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ORIGINAL ARTICLE

Comparison of costoclavicular and lateral sagittal infraclavicular approaches in ultrasound-guided brachial plexus block

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SUMMARY

Objectives: Lateral sagittal infraclavicular approach is frequently used because it has less risk of complications and provides rapid and adequate regional anesthesia. Due to the fact that the brachial plexus is deeper in the infraclavicular region and the approach angle is sharper, it can be technically challenging. In this study, we aimed to compare the costoclavicular approach, which is a newly defined approach, with the lateral sagittal infraclavicular brachial plexus block.

Methods: This prospective, randomized, single-blind study was conducted with a total of 43 patients. There were 21 patients in the lateral sagittal infraclavicular approach group (Group L) and 22 patients in the costoclavicular approach group (Group C). A mixture of 10 ml 1% lidocaine with 10 ml 0.25% bupivacaine was given to both groups under the guidance of ultrasonography. Sensory and motor examinations were performed every five minutes for 30 minutes, and the results were recorded.

Results: Sufficient block formation time was 10 (5–30) minutes in Group C and 15 (5–30) minutes in Group L (p=0.010). Sensory and motor block formation times of each nerve (median nerve, radial nerve, ulnar nerve, and musculocutaneous nerve) were found to be shorter in Group C than in Group L (p<0.05).

Conclusion: The costoclavicular approach provides faster regional anesthesia formation than the lateral sagittal infraclavicular approach.

Keywords: Brachial plexus block; costoclavicular block; infraclavicular block; upper extremity surgery.

Introduction

The infraclavicular approach stands out as an effective and safe approach for brachial plexus block and is used as an alternative or adjunct to general anesthesia in distal arm surgery. It is preferred in the upper extremity, especially in hand, wrist, elbow, and distal arm surgery.[1,2] Some complications of the supraclavicular approach, especially pneumothorax, can be avoided with the infraclavicular approach. The infraclavicular approach is preferred because it reduces complications with ultrasound, provides a more convenient area for catheter insertion, and facilitates catheter care compared to the supraclavicular approach.[3,4] The lateral sagittal infraclavicular approach is the most commonly used infraclavicular approach in recent practice.[5] This method was first introduced by Klaastad et al.[6] in 2004 as a low complication risk method with a needle insertion at the inferior border of the clavicle and medial to the coracoid process.

The costoclavicular approach has gained popularity in recent years as an effective and safe method providing brachial plexus block in the infraclavicular region.[7] In the lateral sagittal infraclavicular approach, the fact that the cords are 3–6 cm deep in the lateral fossa makes imaging and application difficult, and it requires the use of high-volume local anesthetic (LA) for a successful block because the cords are separated from each other and cannot always be visualized together. The medial infraclavicular region is the area where the cords of the brachial plexus are closest and most superficial to each other, and the brachial plexus block can be performed with LA applied to this area.[8] The medial infraclavicular region is surrounded anteriorly by the subclavius muscle and

