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Original research article

A comparison of the paracoracoid technique vs. the costoclavicular approach for infraclavicular brachial plexus block during procedures on the upper limbs

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Abstract

Background: As a result of regional anaesthesia's advantages over general anesthesia, these blocks are now commonplace in contemporary medicine. The use of peripheral nerve blocks for anaesthesia and pain management is widely regarded as the gold standard for outpatient limb surgery.

Methods: This was a prospective, randomized, observer-blinded controlled trial conducted at Department of Anesthesiology, which is a part of JJMMC, Davangere, Karnataka, India between April 2023 to August 2023. Fifty patients (25 men and 25 women, ASA physical status 1 or 2, scheduled for upper limb surgeries) were randomly assigned to either Group-CC or Group-PC. All told, there were 25 persons spread throughout the two groups.

In order to create the local anesthetic, 15ml of 0.5% bupivacaine was combined with 15ml of 2% lignocaine and 5ugs/ml of adrenaline.

Results: In this randomized, observer-blinded trial, 50 patients with similar demographics underwent surgery on their upper limbs. This study aimed to compare the onset times, imaging times, needling times, performance times, needle passes, adverse events, and surgical anaesthesia of the costoclavicular approach and the paracoracoid approach to infraclavicular brachial plexus block using ultrasound guidance.

Conclusion: Compared to the paracoracoid route, we found that the Costoclavicular approach leads to earlier surgical readiness and faster onset of sensori-motor blockade. Block and needle manipulation can be performed much more quickly with the costoclavicular approach than with the paracoracoid approach.

Keywords: Brachial plexus, paracoracoid, infraclavicular and costoclavicular

Introduction

Peripheral nerve blocks have become increasingly common in modern medicine due to the various applications in which they are preferable to general anaesthesia. When it comes to pain management and anesthesia, peripheral nerve blocks are the standard of care for outpatient limb surgery [1]. Regional anaesthesia has been shown to be particularly useful for patients at high risk of surgical problems, such as the elderly, who need surgery on the upper or lower extremities. Now that ultrasonography and the peripheral nerve stimulator have advanced, peripheral nerve blocks can be used instead of general anaesthetic in many cases. There is no longer any need to use a blind landmark technique while administering a peripheral nerve block because of the availability of ultrasound and nerve stimulation guidance. Better quality nerve block, shorter latency, and a smaller dose of local anaesthetic can be achieved with the help of ultrasound because of ultrasound's capacity to view the nerve plexus, which aids in the administration of the local anaesthetic [2, 3]. Ultrasound guidance for peripheral nerve blocks has also decreased the likelihood of unintended vascular or pleural puncture. In the past, nerve stimulation was considered the gold standard treatment for neuronal blocking because of doctors' ability to predict the spread of local anaesthetic to the area around the nerve. Ultrasound has an advantage over nerve stimulators due to this increased transparency. It has been proven that combining an ultrasound guided nerve block approach with a nerve stimulator improves outcomes. The visual guidance ultrasonography provides to the needle's position increases the likelihood of a successful and safer block [4-6]. To apply an infraclavicular block, the paracoracoid approach is typically used. The paracoracoid technique has been proven to have a greater success rate when a single point injection is made at the 6 o'clock position (posterior cord) to the axillary artery. Multiple nerve trunks, not all of which are in the "classical" location, are also housed in the lateral infraclavicular fossa. This hinders the efficient delivery of local anaesthesia to the affected nerves. A unique costoclavicular approach to Infraclavicular block

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has been described by Karmakar *et al*., in which the brachial plexus is targeted just caudal to the collarbone. In the costoclavicular region, lateral to the axillary artery, are the three cords that make up the brachial plexus. He hypothesised that the more concentrated costoclavicular topography would allow for the same "very rapid initiation of brachial plexus blocking" as with a supraclavicular approach [7-9].
A brachial plexus block is a common procedure in contemporary medicine. Blocking the brachial plexus nerves efficiently and safely is a must for any treatment involving the upper extremities. This research aims to compare the success rates of paracoracoid and costoclavicular ultrasound-guided infraclavicular brachial plexus blocks.

Material and Methods
This was a prospective, randomized, observer-blinded controlled trial conducted at Department of Anesthesiology, which is a part of JJMMC, Davangere, Karnataka, India between April 2023 to August 2023. Fifty patients (25 men and 25 women, ASA physical status 1 or 2, scheduled for upper limb surgeries) were randomly assigned to either Group- CC or Group- PC. All told, there were 25 persons spread throughout the two groups.
In order to create the local anesthetic, 15ml of 0.5% bupivacaine was combined with 15ml of 2% lignocaine and 5ugs/ml of adrenaline.

