.15
Height in cms	162.72±8.69	165.2±10.30	0.39
Sex (M/F)	0.92	0.92	1
BMI (kg/sq.m)	24.67±6.12	22.56±6.28	0.22

(p - values for demographic variables)

**Table 2:** Comparison of parameters- block performance duration, onset and duration of sensory and motor blockade and duration of analgesia between both groups

Parameters	CCB (Group C) (Mean±SD)	SCB (Group S) (Mean±SD)	P-value
Duration of performance of block (mins)	9.68±1.11	10.56±1.12	0.035
Onset of sensory nerve block (mins)	8.20±0.58	9.72±0.84	<0.0001
Onset of motor nerve block (mins)	11.72±0.79	12.56±0.92	0.0016
Duration of sensory blockade (mins)	148.56±1.12	148.48±1.00	0.79
Duration of motor blockade (mins)	132.6±1.80	133±1.78	0.45
Duration of analgesia (hours)	13.14±0.91	12.84±0.93	0.2868

have shown ulnar nerve sparing requiring supplemental analgesia or conversion to general anaesthesia, our study did not show any such results in both the groups. Eventhough all the results were in favor of costoclavicular approach, there were no statistically significant difference in postoperative analgesia in both the approaches.

Based on study conducted by Charles et al.<sup>12</sup> costoclavicular approach offers better mechanical stability for catheter placement than the traditional supraclavicular approach as the catheter pierces the pectoralis major and subclavius muscles, a larger proportion of it remains tunneled and hence safe neck movements is achieved. However, we did not use any catheters in our study.

Limitations: this is a single blinded small group study which requires further evaluation in larger groups for validation of our results.

## 5. Conclusion

In our study, we conclude that ultrasound guided costoclavicular brachial plexus block is rapidly executed and has rapid onset of sensory-motor blockade. It has similar duration of postoperative analgesia and safety profile like conventional ultrasound guided supraclavicular block for forearm and hand surgeries. CCB can be used as an alternative technique to supraclavicular approach for providing surgical anaesthesia for forearm and hand surgeries in routine clinical practice.

## 6. Source of Funding

Nil.

## 7. Conflict of Interest

Nil.

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