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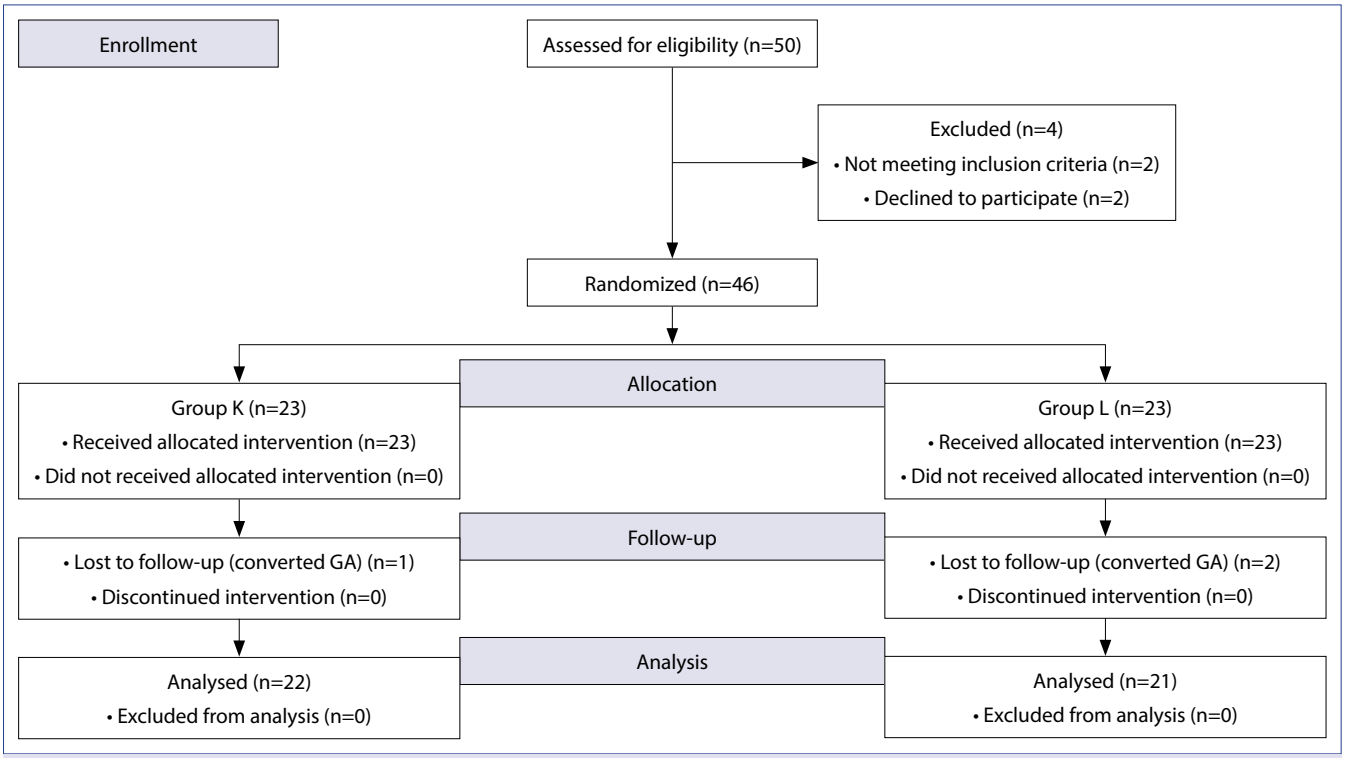

Figure 1. Flow diagram of patient data distribution.

GA: General anesthesia.

the clavicular head of the pectoralis major muscle, and posteriorly by the anterior chest wall. In the costoclavicular approach, imaging and application are easier, and a compact area is created for catheter use thanks to the intermuscular space formed between the subclavius and serratus anterior muscle.[9]

In this prospective, randomized, single-blind study, we aimed to compare the frequently used lateral sagittal infraclavicular approach and the newly defined costoclavicular approach for brachial plexus block in terms of applicability and efficacy.

Material and Methods

Study Design

This prospective, randomized, single-blind study was conducted in Ankara Bilkent City Hospital Department of Anesthesiology and Reanimation, Orthopedics and Traumatology operating room, after the approval of Yildirim Beyazit University Faculty of Medicine Clinical Research Ethics Committee (date: 08.04.2021, approval number: 26379996/33). The study was carried out in accordance with the Principles of the Declaration of Helsinki and was registered on clinicaltrials.gov prior to patient enrollment (NCT04921852).

Study Population

Patients aged 18–70 years, American Society of Anesthesiologists (ASA) I-II group who would undergo elective hand, wrist, forearm, and distal humerus surgery were included in the study. Patients who did not accept regional anesthesia, had a Body Mass Index (BMI)>30 kg/m^2, were pregnant, had coagulopathy, had a known allergy to local anesthetics, had been previously operated on from the infraclavicular fossa, developed neurologic deficits, or had an infection in the infraclavicular region were excluded from the study. As shown in Figure 1, a total of 50 patients were screened for this study, and 43 adult patients who gave written informed consent were enrolled in the study. There were 21 patients in the lateral sagittal infraclavicular approach group (Group L) and 22 patients in the costoclavicular approach group (Group C).

Randomization

Patients who met the criteria for inclusion in the study were identified by interviewing the relevant surgical team. To prevent selection bias and increase the validity of the study, the patients were divided into two groups using the closed opaque envelope method after obtaining informed consent. The ran-

domization process was conducted by individuals other than the researchers, who were not involved in any other part of the study.

All blocks were performed by lead researchers experienced in both techniques. The outcome evaluator (research nurse), who conducted the sensory-motor evaluation after the brachial plexus block, was not present in the anesthesia operating room during the block application. The research nurse, experienced and trained in this field, performed sensory-motor evaluations while unaware of the group distribution and blinded to the study, and followed the patients on the first day after surgery.

