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Original Article

Comparison of different arm positions and angles with ultrasound for infraclavicular block

Orhan Binici, Evren Buyukfirat

Harran Uniıversity Faculty of Medicine Department of Anesthesiology and Reanimation, Sanliurfa, Turkey

Abstract

Aim: Nerve blocks are used more frequently with the introduction of ultrasound. Anesthesiologists prefer the infraclavicular nerve block because of its ease of administration and lack of complications. During the infraclavicular block, it is unclear to what angle the arm is to be given and in what position it is to be made. In our study, we aimed to measure and compare the distances of the axillary artery from the skin by giving different angles to the arm in the presence of ultrasound.

Material and Methods: A total of 30 volunteers between the ages of 20-65 included in the study. While the forearm was in the anatomic position (Group A), the arm abducted from the shoulder at 0.45 and 90 degrees. At each angle, the distances of the different points of the axillary artery (posterior, anterior and central) to the skin compared. The same measurements repeated by flexing the forearm at 90 degrees from the elbow (Group B).

Results: In Group A and Group B, the distances of all points of the axillary artery to the skin found to be inversely proportional to the abduction angle. In all measurements, the shortest skin distance found at 90 degrees of abduction angle ($p< 0.05$). There was no statistically significant difference between Group A and Group B in the same angles

Conclusion: When performing ultrasound guided infraclavicular block, anesthesiologists should prefer the easiest method. We found that the distance of the axillary artery to the skin and needle entry decreased as the abduction angle of the arm increased in three different measurements. As a result of our study, we believe that the best angle for the infraclavicular block can be done by giving 90 degree abduction angle to the arm.

Keywords: Nerve block; ultrasonography; brachial plexus.

INTRODUCTION

Anesthesiologists more prefer peripheral nerve blocks because of providing adequate analgesia, depth of anesthesia and protecting against complications of general anesthesia. With the introduction of ultrasound and increased image quality by the time, the application of peripheral blocks has become easier and the incidence of complications has decreased. During these ultrasound-guided blocks, the patient's consciousness is clear and the airway reflexes are protected. General anesthesia risks such as difficult intubation, postoperative nausea and vomiting, aspiration of gastric content are also reduced (1-3). The infraclavicular nerve block is used in the lower region surgical operations of the middle humerus by giving an ultrasound-guided local anesthetic around the axillary artery. Infraclavicular block is preferred in forearm, wrist and hand surgeries because it can be easily performed with ultrasound and provides good anesthesia quality (4,5). While the ultrasound-guided infraclavicular block is applied, different angles can be given to the arm and forearm to increase visibility, facilitate needle manipulation and apply block faster. There is still no consensus about the recommended abduction angle and the position of the forearm for this block. The main aim of this study is to determine the optimal arm abduction angle and forearm position when applying the infraclavicular block with ultrasound guidance.

MATERIAL and METHODS

After the approval of the Ethics Committee, a total of 30 volunteers aged between 20-65 years and with body mass index (BMI) less than 30 included in our study. The subjects who were traumatized from the upper thoracic region, BMI bigger than 30, had limited shoulder abduction and who could not be able to give a position to the forearm were excluded from the study. First measurements of volunteers (Group A) were done as follows, while the forearm was in the anatomic position, the arm abducted

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Corresponding Author: Evren Buyukfirat, Harran University Faculty of Medicine Department of Anesthesiology and Reanimation, Sanliurfa, Turkey, **E-mail:** evrenbf@gmail.com

with 0, 45 and 90 degree angles from the shoulder. The distance of three points of the axillary artery (posterior, anterior and central) to the skin was measured from the edge of coracoid process and compared at each 0, 45, 90 degrees of abduction angles (Figure 1). After the linear probe of the ultrasound placed in the coracoid region and the image of the axillary artery on the ultrasound screen brought closer to the medial edge, all measurements performed. The same measurements repeated to the same volunteers by flexing the forearm at 90 degrees from the elbow (Group B) (Figure 2). Measurements made by the same person using a single ultrasound (Esaote MyLab 30 Gold, lineerprob, 10-18 MHz, Florance, Italy). The data obtained from the measurements compared between the groups and within the groups.