Inclusion criteria
1. Between the ages of 18 and 60; 2.
2. ASA physical status I or II.
3. A BMI of 18 to 35 kg/m 2.

Exclusion criteria
1. Patient opposition.
2. Pregnancy.
3. Patient with sepsis, hepatic or renal failure, coagulopathy, or sepsis.
4. Allergy to local anaesthesia.
5. Previous infraclavicular fossa surgery.
6. Skin issues that prevent the block.

Once the patient was in the operating room, the usual anaesthetic monitors were placed on them to keep an eye on their vitals (heart rate, blood pressure, and oxygen saturation). A peripheral intravenous line was inserted. Local anaesthetic dosage and administration varied little among the trial groups. To make a local anesthetic, we combined 15 millilitres of 0.5% bupivacaine, 15 millilitres of 2% lignocaine, and 5 micrograms of adrenaline per millilitre.
The patient needs to be in a supine position with the affected limb at their side and their head facing the opposite direction. During paracoracoid ICB, a short-axis picture of the axillary artery can be obtained by sterilely applying the US probe in the lateral infraclavicular fossa medial to the coracoid process in the sagittal plane. The patient's skin was infiltrated from head to toe, and then the block needle was slid cephalad to caudally until its tip was dorsal to the axillary artery52. The local anaesthetic mixture was injected slowly over the course of 30 mL after a negative blood aspiration was performed to avoid intravascular injection.

Results
The patients who participated in this research were split evenly between two groups, each consisting of 25 participant's total.

Table 1: Age distribution

Age Group		Frequency		Total
		PC	CC	
18-20 Years	Count	2	3	6
	% within Group	13.4%	14.6%	14.8%
21-40 Years	Count	12	18	33
	% within Group	51.0%	72.3%	62.2%
41-60 Years	Count	10	2	14
	% within Group	39.5%	12.5%	23.0%
Total	Count	25	25	50
	% within Group	100.0%	100.0%	100.0%

The average age is 30, and the standard deviation is 9.306 among the costoclavicular cohort. The average age of people with infraclavicular deformities is 36.08, with a standard deviation of 8.460. In terms of age distribution, there was no discernible difference between the two groups.

Table 2: Sex Distribution

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Gender		Frequency		Total
		PC	CC	
Male	Count	22	23	45
	% within GROUP Count	84.2%	86.5%	86.5%
Female	% within GROUP Count	2	5	7
	% within GROUP Count	11.6%	14.8%	12.5%
Total	% within GROUP	25	25	50
		100.0%	100.0%	100.0%

In the costoclavicular group, there are 22 male patients, making up 84.6% of the total, and 4 female patients, making up 15.4% of the total.

Weight distribution

The patients in Group-CC have a wide range of weights, from 43 to 71 kilograms, with a mean of 58.35 kilogrammes and a standard deviation of 7.299. Patients in Group-PC have a mean weight of 56.10kgs, ranging from 41kgs to 68kgs.

Table 3: Onset of Sensation and Movement

Sensory and motor onset time:	GROUP	n	Mean (minutes)	Std. Deviation (min)	Std. Error Mean	t value	p value
Sensory Onset Time	PC	25	13.2147	3.92232	0.76923	1.147	0.214
	CC	25	13.200	4.34933	0.86987		
Motor Onset Time	PC	25	12.354	4.18789	0.82131	1.789	0.016
	CC	25	10.300	3.89444	0.77889		

There was a larger dispersion in the CC group's sensory block start time (4.34) than in the PC group (3.92). There is no discernible difference between the two. In the CC group, the standard deviation for motor block onset time was 3.89 seconds, while in the PC group it was 4.18 seconds. There is no discernible difference between the two.

Table 4: Block Time for Performance

Group	n	Mean (minutes)	Std. Deviation (minutes)	Std. Error mean	t value	p value
PC	25	6.147	1.9247	.37714	2.956**	0.001
CC	25	5.478	1.5012	.29357		

In the costoclavicular group, the mean time to complete a block is 5.36 seconds, with a standard deviation of 1.5 seconds. This demonstrates that paracoracoid block is more labour-intensive than costoclavicular block.

Table 5: Temporal Imagery

Group	N	Mean (Secs)	Std. Deviation	Std. Error mean	t value	p value
PC	25	72.1138	28.01478	5.50147	0.498	0.6147
CC	25	68.5146	25.24785	4.95369		

The average imaging time for the costoclavicular region is 68.54 seconds (SD = 25.27). The average imaging time for the paracoracoid group is 72.15 seconds, with a standard deviation of 28.07. The 'p' value of 0.6147 indicates that the result is not statistically significant.