Preoperative Preparation

The patients were evaluated at least one day before the operation and fasted for at least 8 hours. They were reevaluated preoperatively in the operating room, and detailed information was given to all patients in both groups about the procedure to be performed. Informed consent was obtained, and an upper extremity neurologic examination was performed in every patient before the procedure. The Verbal Rating Scale (VRS) to be used in the study was explained to all patients as follows: According to this scale, a cold ice pack would be brought into contact with the patient's skin, and the sensation loss would be assessed by comparing the same areas of the extremities with and without block. Cold sensation was evaluated as 100, and no cold sensation was evaluated as 0. This procedure was used for the examination of the four main nerves. For the median nerve, the lateral 3.5 palmar surface of the fingers was tested; for the radial nerve, the dorsum of the hand; for the ulnar nerve, the medial 1.5 palmar surface of the fingers; and for the musculocutaneous nerve, the lateral surface of the anterior forearm was checked using the cold test.

Motor blockade of each of the four nerves in the ipsilateral upper extremity was also assessed and rated on a 3-point qualitative scale (2=normal motor strength, 1=paresis, and 0=paralysis). Motor blockade tests included index finger and thumb opposition for the median nerve, little finger and thumb opposition for the ulnar nerve, elbow flexion for the musculocutaneous nerve, and wrist extension for the radial nerve.

The patients were taken to the preoperative block room approximately one hour before the operation, and noninvasive blood pressure, electrocardiography, heart rate, and oxygen saturation (SpO2) were monitored. Blood pressure was measured on the contralateral side of the arm to be blocked. Peripheral 20 or 22 Gauge (G) vascular access was established in the arm that was not going to be blocked, and intravenous fluid transfusion was not performed. The patients were placed in the supine position, with the ipsilateral arm abducted 90 degrees. A soft support prepared from operating room covers was placed in the interscapular region, and the head was turned slightly to the opposite side. All block applications were performed after subcutaneous LA (1% lidocaine) infiltration. No sedation or analgesia was administered before, during, or after the block.

Block Performances

Infraclavicular block procedures were performed using a 22 G 80 mm SonoTAP (PAJUNK®) echogenic block needle with ultrasonography (USG) guidance under aseptic conditions. A portable ultrasound (US) machine (Logiq E, General Electric, USA®) with a 6–13 MHz high-frequency linear US probe was used to perform in-plane scanning during the guidance and delivery of the block needle to the target. When the needle tip reached the target and blood was not observed by negative aspiration to prevent unwanted intravascular placement, a total of 20 ml of LA solution containing 0.25% bupivacaine and 1% lidocaine was administered over approximately 2–3 minutes.

Costoclavicular Approach (Group C)

The clavicle, the midpoint of the clavicle, and the tip of the coracoid process were determined. To better define the sonoanatomy of the region, transverse scanning was performed in five consecutive steps from five adjacent points in the medial infraclavicular fossa as follows:

- Step 1: The US probe was placed transversely over the middle of the clavicle, with the marked part of the probe pointing laterally.
- Step 2: The probe was shifted slightly caudally from the inferior border of the clavicle, and the axillary artery and vein were visualized. Maintaining the probe position, the probe was slightly

bowed in the cephalic direction towards the costoclavicular region between the posterior part of the clavicle and the second rib. The US image was adjusted to visualize the three cords of the brachial plexus together lateral to the axillary artery. If the US image was unclear, the US beam was adjusted to be perpendicular to the underlying neurovascular structures, and the medial end of the US probe was rotated slightly caudally.

- Step 3: The probe was shifted slightly laterally, maintaining the same transverse orientation and applying minimal pressure, until the cephalic vein was visualized.
- Step 4: The probe was moved laterally until the thoracoacromial artery was seen originating from the axillary artery.
- Step 5: The probe was shifted laterally up to the lateral infraclavicular fossa.

Additionally, the direction of the probe was kept slightly oblique laterally to align the US beams at right angles to the underlying neurovascular structures. During needle insertion in the costoclavicular space, the cephalic vein and thoracoacromial artery were continuously visualized to avoid puncture. For the same reason, the subclavius muscle was always visualized along with the axillary artery, axillary vein, and cords.

The echogenic block needle was placed in-plane and directed from lateral to medial. The sonographic criteria used to confirm the needle tip position included visualization of the needle tip in the center of the nerve cluster and dissemination of a test bolus injection containing 1–2 ml of 0.9% saline in the center of the nerve cluster. Then, the LA solution was injected slowly into a single point, and the drug distribution was followed. The needle was removed from the block area, and a sterile strip was applied to the entry site. Five minutes after the procedure, the block inspection process was initiated (Fig. 2).