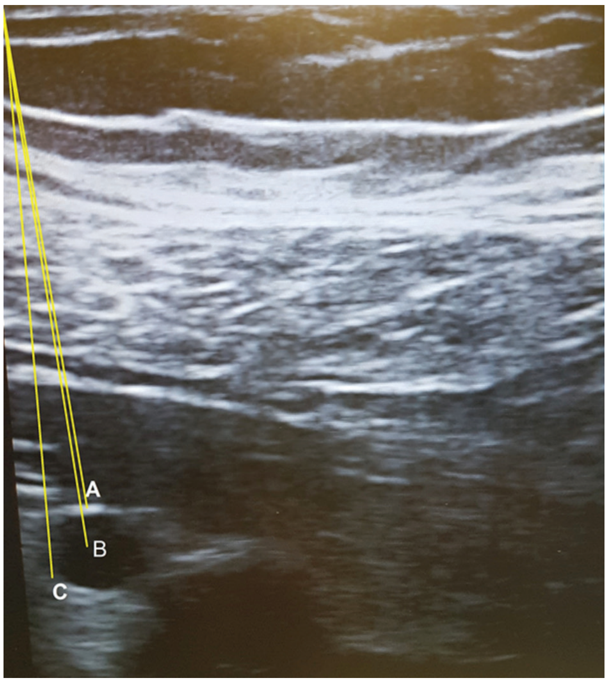

Figure 1. Ultrasound image of the distances of axillary artery reference points to the skin Reference points of axillary artery A; anterior B; central C; posterior

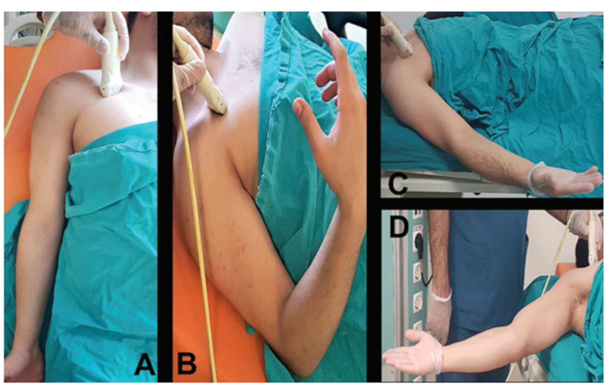

Figure 2. Positions of the arm and angles of abduction given to the arm A; Forearm is in the anatomic position (Group A), arm is abducted with 0 degree angle from the shoulder. **B.** 90 degree flexed forearm from the elbow (Group B), arm is abducted with 0 degree angle from the shoulder, **C.** Forearm is in the anatomic position (GroupA), arm is abducted with 45 degree angle from the shoulder, **D.** Forearm is in the anatomic position (Group A), arm is abducted with 90 degree angle from the shoulder

Statistical analysis

SPSS (Statistical Package for the Social Sciences) 22.0 was performed for statistical analyses. We calculated the sample size according to the results of the first ten subjects in the study. From these differences and assuming a two-tailed α value of 0.05 (sensitivity 95%) and a β value of 0.20 (study power: 80%, effect size: 0.48), we determined that at least 28 subjects were required for our study (G Power 3 power analysis program) (6). We decided to enroll at least 30 subjects in each group. Repeated Measures ANNOVA used for the repeated measures of angle data. Bonferroni test applied for pairwise comparison. P value of less than 0,05 was considered statistically significant.

RESULTS

In Group A measurements, it is determined that the distances of the anterior, posterior and central points of the axillary artery to the skin decreased inversely with the abduction angle. The shortest skin distance determined at 90 degrees for all points. In Group A, there was a statistically significant difference in intragroup comparisons ($p < 0.05$) except anterior point measurement between 45 and 90 degrees of abduction angle (Table 1).

