Original Article

Sonographic assessment of predictors of depth of the corner pocket for ultrasound-guided supraclavicular brachial plexus block

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Abstract

Background and Aims: There is wide variation in depth of brachial plexus in patient population at supraclavicular region. We plan to find the depth of the corner pocket and correlate it with age, weight, height and body mass index (BMI).
Material and Methods: After approval from Ethics Committee, right-sided supraclavicular region of volunteers was scanned. Once an optimal image, which included subclavian artery, pleura, first rib and nerve bundles, was obtained, the "corner pocket" was kept in the middle of the screen and the image was frozen. Depth of the corner pocket from the skin was measured. Thereafter longest distance (LD) approximating needle trajectory was calculated. The Pearson correlation was used to calculate the relation between these two distances and various predictors such as weight, height, and BMI.
Results: Mean shortest distance that is, vertical distance from skin to corner pocket for all volunteers was found to be 1.7 ± 0.8 cm and the mean LD that is, distance traveled by needle entering 1 cm from the edge of foot process to the corner pocket in an in-plane approach was 3.7 ± 0.2 cm. We did not find any significant correlation between age, height versus measured distances. However, significant correlation (0.11) was found between weights, BMI versus two lengths.
Conclusion: Prescanning of supraclavicular region for estimating depth of corner pocket should be done before choosing an appropriate size needle. Furthermore, the needle should not be advanced more than the predicted corner pocket depth.

Key words: Body mass index, brachial plexus, needle

Introduction

Ultrasound guided (USG) supraclavicular brachial plexus block has emerged as a useful tool for nerve localization and thus increasing the success rate along with decreased risk of complications.[1] It allows real-time visualization of the anatomical structures like nerve plexus, pleura and vessels along with the needle. It also shows real-time spread of local anesthetic drug at the site of interest of nerve/plexus block.[1,2] Recently, for the supraclavicular brachial plexus block, the deposition of drug at the corner pocket has been well described and is practiced by most practitioners.[1-4] The corner pocket lies between the first rib inferiorly, the subclavian artery medially and the brachial plexus superiorly.[2,4,5] There have been wide variations in depth of brachial plexus in patient population at supraclavicular region.[6,7] This can vary with age, gender, body habitus and ethnicity.

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Access this article online	
Quick Response Code:	Website: www.joacp.org
	DOI: 10.4103/0970-9185.175665

We planned to elucidate the depth of the corner pocket in supraclavicular brachial plexus block and correlate with basic demographic profile such as age, weight, height and body mass index (BMI).

Material and Methods

The study was conducted after approvals from Ethics Committee of our institution vide reference no. IEC/NP-353/2013 dated August 8, 2013 conducted from 10 to 17 August 2013. Participants were volunteers in the age group of 18-60 years among the staff members. The volunteers were explained about the study and were asked to give written informed consent for participation in the study. The volunteers having any external deformity or previous surgical intervention of the supraclavicular region were excluded.

All evaluations were done by a single investigator with experience of over 50 USG supraclavicular blocks. This investigator performed scan of the right sided supraclavicular region with high frequency (10-12 Hz) linear array transducer of Kontron Imagic ultrasonography instrument (Kontron®, France). Subjects were laid supine without any head ring or head rest and with their heads turned approximately 45° towards the contralateral side. They were scanned for their brachial plexus in their supraclavicular fossa lateral to the clavicular head of the sternocleidomastoid muscle in a coronal oblique view. The depth on the ultrasound machine was set at 4 cm in all subjects. A midline was drawn perpendicular on the screen of the ultrasound. Once an optimal image which included subclavian artery, pleura, first rib and nerve bundles was obtained, the "corner pocket" was kept in the middle of the screen and the image was frozen.