Lateral Sagittal Infraclavicular Approach (Group L)

After obtaining a transverse view of the axillary artery in a circle by performing a sagittal scan with US medial to the coracoid process, LA (lidocaine 1%) was administered subcutaneously on the cephalic side of the US probe. The echogenic needle was visualized in-plane from the same region and advanced posteriorly to the artery. When the feeling of piercing the nerve sheath was perceived at the six o'clock position (considering the axillary artery as a clock), the needle was stopped. It was confirmed that the needle was not in the intravascular position by negative aspiration, and the exact position of the needle tip was determined by injecting 1–2 ml of 0.9% saline.

A total of 20 ml of LA solution was injected at a single point under the artery, observing its distribution to both sides in a 'U' shape. Five minutes after the procedure, the block inspection process was initiated (Fig. 2).

Outcome Measures After the Brachial Plexus Block

In all patients, the duration of block application with US was measured using a chronometer and recorded. Block performance time was defined as the time elapsed between the insertion of the block needle into the skin and the removal of the needle after the block injection was completed. The pain associated with the block was evaluated using VRS, and the presence of paresthesia after the block was evaluated with a yes or no response and recorded. The initial needle insertion was considered the first direction, and any needle advance after a retraction of at least 10 mm was counted as a redirection. The number of needle redirections was recorded. Needle visibility was assessed using a five-point Likert scale (1: very bad, 2: bad, 3: moderate, 4: good, 5: very good).

Complications potentially associated with direct brachial plexus block, such as symptoms of vascular or pleural puncture, ipsilateral Horner's syndrome, intraneural injection, or LA intoxication, were also recorded.

After the block procedure was completed, a researcher unaware of the group allocation evaluated and recorded sensory and motor block every five minutes for 30 minutes. The block procedure was considered complete, and timing began, after LA injection and removal of the block needle.

Sensory block, defined as a loss of sensation to cold (ice) in the cutaneous distribution of the median (MN), radial (RN), ulnar (UN), and musculocutaneous (MCN) nerves, was evaluated and graded according to VRS (0–100, where 100=normal sensation and 0=no sensation). Motor blockade of each