Discussion

A prospective, randomized, observer-blinded trial was conducted on fifty patients with a similar demographic profile who had upper limb surgery. This research aimed to compare the effectiveness and safety of ultrasound-guided infraclavicular brachial plexus blocks administered at the costoclavicular and paracoracoid levels, specifically with regards to block onset time, imaging time, needling time, performance time, the number of needle passes, adverse events, and surgical anaesthesia [10, 11].

Infraclavicular block has never been as popular as other forms of brachial plexus anaesthesia since it requires a larger needle and has an inconsistent landmark. The use of nerve stimulators ensures more reliable blocking than would be possible with conventional paraesthesia. Both landmark and nerve stimulator procedures have the potential to cause neurovascular damage, such as pneumothorax. Since ultrasound can precisely localise and visualise the neural plexus in real time, it offers an advantage over nerve stimulators. Combining ultrasound with neurostimulation increases task completion time compared to ultrasound alone [12, 13], as shown in studies by Dingemans *et al*. 10 and Gurkan *et al*.

Chiyo Ootaki, M.D., *et al*. found that the infraclavicular approach with ultrasonogram guiding was superior to the landmark technique for both precision and patient comfort. That's why we choose to conduct this study using ultrasound. Alessandro Di Filippo *et al*. found that 30ml of local anaesthetic is

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needed for an ultrasound-guided "Double Bubble" infraclavicular Block. They reasoned that using the paracoracoid approach, a single injection near the posterior cord would spread to the other two cords and thereby block the plexus. Due to the dense packing of the cords in the costoclavicular area lateral to the axillary artery, Karmakar *et al*. indicated that only 20 mL of 0.5% ropivacaine is necessary for costoclavicular block under dual guidance with ultrasonography and neurostimulation [14-16].

The ultrasound-guided costoclavicular block MEV of 1.5% lignocaine with epinephrine 5mics/mL was found to be 34 mL by Thitipansotthisopha *et al*.

Since we are using only ultrasound guidance and comparing the costoclavicular and paracoracoid approaches, we have decided to utilise the same volume (30 ml) of local anaesthetic mixture for both groups in our study. There were no statistically significant differences between the groups with respect to age, sex, weight, or ASA Physical status class. No substantial difference was found [17-19].

Our study focused primarily on the onset timing of the sensori-motor block, and we discovered that it happened earlier (11.8 min) in the CC group than in the PC group (14.4 min). In this case, the 'p' value is much smaller than 0.05. Local anaesthesia is more likely to spread to the brachial plexus after a costoclavicular approach because of the uniform topographical arrangement of the three cords. Because there are fewer cords and more variation in where those cords fall in regard to the axillary artery, the PC group has a lower risk [18-20].

However, Leurcharusmee *et al*. 35 reported no differences in block initiation times among groups, contradicting our results. Mean onset times of 16.0 and 16.8 minutes were recorded for the costoclavicular and paracoracoid groups, respectively. The difference between our study and that of Leurcharusmee and colleagues may be attributable, at least in part, to the dosage of local anaesthetic used in each. Significant injectate (35 ml) was used. The cords of the brachial plexus are more closely packed together in the costoclavicular region than they are in the lateral infraclavicular fossa (where the paracoracoid ICB is performed). High injection volumes probably aided in hiding these anatomical differences. Our study used just 30 ml, however it is likely that more densely packed cords in the costoclavicular region would have been blocked by this quantity before those in the paracoracoid approach. The costoclavicular method may have been more rapid in achieving sensorimotor blockade than the paracoracoid approach [23, 24]. Neither the PC group's mean of 14.23 minutes nor the CC group's mean of 12.8 minutes for sensory onset was statistically different from one another. The PC group's onset of motor activity was 13.46 minutes, while the CC group's onset was 11.2 minutes. From a statistical perspective, this is also meaningless. Banchobporn Songthamwat *et al*. found similar outcomes using 25 ml of 0.5% ropivacaine and a CC technique to achieve sensory blocking earlier (10 minutes vs. 20 minutes). Anupreetkaur *et al*. found that the onset of ropivacaine's sensory and motor blockade was more rapid than that of bupivacaine. Our study's distinct sensory onset time [19-21] may be attributed to the fact that Banchobporn Songthamwat *et al*. used a larger dose (25 ml) and a different kind (ropivacaine) of local anaesthetic.