Measurements

Once the image was frozen, two distances were measured:

- Depth of the corner pocket from the skin shortest distance (SD): One end of the caliper is placed on the skin in the midline (in the middle of the screen) and other at the corner pocket.
- Distance from the middle of the footprint to the lateral margin of the image was taken as a base. The equation derived was base = 1/2 footprint as given in figure [Figure 1]. This distance was measured using a caliper. Assuming that in "in-plane" approach, the needle is inserted for the block will enter 10 mm lateral to the probe, the distance of 10 mm was added to the base. Herein, the distance "base + 10" and "SD" form the base and height of an right angle triangle respectively, the hypotenuse longest distance (LD) can be calculated [Figure 1]. This distance can be assumed to be the SD travelled by the needle to the corner pocket with the needle in an "in-plane" approach.

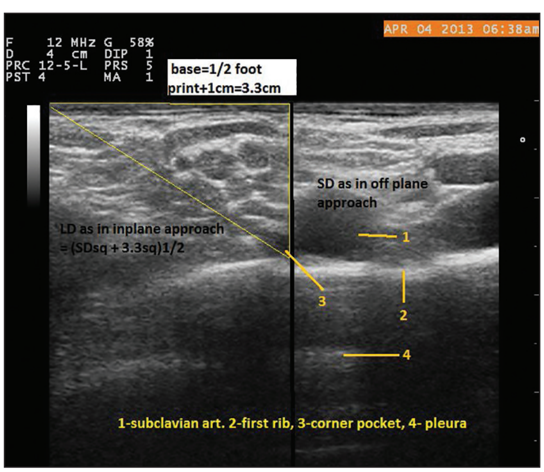

Figure 1: Sonoanatomy of supraclavicular fossa for corner pocket depth estimation (1. Subclavian art, 2. First rib, 3. Corner pocket, 4. Pleura)

For all patients, base will be constant, and SD and LD were noted.

Statistical analysis

This was a cross-sectional study to predict the predictors of depth of the corner pocket in Indian population for supraclavicular brachial plexus block. The sample size of 100 was calculated based on pilot study as there was no previous data related to depth of the corner pocket and its relation to any predictors. The Pearson correlation was used to calculate the strength and significance of the relation between longest length to corner pocket LD and SD to corner pocket SD and the various demographic predictors such as age, weight, height, and BMI.

Results

The 103 volunteers were chosen, but only 100 were finally used for analysis as 3 volunteers did not met our inclusion criteria. Of the 100 volunteers, 68 were male and rests were females. The mean age, weight and height of the subject population were 34 ± 12 years, 63.5 ± 12.7 kg and 1.6 ± 0.8 m respectively. The overall mean BMI was 22.7 ± 4.6 Kg/m^2 (mean BMI for male was 21.9 ± 4.2 kg/m^2 and for female was 24.3 kg/m^2 ± 5.0 kg/m^2).

Mean SD that is, vertical distance from skin to corner pocket for all volunteers was found to be 1.7 ± 0.8 cm and the mean LD that is, distance from site of needle insertion to corner pocket was 3.7 ± 0.2 cm.

Strength of correlation was calculated between these two distances to various demographic parameters [Table 1]. We did not found any significant correlation between these distances and the age or the height. There was a strong (coefficient 0.73) and a significant ($P < 0.001$) correlation between weight and LD. Similarly, weight was found to be strongly (correlation coefficient 0.7) and significantly ($P < 0.001$) correlated with SD. Further, strength of association was calculated between BMI and both distances. A strong and significant correlation was found between BMI and SD (correlation coefficient 0.78, $P < 0.001$) as well as with LD (correlation coefficient 0.72, $P < 0.001$) [Figures 2-5].

Using regression analysis, we arrived at the equation for predicting the depth of the corner pocket based on weight and BMI. In "in-plane" approach LD the equation is LD (in cm) $=0.028 \times$ BMI $+ 3.037$. In "out of plane" approach the

Table 1: The correlations between the study variables and measured distances for corner pocket depth

Parameters	Mean ± SD	SD 1.7 ± 0.8 (cm)		LD 3.7 ± 0.2 (cm)	
		Correlation coefficient	*P*	Correlation coefficient	*P*
Age (year)	33.7±12.3	0.1967	0.050	0.1775	0.077
Height (m)	1.6±0.8	−0.0158	0.876	−0.0346	0.733
Weight (kg)	63.5±12.7	0.7339	<0.001	0.6702	<0.001
BMI (kg/m²)	22.7±4.6	0.7814	<0.001	0.7245	<0.001