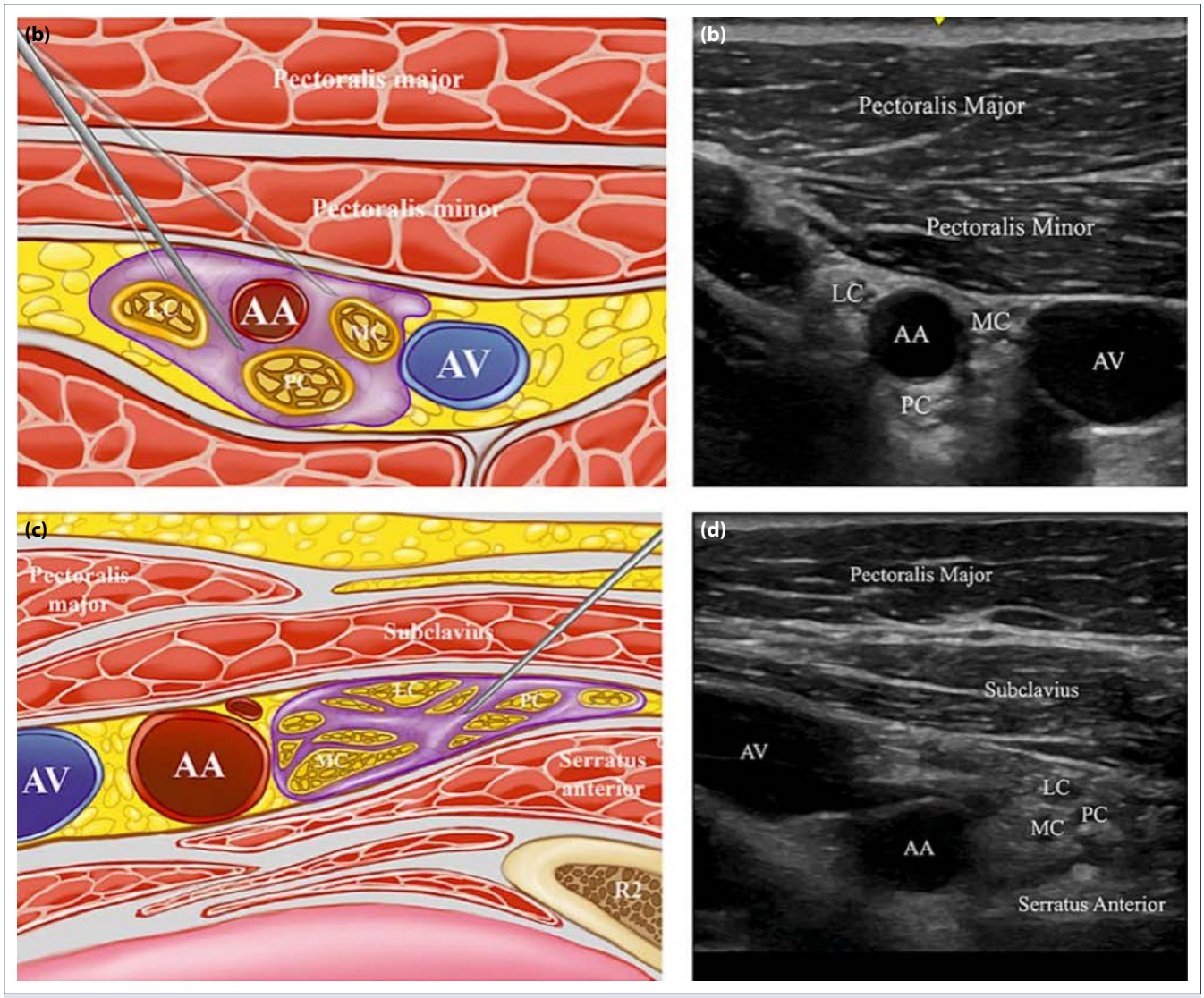

Figure 2. Schematic illustrations related to the injection of local anesthetic for group L and group C **(a, c)**, and sonoanatomy relevant for group L and group C **(b, d)**. **(a)** Schematic illustration of where to inject local anesthetic when using an ultrasound-guided the lateral sagittal infraclavicular approach; **(b)** The sonoanatomy relevant for the ultrasound-guided the lateral sagittal infraclavicular approach; **(c)** Schematic illustration of where to inject local anesthetic when using an ultrasound-guided the costoclavicular approach; **(d)** The sonoanatomy relevant for the ultrasound-guided the costoclavicular approach.

PC: posterior cord; LC: lateral cord; MC: medial cord; AA: axillary artery; AV: axillary vein.

of the four nerves in the ipsilateral upper extremity was also evaluated and graded on a 3-point qualitative scale (2=normal motor power, 1=paresis, and 0=paralysis). Thumb-forefinger, thumb-little finger opposition, elbow flexion, and wrist extension were used to test for motor blockade of MN, UN, MCN, and RN, respectively.

An overall (mean) sensory and motor score was calculated for each patient, and VRS sensory or motor scores of all four nerves tested were calculated at each time point. The onset time for each nerve to develop sensory and motor blockade was defined as the time taken to achieve a VRS of 30 or less and a motor power grade of one or less, respectively. An overall onset time for sensory and motor blockade, considering all four nerves together, was also calculated.

Time to readiness for surgery was defined as the time taken for the total sensory score to be VRS 30 or less and motor power grade one or less in all four nerves tested. Patients who achieved complete sensory (VRS=0), complete motor (motor power grade=0), or complete sensory-motor (sensory VRS=0 and motor power grade=0) block in all four nerves during the study were also calculated and recorded.

Table 1. Patient characteristics

Variables	Group C (n=22)	Group L (n=21)
Age, years, mean±SD	40.05±13.51	44.05±15.46
Sex, M/F, n (%)	13 (59.1)/9 (40.9)	11 (52.4)/10 (47.6)
BMI, kg/m^2, mean±SD	26.16±3.33	26.83±3.53
ASA class, 1/2, n (%)	4 (18.2)/18 (81.8)	8 (38.1)/13 (61.9)
Types of surgery, n, (hand/wrist/elbow/forearm)	13/6/2/1	9/8/3/1
Duration of surgery, minutes, mean±SD	52.64±29.12	65.10±27.91

ASA: American Society of Anesthesiologists; BMI: Body mass index; SD: Standard deviation; K: Costoclavicular; L: lateral sagittal.

Intraoperative Management and Postoperative Follow-Up

Sedation was not applied during the intraoperative period. The block was considered successful if the surgery was completed without requiring LA injection into the surgical area, rescue nerve block, or transition to general anesthesia with loss of consciousness, intravenous opioid administration, or airway support. This decision was entirely at the discretion of the anesthetist performing the application.

Patients were seen or contacted by telephone within 24 hours after surgery by the same research nurse to ensure the absence of residual block, permanent neurological deficit, or both. Patients were directly questioned about any symptoms suggestive of persistent paresthesia (tingling or "pins and needles" sensation) or dysesthesia (abnormal sensation) in the ipsilateral upper extremity of the brachial plexus block. Additionally, any reports of persistent neurological symptoms, sensory, or motor deficits during the first-week follow-up visit with the surgeon were reported back to the investigative team.