Neither the 68.53 seconds spent imaging the costoclavicular group nor the 72.15 seconds spent imaging the paracoracoid group differ by a statistically significant amount. This shows that there was no statistically significant difference between the two groups in the amount of time it took to take a high-quality shot. Leurcharusmee *et al*. [22] found no statistically significant differences between groups when comparing imaging times.

When comparing the costoclavicular and paracoracoid groups, the average time it takes to implant a needle is 4.47 minutes and 5.6 minutes, respectively. The statistical significance level of the 'p' value is 0.005. This study [23] shows that paracoracoid blocks take longer to needle than costoclavicular blocks. Access to the posterior chord of the brachial plexus is challenging since it is tucked away around 6 o'clock with respect to the axillary artery. Needling in the costoclavicular block took less time because the brachial plexus cords are shallower. In a similar study, conducted by Leurcharusmee and colleagues35, there was no statistically significant difference between the two groups with regard to the amount of time spent needling (min), which was 5.6 in the PC group and 6.0 in the CC group. The sum of imaging and needling time in a certain time block. The costoclavicular group averages 5.30 minutes every block. The paracoracoid muscle group has an average block performance time of 6.8 minutes. According to our statistical analysis, the 'p' value has a significance level of 0.002. That a costoclavicular block can be performed in less time than a paracoracoid block is supported by these studies [24, 25].

Leurcharusmee and coworkers also came to similar conclusions about block performance time. PC participants completed their tasks in 6.0 minutes, while CC participants took 6.7 minutes. It is challenging to reach the posterior chord of the brachial plexus in the PC group since it is placed about 6 o'clock from the axillary artery. The costoclavicular block took less time to perform than the supraclavicular block because the brachial plexus cords are more superficially placed (approximately 3-4cm) and are crowded together lateral to the axillary artery. On average, 1.76 needle passes are required in the costoclavicular area. In the paracoracoid group, patients received an average of 2.76 needle insertions. According to statistical analysis, the significance level of the 'p' value is incredibly small (0.001). The number of needle passes for the costoclavicular block was less than that for the paracoracoid block. The favourable grouping of the brachial plexus cords at the costoclavicular location, just laterally

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to the axillary artery, may account for this. Successful brachial plexus blockade during a paracoracoid approach may require multiple injections due to the cords of the brachial plexus being located at a depth of 3-6 cm in the lateral infraclavicular fossa and being separated from one another. Additionally, there is significant variation in the position of the individual cords of brachial plexus relative to the axillary artery. He identified the parietal pleura as lying at the CCS, beneath the axillary veins and cords. As a result, fewer needle sticks occurred during costoclavicular blocks [23-25].

There have been four cases of unintentional vascular puncture; three in the paracoracoid region and one in the costoclavicular region. One possible explanation is because the posterior chord is situated so far behind the axillary artery that it is easy to pierce by accident when reaching for something else. In a research by Bigeleisen P, Wilson M, *et al*., 5% of patients had vascular puncture with ultrasound guidance to treat paracoracoid block. Paracoracoid approach, as found by Leurcharusmee and colleagues [24-26], is associated with a higher risk of vascular breech.

An intercostobrachial block was used as adjunctive therapy for three patients in our CC cohort. Unlike with other types of brachial plexus blocks, the medial aspect of the upper arm skin may not be numbed with the costoclavicular approach. That's why they needed to load up on supplement pills. With reported success rates of 64% for axillary and 87% for intercostobrachial nerve blocks, respectively, research by Bigeleisen P., Wilson M., *et al*. reveals that paracoracoid ICB is surprisingly effective (though not flawless) at anaesthetizing the upper arm. One subject was injected with 1 mg of Midazolam across both the CC and PC groups. To alleviate anxiety during surgery, fentanyl (1 mcg/kg) is administered intraoperatively. There were no postoperative cases of Horner's syndrome, hoarseness of voice, hemi-diaphragmatic palsy, or paresthesia [24-26].

Conclusion

The Costoclavicular approach has been shown to induce sensori-motor blockage and surgical preparedness more quickly than the paracoracoid approach. The costoclavicular group likewise required much less time for block and needle manipulation than the paracoracoid group. Patients with coagulopathy can have the costoclavicular approach done safely because there is a lower risk of vascular puncture compared to the paracoracoid one. When other treatments for brachial plexus fail, this can be thought of as a feasible alternative. Horner's syndrome and pneumothorax were not observed in either group, and the only complication was an inadvertent vascular puncture in the paracoracoid group.

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