BMI = Body mass index, SD = Shortest distance, LD = Longest distance

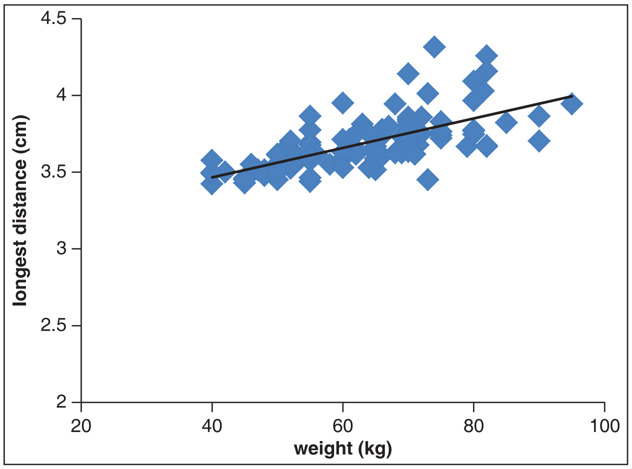

Figure 2: Distribution of longest distance (cm) with weight (kg)

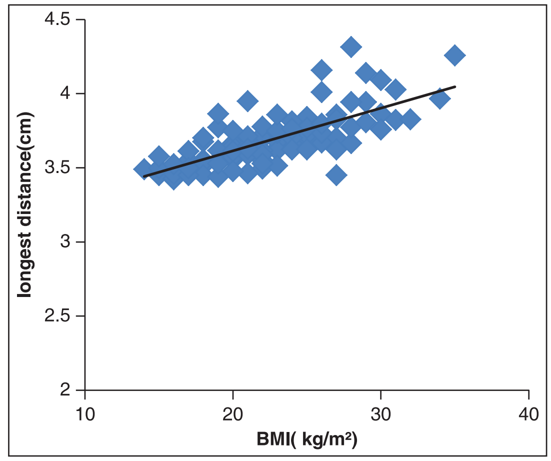

Figure 3: Distribution of longest distance (cm) with body mass index (kg/m²)

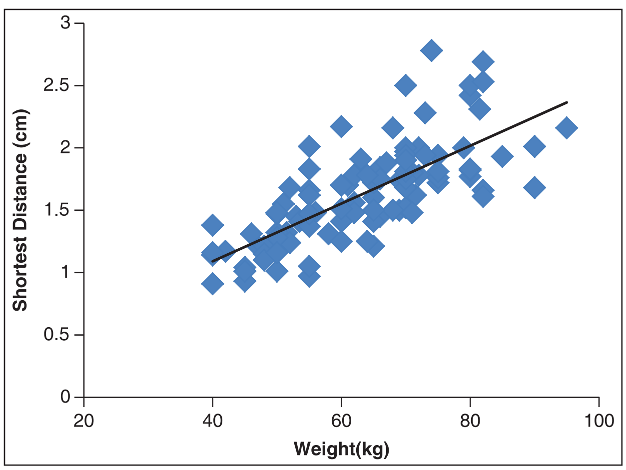

Figure 4: Distribution of shortest distance (cm) with weight (kg)

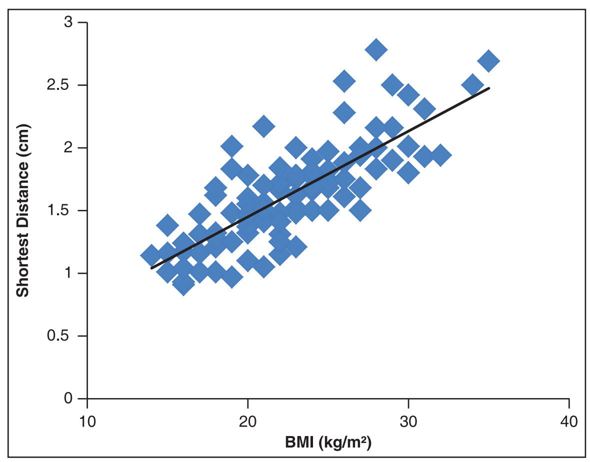

Figure 5: Distribution of shortest distance (cm) with body mass index (kg/m²)

equation is SD (in cm) $=0.068 \times \text{BMI} + 0.085$. This equation can be used determine the depth of the corner pocket in the respective approaches.