Sample Size and Statistical Analysis

G*Power (version 3.1.9.2) was used to calculate the number of patients to be included in the study. A pilot study was conducted to calculate the sample size. In the pilot study, the onset time of the sensory block was 8.75±5.17 minutes in the costoclavicular approach, while it was 13.75±5.34 minutes in the lateral sagittal infraclavicular approach. Based on these results, the estimated sample size was calculated as 38 patients (19 for each group) with 80% power and a 0.05 Type 1 margin of error. Considering the possibility of exclusions, 23 patients for each group were included in the study.

Descriptive statistics for continuous data were presented as Mean, Standard Deviation, Median, Minimum, and Maximum values, while discrete data were expressed as numbers and percentages. The Shapiro-Wilk test was used to assess the conformity of continuous data to a normal distribution. For comparison of continuous data between the two groups, the T-test was used for normally distributed data, and the Mann-Whitney U test was applied for non-normally distributed data. Chi-square and Fisher's Exact tests were used for group comparisons of nominal variables.

The data were analyzed using IBM SPSS for Windows version 20 (IBM Corp, Armonk, NY, USA), and the level of statistical significance was set at a p-value of <0.05.

Results

As presented in Table 1, both study groups were compared according to demographic data and clinical parameters, and the characteristics were found to be similar.

Brachial plexus block was successfully performed in 22 of 23 participants in Group C and 21 of 23 participants in Group L without the need for additional LA, sedation, general anesthesia, or rescue block. The data of all 43 participants were analyzed. Sufficient block formation time for surgery was 10 (5–30) minutes in Group C and 15 (5–30) minutes in Group L, with Group C providing statistically faster preparation for surgery (p=0.010, p<0.05). Needle visibility was found to be better in Group C, scoring 5 (3–5) on the five-point Likert scale compared to Group L (p=0.004, p<0.05).

Table 2. Block performance data

Variables	Group C (n=22)	Group L (n=21)	p
Sufficient block formation time for surgery, minutes, mean±SD /median (min–max)	10.91±6.48 /10 (5–30)	15.24±5.58 /15 (5–30)	**0.010**[a,*]
Needle visibility, Likert scale, mean±SD /median (min–max)	4.59±0.66 /5 (3–5)	3.90±0.83 /4 (2–5)	**0.004**[a,*]
Number of needle attempts, median (min–max)	1 (1–1)	1 (1–1)	1.000[a]
Number of needle redirections, n (%)	7 (31.8)	11 (52.4)	0.172[c]
Block performance time, seconds, mean±SD /median (min–max)	158.14±38.01 / 152.5 (110–250)	150.19±38.26 / 143 (100–250)	0.498[b]
VRS scores, mean±SD / median (min–max)	22.27±9.22 /20 (10–50)	22.38±9.43 /20 (10–40)	0.975[a]
Patient satisfaction scores, median (interquartile range)	5 (5–5)	4 (2.5–5)	**0.016**[a,*]
Surgeon satisfaction scores, median (interquartile range)	5 (5–5)	5 (5–5)	1.000[a]
Paresthesia, n (%)	4 (18.2)	1 (4.8)	0.345[c]
Vascular puncture, n (%)	3 (13.6)	4 (19)	0.698[c]

a: Mann-Whitney U test; b: T-test; c: Chi-square test; *: Statistically significant difference between groups; SD: Standard deviation; VRS: Verbal Rating Scale; C: Costoclavicular; L: Lateral sagittal.

Table 3. The formation times of sensory and motor block in the patients in groups C and L

Variables	Group C (n=22)	Group L (n=21)	p
MN sensory block formation time, minutes, mean±SD /median (interquartile range)	8.18±4.51 /5 (5–10)	14.52±6.50 / 15 (10–20)	**0.001**[a,*]
RN motor block formation time, minutes, mean±SD /median (interquartile range)	10.23±6.63 / 10 (5–15)	13.81±4.97 / 15 (10–15)	**0.016**[a,*]
UN sensory block formation time, minutes, mean±SD /median (interquartile range)	9.05±6.04 / 5 (5–15)	12.86±4.35 / 15 (10–15)	**0.009**[a,*]
MCN sensory block formation time, minutes, mean±SD /median (interquartile range)	8.41±3.89 / 10 (5–10)	12.86±6.03 / 10 (10–15)	**0.005**[a,*]
MN motor block formation time, minutes, mean±SD /median (interquartile range)	12.27±4.55 / 10 (10–15)	19.50±5.10 / 20 (15–20)	**0.001**[a,*]
RN motor block formation time, minutes, mean±SD /median (interquartile range)	12.86±4.62 / 10 (10–15)	18.25±6.12 / 20 (15–23.75)	**0.004**[a,*]
UN motor block formation time, minutes, mean±SD /median (interquartile range)	12.86±6.99 / 10 (10–15)	15.25±4.12 / 15 (15–20)	**0.030**[a,*]
MCN motor block formation time, minutes, mean±SD /median (interquartile range)	11.36±5.38 / 10 (10–11.25)	16.43±5.73 / 15 (12.5–20)	**0.001**[a,*]