Table 1.Comparison of distances of axillary artery reference points to skin at different angles

	Mean±Std. Deviation	N	P		P
A0a	30.11±5.64	30	0.000*	A0a - A45a	0.000*
A45a	28.81±5.29	30		A45a - A90a	0.002*
A90a	27.50±5.63	30		A90a - A0a	0.000*
A0b	28.75±5.08	30	0.000*	A0b - A45b	0.034*
A45b	27.88±5.33	30		A45b - A90b	0.010*
A90b	26.73±5.38	30		A90b - A0b	0.000*
A0c	26.61±5.59	30	0.002*	A0c - A45c	0.027*
A45c	25.51±5.38	30		A45c - A90c	0.067
A90c	24.67±5.85	30		A90c - A0c	0.007*
B0a	30.48±4.10	30	0.000*	B0a - B45a	0.000*
B45a	28.71±4.90	30		B45a - B90a	0.004*
B90a	27.87±4.88	30		B90a - B0a	0.000*
B0b	29.31±4.22	30	0.000*	B0b - B45b	0.001*
B45b	27.73±4.63	30		B45b - B90b	0.005*
B90b	26.90±4.47	30		B90b - B0b	0.000*
B0c	26.68±4.67	30	0.000*	B0c - B45c	0.000*
B45c	25.37±5.22	30		B45c - B90c	0.008*
B90c	24.36±4.49	30		B90c - B90c	0.000*

A: Group A (Forearm at anatomic position) B: Group B (Forearm at 90 degree flexion)
Reference points of axillary artery a;anterior b; central c; posterior
Results are presented as the mean ± standard deviation (mm)
*p < 0.05 was considered statistically significant

B group measurements performed by flexing the forearm 90 degrees from the elbow. In Group B, the distances of all points to the skin were decreased inversely with the angle. The skin distance of all points of the axillary artery was found to be at least at 90 degrees. In Group B, there was a statistically significant difference in intragroup comparisons ($p < 0.05$) (Table 1). There was no significant difference between the A and B groups in the measurements of the axillary artery points at the same angles (Table 2).

Table 2. Comparison of distances of axillary artery reference points to skin between groups

	Mean± Std. Deviation	N	P
A0a	30.11±5.64	30	0.499
B0a	30.48±4.10	30	
A0b	28.75±5.08	30	0.228
B0b	29.31±4.22	30	
A0c	26.61±5.59	30	0.893
B0c	26.68±4.67	30	
A45a	28.81±5.29	30	0.796
B45a	28.71±4.90	30	
A45b	27.88±5.33	30	0.745
B45b	27.88±5.33	30	
A45c	25.51±5.38	30	0.747
B45c	25.37±5.22	30	
A90a	27.50±5.63	30	0.470
B90a	27.87±4.88	30	
A90b	26.73±5.38	30	0.709
B90b	26.90±4.47	30	
A90c	24.67±5.85	30	0.537
B90c	24.36±4.49	30	

A: Group A (Forearm at anatomic position) B: Group B (Forearm at 90 degree flexion)
Reference points of axillary artery a; anterior b; central c; posterior
Results are presented as the mean ± standard deviation(mm)
$p < 0.05$ was considered statistically significant

DISCUSSION

Infraclavicular nerve block is frequently preferred for surgical procedures under the distal humerus. It is easily applied in the presence of ultrasound and it has always been popular since it has fewer complications such as pneumothorax, phrenic nerve block and stellate ganglion block (7,8). To move away from the pleura when this block is applied, the site of entry is usually chosen as the coracoid region. When we made our measurements with ultrasound probe, we took images from this region. In the application of ultrasound-guided infraclavicular block, practitioners make different angles to make the image clearer, to reach the desired points around the axillary artery and to facilitate manipulation of the needle. There is still no consensus on which angle should be given to the arm and forearm during this block. In our study, we aimed to measure and compare the distance of certain points of the axillary artery from the skin by giving different angles to the arm and forearm.