Discussion

We observed from our study that weight and BMI are correlated with the depth of the corner pocket for USG brachial plexus block. On the other hand, there is no correlation of age and height of the patient with the depth of the corner pocket for USG brachial plexus block.

Ultrasound guided supraclavicular brachial plexus block is mainstay of upper limb surgery. In supraclavicular block, the probe is placed in the supraclavicular fossa in a coronal oblique plane. The pulsating, hypoechoic subclavian artery is identified, lying above the hyperechoic first rib. Once the artery, rib, pleura and plexus are simultaneously in view, the aim is to guide the needle towards the "corner pocket" between the first rib inferiorly, the supraclavicular artery medially and the nerves superiorly.[8] In one of the needle approaches, which involve an "in-plane" technique, the needle tip can be better visualized. In this, the needle is inserted in a lateral-to-medial direction in the long axis of the transducer. While this method benefits from a generally unobstructed route straight to the "corner pocket," the major disadvantage is that the needle trajectory is toward the pleura.

We estimated the lateral-to-medial needle trajectory distance for "in-plane" approach. Though the literature quotes both medial-to-lateral or lateral-to-medial needle trajectory for "in-plane" approach, but the success rate has been reported similar with either of the technique.[9] However, our study estimation of "corner pocket depth" and use of ultrasound to localize pleura will help to avoid any accidental pleural puncture. The medial-to-lateral direction may be limited as it requires negotiation of subclavian artery to reach most dependent components of the brachial plexus, usually the inferior trunk.[10] This may be more challenging in view of avoiding vascular puncture and failure of the block may occur if the inferior trunk supplying territory via ulnar nerve is spared.[9]

A volunteer study conducted by Perlas *et al*. showed that in supraclavicular block, the mean skin-to-nerve distance was 0.9 ± 0.3 cm when measured by ultrasound. On the other hand, Brown *et al*. measured the distance from skin to brachial plexus in supraclavicular region by magnetic resonance imaging and reported the distance to vary from 1.8-3.0 cm in female to 3.0-4.5 cm in males.[10] This showed that there is wide variation in the depth of brachial plexus in the supraclavicular region in the normal population. Also, these studies have been done in the western population and may not be applicable to Indian population because of the variation in basic physique. The results in our study have shown that SD and LD have no correlation with age and height. There is a significant correlation ($P < 0.0001$) between weight and BMI versus both the distances (SD and LD). This may be particularly important in the selection of needle length in low BMI patients as selection of longer needle in low BMI patients can lead to complications like pleura and vascular puncture. Our study confirmed the findings that there is wide variation in distance to the corner pocket both in "in-plane" and out of the plane approach to USG supraclavicular block. The equation was derived which can be used to determine the rough estimate of the depth of the corner pocket in both the approaches. We advise that appropriate size needle for the procedure can be calculated using these equations at least in Indian population.

The strength of the study lies in the fact that our results would be applicable to Indian population. Since the sample volunteers did not have high BMI it may not be applicable on obese and needs further validation.

In conclusion, prescanning of supraclavicular region for estimating the depth of corner pocket should be done before choosing an appropriate size needle and the needle should not be advanced more than the predicted corner pocket depth.

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How to cite this article: Yadav N, Ayub A, Garg R, Nanda S, Gupta B, Sawhney C. Sonographic assessment of predictors of depth of the corner pocket for ultrasound-guided supraclavicular brachial plexus block. J Anaesthesiol Clin Pharmacol 2016;32:25-8.

Source of Support: Nil, **Conflicts of Interest:** None declared.