a: Mann-Whitney U test; *: Statistically significant difference between groups; SD: Standard deviation; MN: Median nerve; RN: Radial nerve; UN: Ulnar nerve; MCN: Musculocutaneous nerve; C: Costoclavicular; L: Lateral sagittal.

Patient satisfaction was better in Group C (p=0.016, p<0.05), while surgeon satisfaction was high and similar in both groups. There was no statistically significant difference between the duration of block performance, VRS scores, number of needle attempts, and needle directions in both groups. In Group C, paresthesia was observed in four of 22 patients, and vascular puncture was observed in three, whereas in Group L, paresthesia was observed in one of 21 patients, and vascular puncture was observed in four (Table 2). Horner's syndrome and diaphragmatic paralysis were not observed in either group.

As shown in Table 3, sensory and motor block formation times of each nerve (MN: median nerve, RN: radial nerve, UN: ulnar nerve, MCN: musculocutaneous nerve) were shorter in Group C than in Group L ($p<0.05$).

No complaints were reported by the patients at the postoperative 24th hour and seventh day.

Discussion

In this single-blind, randomized study, we compared two ultrasound-guided block methods performed in the infraclavicular region of the brachial plexus in terms of sufficient block formation times for surgery. We observed that the costoclavicular approach provides faster surgical preparation than the lateral sagittal infraclavicular approach.

Leurcharusmee et al.[10] published one of the first studies comparing the lateral sagittal infraclavicular approach and the costoclavicular approach. They used 35 ml of LA containing 1% lidocaine and 0.25% bupivacaine in the study. They found both methods to be safe and effective for surgical anesthesia. Using a sensorimotor scale with a total of 16 points to determine the duration of surgical block, they found no significant difference between the two groups in terms of sufficient block formation time for surgery. They suggested that this result might be due to the 35 ml volume used, which compensates for the advantage of the compact area provided by the costoclavicular approach. They recommended clarifying this with low-volume comparisons.

Songthamwat et al.[11] used 25 ml of 0.5% ropivacaine in their study, arguing that when a pure and long-acting agent is used, surgical block will occur faster with the costoclavicular approach. Their findings indicated that the costoclavicular approach was faster in terms of complete sensory and motor block formation. They proposed that the rapid detection of the costoclavicular approach might be due to multifactorial reasons, such as differences in dose, volume, and type of LA used. Additionally, they noted that the 1% lidocaine used in the LA mixture in the Leurcharusmee et al.[10] study might have masked the potential advantages of the costoclavicular approach.[11]

Dost et al.[12] found the costoclavicular approach to be faster in terms of complete sensory block formation in their study using 20 ml of 0.5% bupivacaine. However, unlike the other two studies,[10,11] they did not observe a significant difference between the groups in terms of motor block formation.[12]

In our study, it was shown that the costoclavicular approach provides surgical anesthesia significantly faster than the lateral sagittal infraclavicular approach using 20 ml of an equal mixture of long- and short-acting LA. Based on these findings, we believe that the volume of LA used plays an important role in the observed differences. Although the LA mixture in our study is the same as that used by Leurcharusmee et al.,[10] it was demonstrated that the costoclavicular approach provides faster full sensory and motor block despite using a smaller volume.

The use of high volumes of LA demonstrates that the costoclavicular approach masks the advantage of the compact area where the cords are close to each other and prevents a significant difference between approaches. This also supports the idea that a successful block can be achieved with a low volume in the costoclavicular approach.[8–11]

Another issue to consider is the variability in measurement systems used to calculate sufficient block formation times for surgery across these studies. We employed the scale used by Songthamwat et al.,[11] but the lack of a standardized method to determine sufficient block times for surgery may affect the results.