The axillary artery is a basic landmark for ultrasound guided infraclavicular block and it can be easily identified by ultrasonography (9). We used the axillary artery as a surrogate marker because the brachial plexus at the infraclavicular level is difficult to locate.

Sauter et al. (10) reported that the posterior and medial cords are slightly deeper than the axillary artery and the lateral cord presents a great variability in its depth. Likewise, Cornish and Nowitz (11) used magnetic resonance imaging with four parasagittal sections medial to the coracoid process in order to measure the plexus depth. Ruiz et al. (12) studied with ultrasonography in an oblique sagittal plane which makes the comparison of both studies difficult. As a result of the data obtained in two studies, the depth of the plexus was similar to each other. Finally, they reported that; the depth of the plexus is reduced with the abduction of the arm. Ruíz et al. reported that the distance of brachial plexus to skin decreased from 0 to 90 degrees in which they measured via ultrasound from the infraclavicular region by giving 0, 45 and 90 degrees abduction to the arm (12).

In another study; the plexus was found closer to the skin by abducting the arm. Abduction is also recommended because of reducing the risk of pneumothorax and artery puncture (13). In another study with ultrasound-guided infraclavicular catheter insertion, it was stated that abduction of arm improved the image quality (14). It was found that the best angle closest to the skin and away from the pleura was 90 degree angle in the measurements performed at 4 different angles from the infraclavicular region (15).

In our study, we tried to measure the distance of the axillary artery from the skin to 3 different reference points. When the forearm was in the anatomic position (Group A), in comparison with 0, 45 and 90 degrees in the arm abduction, the distance to the skin decreased as the angle increased 0 to 90 degree. The reduction in the 3 reference points of the axillary artery was significant. In other words, in the measurements made for three angles, the axillary artery was found to be at the closest distance to the skin in 90 degree angle ($p < 0.05$) (Table 1) (Figure 2D). In our study, when the forearm was brought to the flexion at an angle of 90 degrees from the elbow (Group B) and the abduction was performed to the arm at 0.45 and 90 degrees from the shoulder area, the distance of the reference points to the skin was decreased as the angle increased ($p < 0.05$) (Table 1).

During ultrasound guided infraclavicular block, a local anesthetic is injected around the axillary artery. To understand how the axillary artery has changed during the abduction, we have taken our measurements by taking three different points. In accordance with the literature, our study showed that the axillary artery approached to the region where the needle penetrated and to the skin with the abduction angle. Researchers found that brachial plexus measurements with ultrasound can be varied (12). In our study, we performed all our measurements by basing the ultrasound probe on the coracoid process and the axillary artery on the medial side. In our study, we found that the flexion of the forearm at 90 degrees did not change the distances of the reference points of the axillary artery to the skin. As a result; we understand that the flexion of the forearm does not bring the axillary artery closer to the skin and that the position given to the forearm does not affect the infraclavicular block.

The main limitations of this study are that we didn't measure the coracoid-axillary artery distance, distance from the pleura to the axillary artery and distance between the supposed puncture sites of the skin to the pleura.

CONCLUSION

When performing ultrasound guided infraclavicular block, anesthesiologists should prefer the easiest method. In the measurements, we made in three different angles, as the abduction angle of the arm increased the distance of the axillary artery to the skin decreased. The flexion to the forearm did not affect the distance of the axillary artery to the skin. As a result, we can say that the ultrasound-guided infraclavicular block is best done by giving an abduction angle of 90 degrees to the arm from the coracoid process.

Competing interests: The authors declare that they have no competing interest.
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Orhan Binici ORCID: 0000-0002-3158-8252
Evren Buyukfirat ORCID: 0000-0002-6396-0426

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