In the literature, there are few studies comparing the lateral sagittal infraclavicular approach and the costoclavicular approach, as the costoclavicular approach is a newly defined method. These studies have been conducted with varying volumes and concentrations of LA: 35 ml of a mixture containing 1% lidocaine and 0.25% bupivacaine,[10] 25 ml of 0.5% ropivacaine,[11] 20 ml of 0.5% bupivacaine,[12] and 25 ml of a mixture containing 1% lidocaine and 0.2% bupivacaine.[13]

In a sonoanatomy study of the technique and block dynamics, Li et al.[5] reported that the costoclavicular approach is efficient with a small volume (20 ml). Karmakar et al.[9] stated that the costoclavicular ap-

proach is effective with 20 ml of 0.5% ropivacaine in a defining study of the method. In a minimum effective volume (MEV) study conducted using the ultrasound-guided costoclavicular approach, Sotthisopha et al.[14] showed that the MEV90 (the minimum effective volume in 90% of patients) of lidocaine 1.5% with epinephrine 5 µg/mL is 34 ml, while Wong et al.[15] reported that the MEV90 of 0.5% ropivacaine required to produce surgical anesthesia with an ultrasound-guided costoclavicular approach is 20.9 ml. Additionally, Kewlani et al.[16] reported that the ED50 (the median effective dose in 50% of patients) is 13.5 ml, and ED95 is 18.9 ml of 0.5% ropivacaine for surgical anesthesia in the ultrasound-guided costoclavicular approach.

The combination of short-acting and long-acting LAs is frequently used in clinical practice to accelerate the onset of block while maintaining its duration. With such combinations, a faster onset of block is achieved than with a long-acting agent alone. Considering previous studies [10–17] and our clinical experience, we used 20 ml of an LA mixture containing 1% lidocaine and 0.25% bupivacaine in our study. Our aim was to provide an effective and faster onset surgical block while avoiding the systemic effects of high doses and volumes of LA.

In our study, we found that the costoclavicular approach was faster than the lateral sagittal infraclavicular approach in terms of readiness for surgery and complete sensory and motor block formation times.

Dost et al.[12] found that patient and surgeon satisfaction were high and similar in both groups in their study comparing the lateral sagittal infraclavicular approach and the costoclavicular approach in terms of block dynamics, as well as patient and surgeon satisfaction. In our study, patient satisfaction was found to be significantly higher in the costoclavicular approach compared to the lateral sagittal infraclavicular approach, while surgeon satisfaction was high and similar in both methods. In Dost et al.'s [12] study, sedation was applied during the block procedure, whereas in our study, sedation was not applied. This leads us to think that reduced needle visibility and greater difficulty in maneuvering during the lateral sagittal infraclavicular approach may cause more discomfort to patients.

In our study, paresthesia was observed in 4 patients in Group C, while it was observed in only 1 patient in Group L. The lack of statistically significant results can be attributed to the fact that the sample size was not calculated based on side effects. This result is similar to the findings of Leurcharusmee et al.'s [10] study. While the rate of vascular puncture was found to be significantly higher in Group L in Leurcharusmee et al.'s[10] study, we did not find a significant difference between the two groups in terms of vascular puncture. We associated this with the fact that the block procedures in our study were performed exclusively by highly experienced researchers.

Leurcharusmee et al.[10] reported that Horner's syndrome was observed in two patients in Group C, and diaphragmatic paralysis was observed in 9% of the patients in both block groups. Similarly, Songthamwat et al.[11] reported that Horner's syndrome was not observed in Group L but was seen in two of 20 patients in Group C. In our study, we attributed the absence of these complications to the smaller volume of LA used.

In line with the studies by Songthamwat et al.[11] and Dost et al.,[12] we did not encounter any complications related to the block during the postoperative 24th hour and seventh-day follow-up of the patients.

Limitations

The limitations of our study include the inability to establish specific criteria for determining readiness for surgery, relying instead on waiting for surgery to begin. Additionally, all patients were monitored only during the first 24 hours and at the first-week follow-up visit, which may be insufficient to detect potential long-term neurological dysfunction.

Conclusion

In conclusion, the costoclavicular approach, a new method in brachial plexus block in the infraclavicular region, provides faster surgical preparation than the most commonly used lateral sagittal infraclavicular approach. In the costoclavicular approach, the brachial plexus is more superficial compared to the lateral sagittal infraclavicular approach, which improves needle visibility and facilitates probe and needle manipulation. These factors reduce the anesthesiologist's strain and allow the procedure to be performed more comfortably, enhancing patient comfort and satisfaction.

Considering these advantages, further studies are needed to explore the potential benefits of the costoclavicular approach in specific patient groups, such as obese and pediatric patients.

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